
Physics

For Rwandan Schools

Senior 1

Teacher's Guide

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Introduction

1. Basic Information

1.1 Organization of the book

This teacher's guide is organised into **two** main parts. **Part 1** is the general introduction section with details pedagogical issues. **Part 2** is the main topics area. It gives the details of the expected learning **units** as organised in the learner's book. The main elements of Part 2 are:

- **Topic Area:** Detailing the various **Sub-topic Areas** and the units covered under the topic area.
 - **Unit heading:** This is accompanied by some text in the learner's book to motivate the learners. Also, the total number of lessons per unit is given.
 - **Key Unit Competence:** This is the competence which will be achieved once students have met all the learning objectives in the unit.
 - Outline of **main sections** in the unit: Is a quick summary of the sub-topics covered under the unit.
 - **Learning Objectives:** The content in this area is broken down into three categories of learning objectives, That is; knowledge and understanding; skills; attitudes and values.
- **Knowledge and understanding:** As in the existing curriculum, knowledge and understanding is very important.
 - **Skills:** It is through the skills that students apply their learning and engage in higher order thinking. These skills relate to the upper levels of Bloom's taxonomy and they lead to deep rather than surface learning.
 - **Attitudes and values:** Truly learning requires appropriate attitudes and values that relate to the unit.
- **Links to other subjects:** It is important for learners to gain an understanding of the interconnections between different subjects so that learning in each subject is reinforced across the curriculum. This platform does exactly that. It prepares the teacher to pass this information to the learners so that they are aware!
 - **Assessment Criteria:** This is meant to evaluate whether learners have succeeded in achieving the Key Unit Competence(s) intended.

This section will help the teacher in assessing whether the unit objectives have been met.

- **Background information:** This is the introduction part of the unit. It aims at giving insights to the teacher on the subject matter.
- **Additional information for the teacher:** This section gives more information than what the syllabus recommends for purposes of preparing the teacher to answer tough questions from learners.
- **Learning Activities:** These are given per lesson and have the following sub-sections:
 - Lesson titles
 - Specific objectives of the lesson
 - Materials and learning resources
 - Teaching methodology
 - Suggested teaching/learning approaches
 - Generic competences covered
 - Cross-cutting issues covered
 - Special needs and multi-ability
 - Formative assessment
 - Extended exercises/activities for fast learners and remedial (reinforcement) exercises/activities for slow learners.
 - Answers to self-evaluation exercises

These are repeated across all lessons until the end of the unit followed by the answers or tips to the test questions at the end of every unit.

1.2 The Structure of the syllabus

Physics is taught in both O-level and A-level, but S1, S2 and S3 must do physics. However, in A-level, physics is optional. At every grade, the syllabus is structured in **Topic Areas**, and then further broken down into **Units**. The units have the following elements:

- Each unit is aligned with the Number of Lessons.
- Each unit has a key unit competency whose achievement is pursued by all teaching and learning activities undertaken by both the teacher and the learners.
- Each unit key competency is broken into three types of learning objectives as follows:
 - *Type I:* Learning objectives relating to knowledge and Understanding. These are associated with Lower Order Thinking Skills or **LOTS**.
 - *Type II and Type III:* These Learning objectives relate to acquisition of skills, Attitudes and values. They are associated with Higher Order Thinking Skills or **HOTS**. They are actually considered to be the ones targeted by the present reviewed syllabus.
- Each Unit has a **Content** area which indicates the scope of coverage of what a teacher should

teach and learner should learn in line with stated learning objectives.

- Each unit suggests learning activities that are expected to engage learners in an interactive learning process as much as possible (learner-centered and participatory approach).
- Finally, each unit is linked to other subjects, its assessment criteria and the materials (or resources) that are expected to be used in teaching and learning process.
- In all, the syllabus of Physics for O-level has got eight topics area namely:
 - Physical quantities
 - Mechanics
 - Heat
 - Thermodynamics
 - Electricity
 - Light
 - Electronics
 - Environmental physics

As for units, there are a total of **13** units in senior one (S1).

1.3 Background Information on new curriculum

The goal to develop a competence-based society, the globalization process, and particularly the growth of the world market and competition at the global level, as well as a shift from knowledge-based to competence-based curriculum necessitated a comprehensive review of the national curriculum to address the

required skills in the Rwandan education system.

It is against this background that the Physics syllabus at O-level was reviewed to ensure that the syllabus is responsive to the needs of the learner with a shift from knowledge-based learning to competence-based learning. Emphasis in the review has been on building skills and competencies, as well as streamlining the coherence of the existing content by benchmarking against a number of best practice syllabi.

The new Physics syllabus guides the interaction between the teacher and the learner in the learning processes and highlights the essential practical skills and competencies a learner should acquire, during and at the end of each learning unit.

1.4. Rationale of teaching and learning physics

1.4.1. Physics and society

Physics is one of the natural science subjects and contributes significantly to global socioeconomic transformation through its discoveries. These have led to development of new technologies in all fields of production and are beneficial to mankind. Applications of Physics knowledge is evident in industries such as engineering, transport (automobiles, trains, planes, etc.), medicine and Information and Communication Technology (ICT).

Physics significantly contributes to the advancement of new technologies that arise from theoretical breakthroughs. For example, advances and understanding of electromagnetism or nuclear physics has led to the development of new products, which have dramatically transformed the modern society. Some of the discoveries based on Physics knowledge include televisions, computers, electrical appliances, and nuclear weapons advancements in thermodynamics and mechanics, which led to industrialization

Physics is key to the Rwandan education ambition of developing a knowledge-based society. It promotes science and technology, which are necessary for learners to be competitive in both regional and global job markets. This new curriculum will address gaps in appropriate skills and attitudes provided by the current Rwandan Education system.

1.4.2. Physics and learners

Physics is a worthwhile subject because it prepares students for the real world of work by providing career pathways in mechanical engineering, construction engineering, information and communication technology and other related fields. Physics provides skills that guide in the construction of theories and laws that help to explain natural phenomenon and enable management of the environment.

It also provides answers to problems faced in our modern society by empowering students to be creative and innovative leading to independent approaches of solving daily life problems. Through physics students explore the laws and rules that govern all natural phenomena observed in the universe.

Competence-based learning refers to systems of instruction, assessment, grading, and academic reporting that are based on students demonstrating that they have acquired and learned the prerequisite knowledge, skills and attitudes as they progress through their education. Apart from being integrative, the newly revised syllabus guides the interaction between the teacher and the learner in the learning process. It further puts greater emphasis on skills a learner should acquire during each unit of learning. As a competency-based syllabus, it elaborates on the three aspects of **knowledge, skills** and **attitudes** in science.

1.5 Types of competencies and their acquisition

Competencies are statements of the characteristics that students should demonstrate which indicate they are prepared and have the ability to perform independently in professional practice. The two types of competencies envisaged in this curriculum are **basic** and **generic** competencies.

a) Basic competencies

Basic competencies are addressed in the stated broad subject competencies and in objectives highlighted year on year basis and in each of units of learning. They include:

i) Literacy

- Reading a variety of texts accurately and quickly.
- Expressing ideas, messages and events through writing legible texts in good hand-writing with correctly spelt words.
- Communicating ideas effectively through speaking using correct phonetics of words.
- Listening carefully for understanding and seeking clarification when necessary

ii) Numeracy

- Computing accurately using the four mathematical operations.
- Manipulating numbers, mathematical symbols, quantities, shapes and figures to accomplish a task involving calculations, measurements and estimations.
- Use numerical patterns and relationships to solve problems related to everyday activities like commercial context and financial management.
- Interpreting basic statistical data using tables, diagrams, charts and graphs.

iii) ICT and digital competencies

- Locating, extracting, recording and interpreting information from various sources.
- Assessing, retrieving and exchanging information via internet or cell phones.
- Using cell phones and internet for leisure and for money transactions.
- Using computer keyboard and mouse to write and store information.
- Using information and communication technologies to enhance learning and teaching(all subjects)

iv) Citizenship and national identity

- Relating the impact of historical events on past and present national and cultural identity.
- Understanding the historical and cultural roots of Rwandan society and how the local infrastructure functions in relation to the global environment.
- Demonstrating respect for cultural identities and expressing the role of the national language in social and cultural context.
- Advocating for the historical, cultural and geographical heritage of the nation within the global dimension.
- Showing national consciousness, a strong sense of belonging and patriotic spirit.

- Advocating for a harmonious and cohesive society and working with people from diverse cultural backgrounds.

v) Entrepreneurship and business development

- Applying entrepreneurial attitudes and approaches to challenges and opportunities in school and in life.
- Understanding the obligations of the different parties involved in employment.
- Planning and managing micro projects and small and medium enterprises.
- Creation of employment and keeping proper books of accounts.
- Risk-taking in business ventures and in other initiatives.
- Evaluating resources needed for a business.

vi) Science and technology

- Apply science and technology skills to solve practical problems encountered in everyday life including efficient and effective performance of a given task.
- Develop a sense of curiosity, inquisitiveness and research to explain theories, hypotheses and natural phenomena
- Reason deductively and inductively in a logical way.
- Use and experiment with a range of objects and tools of science and technology and draw appropriate conclusions.

b) Generic competencies

The generic competencies are competencies that must be emphasized and reflected in the learning process. They are briefly described below and teachers must ensure that learners are engaged in tasks that help them to acquire the competencies.

(i) Critical thinking and problem solving skills: The acquisition of such skills will help learners to think imaginatively, innovatively and broadly and be able to evaluate and find solutions to problems encountered in their surroundings.

(ii) Creativity and innovation: The acquisition of these skills will help learners to take initiatives and use imagination beyond knowledge provided in classroom to generate new ideas and construct new concepts.

(iii) Research skills: This will help learners to find answers to questions based on existing information and concepts and use it to explain phenomena from gathered information.

(iv) Communication in official languages: Teachers, irrespective of being language teachers will ensure the proper use of the language of instruction by learners. The teachers should communicate clearly and confidently and convey ideas effectively through spoken and written word, applying appropriate language and relevant vocabulary.

(v) Cooperation, inter personal management and life skills: This will help the learner to cooperate in a team in whatever task assigned and to practice positive ethical moral values and while respecting rights, feelings and views of others. Perform practical activities related to environmental conservation and protection. Advocate for personal, family and community health, hygiene and nutrition and responding creatively to a variety of challenges encountered in life.

(vi) Lifelong learning: The acquisition of such skills will help learners to update knowledge and skills with minimum external support. The learners will be able to cope with evolution of knowledge advances for personal fulfillment in areas that are relevant to their improvement and development.

1.6 Broad Physics competencies

During and at the end of learning process, the learner can:

Analyse and explain physics phenomena relating to life experience.

Use and experiment with a range of scientific and technological tools and equipment and draw appropriate conclusions;

Demonstrate curiosity, research skills and creativity;

Apply scientific inquiry and methods to investigations;

Apply knowledge of mathematics and technology to scientific investigation;

Observe, analyse, evaluate and interpret without prejudice and make reasonable decisions;

- Use principles of scientific methods and experimental techniques to solve specific problems in life;
- Develop attitudes in which scientific investigation depends on honesty, persistence, critical thinking and tolerance of uncertainty;
- Appreciate the scientific, social, economic, environmental and technological implications of physics;
- Identify legal and ethical requirements for proper use, care, handling and disposal of organisms and chemicals into the environment;
- Identify safe and appropriate techniques used in the preparation, storage, dispensing and supervision of materials used in science instructions;
- Identify national legal requirements and standards for safe preparation, use, storage, and disposal of the materials used.

1.7 Physics and developing competencies

The policy documents based on national aspirations identify some ‘Basic Competencies’ alongside the ‘Generic Competencies’ that will develop higher order thinking skills and help students to learn subject content and promote application of acquired knowledge and skills.

Through observation, experimentation, and presentation of information during the learning process, the learner will not only develop deductive and inductive skills, but also acquire cooperation, communication, critical thinking and problem solving skills. This will be realized when learners make presentations leading to inferences and conclusions at the end of learning unit. This will be achieved through learner group work and cooperative learning of physics, which in turn will promote interpersonal relations and teamwork.

The manipulation of apparatus and data during class experiments and the undertaking of project work by learners will involve analytical and problem solving skills directed towards innovation, creativity and research activities by the learners.

The acquired knowledge from learning physics should help develop a responsible citizen who uses scientific reasoning and attitudes to develop confidence in reasoning independently. The learner should show concern for individual attitudes, environmental protection and comply with the scientific method of reasoning. The scientific method should be applied with the necessary rigor and intellectual honesty to promote critical thinking while systematically pursuing the line of thought.

1.8 Cross-cutting issues to be infused during learning

These are emerging issues, which need to be incorporated in the learning

process. Each of the cross-cutting issues has its own important programme of learning reflecting key national priorities. This learning is integrated into the syllabuses of subjects across the curriculum rather than each issue having a dedicated timetable slot of its own. As a result of this integration, the learning activities in the units of subjects across the curriculum incorporate all the learning associated with the cross-cutting issues. The eight cross-cutting issues are:

a) Peace and Values Education

The need for Peace and Values Education in the curriculum is obvious. Peace is clearly critical for society to flourish and for every individual to focus on personal achievement and their contribution to the success of the nation. Values education forms a key element of the strategy for ensuring young people recognize the importance of contributing to society, working for peace and harmony and being committed to avoiding conflict.

b) Financial Education

- Financial education makes a strong contribution to the wider aims of education. It makes learning relevant to real life situations. It aims at a comprehensive financial education program as a precondition for achieving financial inclusion target and improves the financial capability of Rwandans. Financial education has a key role of not only improving knowledge

of personal but also transforming this knowledge into action. It provides the tools for sound money management practices on earnings, spending, saving, borrowing and investing. Financial education enables people to take appropriate financial services both formal and informal that are available to them and encourages financial behaviours that enhance their overall economic well-being.

c) Standardisation Culture

- Standardisation Culture develops learners' understanding of the importance of standards as a pillar of economic development and in the practices, activities and lifestyle of the citizens. It is intended that the adoption of standardization culture should have an impact upon health improvement, economic growth, industrialization, trade and general welfare of the people. While education is the foundation and strength of our nation, standards are one of the key pillars of sustainable economic development.

d) Genocide Studies

- Genocide Studies provides young people with an understanding of the circumstances leading to the genocide and the remarkable story of recovery and re-establishing national unity. Genocide Studies helps learners to comprehend the role of every individual in ensuring

nothing of the sort ever happens again.

- The intent of a cross-cutting curriculum around the topic of genocide is to fight against genocide, genocide denial, and genocide ideology; and to equip students with a more fundamental and comprehensive understanding of the genocide, thereby preventing further human rights violations in the future and enabling Rwanda's population of young people to more competently and thoughtfully enter the workforce. So, it needs to be emphasized.

e) Environment and sustainability

- The growing awareness of the impact of the human race on the environment has led to recognition of the need to ensure our young people understand the importance of sustainability as they grow up and become responsible for the world around them. Hence Environment and Sustainability is a very important cross-cutting issue. Learners need basic knowledge from the natural sciences, social sciences and humanities to understand and interpret principles of sustainability. They also need skills and attitudes that will enable them in their everyday life to address the environment and climate change issue and to have a sustainable livelihood.

f) Gender education

There is a strong moral imperative to afford every individual their basic human rights and gender inequality results in women and girls being treated less favourably than men. A strongly negative impact of unequal treatment, which affects the nation as a whole, is the fact that it results in women being held back and their talents and abilities not being fully realised. With a good understanding of the principles of Gender Equality, it is intended that future generations will ensure that the potential of the whole population is realised.

g) Comprehensive sexuality education (HIV/AIDS, STI, Family planning, Gender equality and reproductive health)

Comprehensive sexuality education, which is age appropriate, gender sensitive and life skills based can provide young people with the knowledge and skills to make informed decisions about their sexuality and life style. Preparing children and young people for the transition to adulthood has been one of humanity's greatest challenges with human sexuality and relationships at its core. Few young people receive adequate preparations for their sexual lives. This leaves them potentially vulnerable to coercion, abuse and exploitation. Unintended pregnancy and sexually transmitted infections

(STIs) including HIV/AIDS. Many young people approach adulthood faced with conflicting and confusing messages about sexuality and gender. This is often exacerbated by embarrassment, silence, disapproval and open discussion of sexual matters by adults (parents, teachers) at very time when it is most needed.

Comprehensive sexuality education supports a rights - based approach in which values such as respect, acceptance tolerance, equality, empathy and reciprocity are inextricably linked to universally agreed human rights. A clear message concerning these dangers and how they can be avoided, from right across the curriculum, is the best way to ensure that young people understand the risks and know how to stay healthy.

h) Inclusive Education

Inclusive education involves ensuring all learners are engaged in education and that they are welcomed by other students so that everyone can achieve their potential. Inclusive practice embraces every individual regardless of gender or ability including those with learning difficulties and disabilities. The almost focus of inclusive curriculum is on ensuring participation in education of learners with different learning styles and other difficulties. To be successful, it entails a range of issues including teacher's positive attitudes, adapting the learning resources, differentiation

of teaching and learning methods and working together. Overall, the benefits of an inclusive curriculum extend to all learners.

1.9 Special needs education and inclusivity

All Rwandans have the right to access education regardless of their different needs. The underpinnings of this provision would naturally hold that all citizens benefit from the same menu of educational programs. The possibility of this assumption is the focus of special needs education. The critical issue is that we have persons/ learners who are totally different in their ways of living and learning as opposed to the majority. The difference can either be emotional, physical, sensory and intellectual learning challenges traditionally known as mental retardation. These learners equally have the right to benefit from the free and compulsory basic education in the nearby ordinary/mainstream schools. Therefore, the schools' role is to enrol them and also set strategies to provide relevant education to them. The teacher therefore is requested to consider each learner's needs during teaching and learning process. Assessment strategies and conditions should also be standardised to the needs of these learners. Also, ensure that you include learners with special educational needs in classroom activities as much as possible.

The special needs children can fall in any of the following common categories:

- Physical difficulties
- Visual difficulties
- Hearing difficulties
- Mental difficulties
- Genocide traumatized learners

The teacher should identify such cases and help facilitate the affected learners learning. For example, learner's with visual and hearing difficulties should sit near the teacher's table for easy supervision and assistance. The following are some suggestions on how to support special needs children in your class.

a) Learners with physical difficulties

In this group of learners, the affected areas are normally some body parts, especially the limbs. There may be partial or total loss of use of the limbs. In case the legs are affected, the learners will need assistance during activities that involve movement. This could be during a nature walk and other activities that learners have to stand for some reason. The teacher should organise for the learner's ease of movement around. The learner should also be given time to catch up with the others.

In case the hands are affected, the learners should be given more time to finish their work. In both cases, the learners should not be pressurized to do things that can cause injury or ridicule.

b) Learners with visual difficulties

These learners normally have problems with their eyesight. They should sit in a position where they are able to see the chalkboard without straining.

Note

The learner could be longsighted or short sighted.

The material to be observed should be brought closer to the learner and a magnifying lens used where necessary. The teacher should use large diagrams, charts and labels. In some cases, the learners can be allowed to touch and feel whatever they are looking at. Other learners can assist by reading aloud. The lighting system in the classroom can also be improved.

The teacher should read aloud most of the things he/she writes on the chalkboard.

c) Learners with hearing difficulties

The affected part in this case is the ear. The learner should have **hearing aids**. The teacher should use as many visual aids as possible. They should also project their voice and always talk while facing the learners. Use of gestures and signs while talking helps the learner figure out what the teacher is saying as well.

d) Learners with speech difficulties

A common example in a normal class is the **stammerer**. They always speak with a lot of difficulties. The teacher should be patient with them and encourage such learners to express themselves in their own way. Such learners should be given more written exercises.

e) Learners with mental difficulties

The teacher should try to identify the nature and level of the mental difficulty. Learners with mental difficulties should then be given special assistance and attention at an individual level. They can be given special tests or assessments. In general, all the learners with difficulties should be reinforced promptly. This encourages and motivates them. The teacher and the rest of the class should never ridicule learners with any of the difficulties. Note that generally, people with any kind of disability can be very sensitive to any kind of negative comments or criticism.

*Remind them that **'DISABILITY IS NOT INABILITY'**.*

The teacher should avoid giving privileges where the learners do not deserve them. Treat them fairly but not with undue favours. In extreme cases it can be recommended for the learners to join a special school.

f) Genocide traumatized learners

Studies have shown that learners from families that were affected by genocide suffer post-traumatic stress disorder (PTSD). As such, they need to be treated as a special case. As a teacher, you need to be careful when dealing with such learners. Also, the teacher needs to be in control especially when

the topic under discussion touches on genocide issues. Any language that may elicit emotional reactions from learners either by fellow learners or by the teacher him or herself should be avoided.

2. Preparing to teach and the teaching process

2.1 Understanding the Scientific process

Although the process of science aims at guiding the learners on how, rather than what to learn, the process of discovering or finding out cannot exist without content or something to be found out. For example, a teacher cannot teach about classification without something to classify, for instance. On the other hand, nothing can be classified without knowledge of the materials to be classified. It is, therefore, necessary for the teacher to strike a balance between giving some scientific information and guiding the learners to discover on their own through investigations.

Problem-solving in Science

In order to apply the scientific method of solving problems, learners need certain skills. The process of scientific problem solving can be seen as a continuous chain through the following steps:

1. Identifying the problem
2. Collecting information and making relevant observations
3. Making predictions, building a theory or a hypothesis
4. Designing experiments
5. Carrying out or doing the experiments
6. Recording the results.
7. Analysing results
8. Making conclusions after comparing predictions with results.
9. Communicating or reporting and exchange of information.

Most often we do not consciously think about each of these steps every time we try to solve a practical problem. The approach we use to solve our daily problems many times becomes a habit. It is during the early years of our lives that basic patterns of behaviour are established. Therefore, it is very important for learners to master the skills of problem-solving. These skills should be applied many times over to solve problems at the learner's own level of understanding and interest.

Among the basic skills necessary for carrying out the process of scientific problem solving are:

- Asking questions.
- Collecting relevant information.
- Making predictions.
- Constructing and collecting apparatus and materials.
- Sorting and classifying.
- Recording of information and results.
- Reporting and exchange of information (communication).

Let us briefly discuss each of them.

a) Asking questions

Learners should be encouraged to ask any question(s) which arise from their work. It is the responsibility of the teacher to help the learners to find answers to their questions or problems through their own observations and experiments.

Instead of giving answers directly, the teacher should help to put the learners in a situation whereby they can find out the answers for themselves. Sometimes, the nature of the learners' questions makes this impossible. In such a case, the teacher should give an honest answer and research to find the answer.

b) Collecting information

We can use all our senses to learn more about the world around us. Learners should be encouraged to observe keenly, listen, feel, smell and even taste with caution. Sometimes information can be obtained from suitable reference materials and experts. Whatever the source, careful gathering of information is a major step in problem solving. It may also lead to discovery of new problems which will need solving.

c) Making predictions or hypotheses

Predicting is not the same as guessing. We make a prediction only after careful consideration of the information available to us. In other words, because we observed that certain things took place in the past, we suppose that certain other things will happen in the

future. For example, if the position of the shadow of a flag post is marked on the ground at 9.00 am, 10.00 am and 11.00 am in the morning, then the learners can predict where the shadow will fall at noon with some level of accuracy.

d) Construction and collection of apparatus and materials

Experiments in science most often require apparatus, equipment and other materials. These can be acquired through collection and construction using locally available materials.

A good science teacher is often described as a scavenger and his learners, as young scavengers. This means that they collect as many waste materials as possible.

Every class should have a science corner or store at which they keep the apparatus and materials safely.

e) Sorting and classifying

Learners should be given an opportunity to group things in ways they themselves believe are suitable. The process of sorting and arranging things gives learners valuable practice in decision making.

Through classifying, patterns may emerge which may help to solve problems and unveil new ones.

f) Recording of information

Learners should be encouraged to keep a record of what they do as well as what they observe. These records may be in the form of drawings, charts, models or

reports. When records are analysed, conclusions and appropriate decisions can be made.

g) Drawing conclusions

A skilful teacher can help the learners to look for simple cause and effect relationships based on observations made or the results obtained from an experiment analysed.

A conclusion may be the solution to a problem and sometimes may lead to new problems.

h) Reporting and exchange of information (Communication)

Learners should be made to realise that they can learn from one another. They should be encouraged to exchange information through reports, displays and discussions.

The conclusions made from an investigation should be communicated to other people who may use it to solve a practical problem.

2.2 Important attitudes in learning of physics

a) In learners

There are certain useful attitudes, which the teacher should help to develop in the learners as they carry out investigations in science. Science as a problem solving discipline is expected to make an impact on a learner's general behaviour.

The nature of the scientific method demands learners to be honest with themselves as they record results and make unbiased conclusions. They should

be aware of the danger involved in making generalisations out of limited information. They should be open-minded and able to distinguish between propaganda and truth.

Some of the scientific attitudes that learners should develop include:

- **Practical approach** – to problem solving. Learners should seek answers to their questions and problems by carrying out investigations wherever possible.
- **Responsibility** – A learner should be responsible enough to effect tasks apportioned and take good care of apparatus during and after an investigation.
- **Cooperation** – Learners will often be working in groups while carrying out investigations and need therefore to cooperate with all other members of the group.
- **Curiosity** – Learners should have a curious attitude as they observe things and events around them. This is the first step towards solving a problem.
- **Self-confidence** – Learners should have the will to attempt to solve a problem. The feeling of self confidence can be strengthened in young learners if they experience many small successes that win approval and encouragement from the teacher. The problems which learners attempt to solve should not be so difficult that they lead to frustration.

- **Honesty** – As they make observations, record, analyse results and draw conclusions.
- **Patience** – Learners should be patient for the results of an experiment which may take time to manifest.

In teachers

- Engage students in variety of learning activities
- Apply appropriate teaching and assessment methods
- Adjust instructions to the level of the learner
- Creativity and innovation
- Makes connections/relations with other subjects
- Show a high level of knowledge of the content
- Develop effective discipline skills manage adequately the classroom
- Good communicator
- Guide and counsellor
- Passion for children teaching and learning.

2.3 Philosophy of teaching

Physics

In the teaching of science, two definite approaches or techniques have been used. The first is the **passive traditional** approach where the teacher is the central figure around whom all other things revolve. In this setup, the teacher talks and issues commands. The learners sit and listen. The teacher treats the learners like an ‘empty pot’ waiting for information to be poured into it.

A small amount may enter, some will stay in while the rest evaporates. This teachercentred approach **has no place** in our schools today. In the second approach, which we call the dynamic or **activity-oriented** approach and which is being advocated for, the learners are active participants in the learning process. They are the doers and the materials and apparatus they work with are the tellers. The teacher’s role is that of a guide and facilitator in the learning process. Physics is a practical subject and learners understand it best by doing.

a) Learner’s role in learning Physics

Learning takes place only when the learner has internally digested and assimilated the material to be learnt. As such, learning is a highly personal and individual process. It therefore means that a learner must be actively engaged in the learning exercise.

For active participation in learning, the learner must:

- (a) Develop the curiosity, powers of observation and enquiry by exploring the local environment.
- (b) Raise questions about what is observed.
- (c) Suggest solutions to those questions and carry out investigations to search for answers.
- (d) Manipulate a variety of materials in search of patterns and relationships while looking for solutions to problems.

The competence-based approach considers the learning process to involve the construction of meaning by learners. Simply, it emphasizes the need for children to think about scientific activity in order to make sense of and understand the scientific concepts being introduced. In this new dispensation, learners are in the driver's seat, which implies they will construct their knowledge by posing questions, planning investigation, conducting their own experiments, analysing and communicating results. More specifically, when engaging in inquiry, learners will describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others. By so doing, the learners will take ownership of the learning process.

Learners' activities are indicated against each learning unit reflecting their appropriate engagement in the learning process. Even though they do not necessarily take place simultaneously in each and every physics lesson and for all levels, over time learners get involved in the following activities:

- Observing and, where possible, handling and manipulating real objects;
- Pursuing questions which they have identified as their own even if introduced by the teacher;
- Taking part in planning investigations with appropriate controls to answer specific questions;

- Using and developing skills of gathering data directly by observation or measurement and by using secondary sources;
- Using and developing skills of organizing and interpreting data, reasoning, proposing explanations, making predictions based on what they think or find out;
- Working collaboratively with others, communicating their own ideas and considering others' ideas;
- Expressing themselves using appropriate scientific terms and representations in writing and talk;
- Engaging in lively public discussions in defense of their work and explanations;
- Applying their learning in real-life contexts;
- Reflecting self-critically about the processes and outcomes of their inquiries.

During this reciprocal interaction, what learners will acquire is not only content knowledge, but a number of skills including how to approach a problem, identify important resources, design and carry out hands-on investigations, analyze and interpret data, and, perhaps most importantly, recognize when they have answered the question or solved the problem.

b) Teacher's role in learning and teaching

The teacher is one of the most important resources in the classroom.

The teacher's role is central to the successful implementation of the learning programme in the school. The role of the teacher will remain critical however, instead of being the "sage on the stage", the teacher will rather be "**the guide on the side**" who acts as facilitator in a variety of ways which include:

- Encouraging and accepting student autonomy and initiative;
- Using raw data and primary sources, along with manipulative, interactive, and physical materials;
- Using cognitive terminology such as classify, analyse, predict, and create when framing tasks.
- Allowing student responses to drive lessons, shift instructional strategies, and alter content;
- Familiarizing themselves with students' understandings of concepts before sharing their own understandings of those concepts;
- Encouraging students to engage in dialogue, both with the teacher and one another;
- Engaging students in experiences that pose contradictions to their initial hypotheses and then encouraging discussion;
- Providing time for students to construct relationships and create metaphors
- Nurturing students' natural curiosity.
- Organising the classroom to create a suitable learning environment.

- Preparing appropriate materials for learning activities.
- Motivating learners to make them ready for learning.
- Coordinate learners' activities so that the desired objectives can be achieved.
- Assessing learners' activities and suggest solutions to their problems.
- Assist learners to consolidate their activities by summarising the key points learnt.

From time to time, the teacher should interact with the learners individually or in groups to diagnose their weaknesses and frustrations, appraise their efforts, imagination and excitement. This will assist and guide them in the task of learning. The teacher must make an effort to teach learners how to team up but still have each learner directly involved in working with materials, consulting with the teacher and with fellow learners. Remember that whatever you do during the class, the interests of the learner remain paramount! Therefore the teacher should allow and encourage the learners to:

- Explore their local environment.
- Ask questions about things and events.
- Make observations.
- Perform simple investigations and experiments to seek answers to their questions.
- Talk to each other and to

the other learners about their experiences, interests, problems, successes and even frustrations.

- Play and make models of things that interest them.

There is no doubt that scientific knowledge is increasing at such a rapid rate that it is impossible for any teacher to teach, or any child to learn, all the information available on any particular topic, within the time allocated. As an alternative, we should take on a strategy that is practical and time-saving. It involves equipping the learners with skills, which they can use to find out information, and solutions to problems in science and in their daily lives. We therefore advocate the teaching of science as a process, combined with providing basic science facts, which are appropriate in content to the age and stage of mental development of children under your charge. The scientific skills which the teacher must endeavor to introduce and promote in his /her learners include:

observing, comparing, classifying (sorting), recording, predicting, experimenting, measuring, controlling variables, collecting data, recognising patterns and relationships, analysing and interpreting data, making conclusions (inferring) and communicating.

These skills, used in conjunction with the introduction of basic science facts will form a firm foundation which learners can build more as they learn both inside and outside of school.

Education at school is about children learning. The process of organizing learners' learning so as to achieve the aims and objectives of the curriculum involves bringing together the needs and characteristics of the learners. To do this, the skills, knowledge and experience of the teacher are all required within a given situation.

2.3 Skills required of physics teacher

- Engage students in variety of learning activities.
- Use multiple teaching and assessment methods.
- Adjust instructions to the level of the learner.
- Creativity and innovation.
- Makes connections/relations with other subjects.
- Should have a high level of knowledge of the content.
- Effective discipline skills.
- Good classroom management skills.
- Good communicator.
- Guidance and counselling.
- Passion for teaching children and learning.

2.4 Teaching resources

These refer to things that the teacher requires during the teaching process. They include:

- The classroom
- Textbooks

- Wall charts and wall maps
- Materials and apparatus
- Various tools and equipment
- Science kit
- Models
- Resource persons
- Social facilities such as health centres, other learning institutions, community organisations, etc.
- Enterprises such as agricultural farms, industries, among others.

a) Classroom as a learning environment

Classroom generally refers to the place where learning takes place. Learners learn from everything that happens around them, such as the things that they hear, see, touch, taste, smell and play with. It is therefore important for the teacher to make his classroom an attractive and stimulating environment. This can be done by:

- Carefully arranging the furniture and desks
- Putting up learning and teaching aids on the walls. Examples are wall charts or pictures or photographs.
- Displaying models
- Providing objects for play for example toys.
- Having a display corner in the classroom where learners display their work.
- Securing a storage area

The materials in the classroom should get the learners thinking and asking questions about what is around them

and encourage them to do worthwhile activities.

2.5 Classroom organization

A well organised classroom is an asset to good Physics teaching but there is no one correct style to suit all classrooms and situations. However, the teacher should consider the following factors when organising the classroom:

- (a) Furniture should be well arranged so as to allow free movement of learners and the teacher.
- (b) Set a corner for storing materials so as not to obstruct learners or distract them.
- (c) The number of learners in the class and their ages.
- (d) Learners should be reasonably spread out so that they do not interfere with one another's activities.
- (e) The series of lessons or activities going on for a number of days or weeks such as individual or group work or whole class.
- (f) Classroom itself, that is, positions of windows, doors such that learners face the lighted areas of the room.
- (g) Personal preferences. But these should be in the interest of the learners especially where you normally stand, you should be able to communicate with all learners, and also have a general view of all learners in the class.

Grouping learners for learning

Most of the Physics activities are

carried out in groups to facilitate active participation of all the learners and therefore the teacher should place 2 or 3 desks against each other and then have a group of learners sitting around those desks.

In certain activities, the teacher may wish to carry out a demonstration. In this case, the learners should be sitting or standing in a semicircle, or arranged around an empty shape of letter “U” such that each learner can see what the teacher is doing clearly and without obstruction or pushing. If the learners are involved in individual work, each learner can work on the floor or on the desk or a portion of the desk if they are sharing. In this case, they need not face each other.

Grouping learners for learning has increasingly become popular in recent years. In fact, the shift from knowledge-based to competence curriculum will make grouping the norm in the teaching process. Grouping learners can be informed by one or all of the following:

- (a) Similar ability grouping.
- (b) Mixed ability grouping.
- (c) Similar interests grouping.
- (d) Needs grouping.
- (e) Friendship grouping.
- (f) Sex grouping.

In Physics, groupings are commonly those of types (a), (b), (c) and (d). Grouping learners has several advantages such as:

- (a) The individual learner’s progress and needs can easily be observed.
- (b) The teacher learner relationship is enhanced.
- (c) A teacher can easily attend to the needs and problems of a small group.
- (d) Materials that were inadequate for individual work can now easily be shared.
- (e) Learners can learn from one another.
- (f) Cooperation among learners can easily be developed.
- (g) Many learners accept correction from the teacher more readily and without feeling humiliated when they are in a small group rather than the whole class.
- (h) Learners’ creativity, responsibility and leadership skills can easily be developed.
- (i) Learners can work at their own pace.

The type of “grouping” that a teacher may choose depends on:

- (a) The topic or task to be tackled.
- (b) The materials available.
- (c) Ability of learners in the class (fast, average, slow).

However, the teacher must be flexible enough to adjust or change his/her type of grouping to cope with new situations.

There is no fixed number of learners that a group must have. This again will be dictated by such factors as the task to be done, the materials, characteristics of learners in your class, size and the

space available. However, groups should on average have between **four to seven learners**. You can also resort to pair work depending on the nature of the content being taught at the time.

There is no one method or approach to teaching that is appropriate to all lessons. A teacher should, therefore, choose wisely the method to use or a combination of methods depending on the nature of the topic or subtopic at hand.

2.6 Safety in the classroom

Learners in Senior 1 are very active and curious. As such, they are inclined to getting harmed and injured. They should therefore be constantly protected from sources of injury and harm. The teacher is therefore advised to take strict safety precautions whenever learners are in class or outside the classroom. Some areas that need consideration as far as safety is concerned include:

- During tasting and smelling things
- When using tools and equipment
- During experiments, demonstrations involving use of fire or harmful chemicals
- When handling glass apparatus
- When handling sharp or pointed objects like machete, pair of scissors, razor blade, knife, etc.
- During nature walks and field visits. Learners should avoid handling poisonous plants and harmful animals, etc.

Remember, according to Rwanda laws, the teacher is responsible for the safety of the children during the period he or she is handling them.

a) Apparatus and materials

For learners to study science through the activity method, a number of materials and apparatus are required. The important role played by materials in learning has been felt for centuries. This is noted for instance in the old Chinese proverb that says:

- *What I hear I forget*
- *When I see I remember*
- *When I do I understand*

Teaching and learning of Physics entails practical activities for better conceptualisation of concepts and facts. The successful implementation of the competence based curriculum requires Physics laboratories, textbooks, charts and ICT tools like computers and projectors.

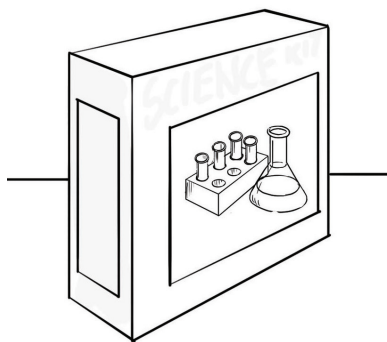
There are some Physics concepts that cannot be easily explained and some experiments that cannot be done in our school laboratories due to safety reasons. The use of ICT in teaching and learning is vital. With ICT, these concepts can be visualised by use of animations and simulations. Similarly both teachers and learners are encouraged to use the Internet for research as well as other ICT tools, for teaching and learning purposes.

Improvisation

If each learner is to have a chance of experimenting, cheap resources must be made available. Expensive, complicated apparatus may not always be available in most schools. Such sophisticated equipment made by commercial manufacturers are usually expensive and majority of schools cannot afford them. The teacher is therefore advised to improvise using locally available materials as much as possible. Improvisation should however not be regarded as a cheap substitute of proper laboratory equipment. Many of the great masters of Science used improvised apparatus and many great discoveries have been made using improvised equipment.

c) Science Kit

A science kit is a special box containing materials, apparatus and equipment necessary to conduct an array of experiments. The content of the physics kit depends on the curriculum requirements per level. Most science kits are commercially available and target particular levels of learners. However, the teacher is encouraged to come up with a kit based on the syllabus requirements.



d) Resource persons

A resource person refers to anybody with better knowledge on a given topic area. Examples include health practitioners such as doctors, nurses and laboratory technologists, agricultural extension officers, environmental specialists among others. Depending on the topic under discussion, the teacher can organise to invite a resource person in that area to talk to learners about the topic. The learners should be encouraged to ask as many questions as possible to help clarify areas where they have problems.

e) Models

A model refers to a three-dimensional representation of an object and is usually much smaller than the object. Several models are available commercially in shops. Examples include model of the heart, skin, lungs, eye, ears, among others. These can be purchased by schools for use during practicals.

2.7 Teaching methods

There is a variety of possible ways in which a teacher can help the Learners to learn. These include :

- (a) Direct exposition
- (b) Discovery or practical activity
- (c) Group, class or pair discussion
- (d) Project method
- (e) Educational visit/ field trips
- (f) Teacher demonstration
- (g) Experimentation

The particular technique that a teacher may choose to use is influenced by several factors such as:

- The particular group of learners in the class
- The skills, attitudes and knowledge to be learned
- Learning and teaching aids available
- The local environment
- The teacher's personal preference
- The prevailing weather
- The requirements of the Science syllabus

a) Direct exposition

This is the traditional way of teaching whereby the teacher explains something while the learners listen. After the teacher has finished, the learners may ask questions. However, remember that in competence-based curriculum, this technique should be used very minimally.

b) Guided Discovery

In this technique, the teacher encourages learners to find out answers to problems by themselves. The teacher does this by:

- Giving learners specific tasks to do
- Giving learners materials to work with
- Asking structured or guided questions that lead learners to the desired outcome

Sometimes learners are given a problem to solve and then left to work in an open-ended manner until they find out for themselves.

With the introduction of the new curriculum, this is the preferred method of teaching.

c) Group or class discussion or pair work

In this technique, the teacher and learners interact through question and answer sessions most of the time. The teacher carefully selects his questions so that learners are prompted to think and express their ideas freely, but along a desired line of thought. Discussion method should take learners from known to unknown in a logical sequence; and works well with small groups of learners. The disadvantage of this method is that some learners maybe shy or afraid to air their opinions freely in front of the teacher or their peers. This may give them more confident learners a chance to dominate the others. However, the method should be embraced as it intends to eliminate the lack of confidence in learners. Further, it is hoped that it will help improve interpersonal and communication skills in learners.

d) Project method

In this approach, the teacher organises and guides a group of learners or the whole class to undertake a comprehensive study of something in real life over a period of time such as a week or several weeks.

Learners using the project method of studying encounter real life problems which cannot be realistically brought into a normal classroom situation. A project captures learners' enthusiasm, stimulates their initiative and encourages independent enquiry. The teacher, using the project method, must ensure that the learners understand the problem to be solved and then provides them with the necessary materials and guidance to enable them carry out the study. The teacher can use the project method for topics, which cannot be adequately studied during the normal time-tabled school lessons.

Disadvantages

If a project is not closely supervised, learners easily get distracted and therefore lose track of the main objective of their study. Studying by the project method does not work well with learners who have little or no initiative.

e) Educational visits and trips/ nature walks

This is a lesson conducted outside the school compound during which a teacher and the learners visit a place relevant to their topic of study. An educational visit/nature walk enables learners to view their surroundings with a broader

outlook that cannot be acquired in a classroom setting. It also allows them to learn practically through first-hand experience. In all "educational visit/nature walk lessons", learners are likely to be highly motivated and the teacher should exploit this in ensuring effective learning. However, educational visits are time consuming and require a lot of prior preparation for them to succeed. They can also be expensive to undertake especially when learners have to travel far from the school.

f) Demonstration lessons

In a demonstration, the teacher shows the learners an experiment, an activity or a procedure to be followed when investigating or explaining a particular problem. The learners gather around the teacher where each learner can observe what the teacher is doing. It is necessary to involve the learners in a demonstration, for example by:

- Asking a few learners to assist you in setting up the apparatus.
- Requesting them to make observations
- Asking them questions as you progress with the demonstration.

This will help to prevent the demonstration from becoming too teacher-centred.

When is a demonstration necessary?

A teacher may have to use a demonstration, for example when:

- The experiment/procedure is too

- advanced for learners to perform.
- The experiment/ procedure is dangerous
- The apparatus and materials involved are delicate for learners to handle.
- Apparatus and equipment are too few

2.8 Planning to teach

The two most important documents in planning to teach are the schemes of work and the lesson plan.

a) Schemes of work

A scheme of work is a collection of related topics and subtopics drawn from the syllabus and organised into lessons week by week for every term. It is also a forecast or plan that shows details under these subheadings:

- Week
- Key unit competency
- Lesson
- Learning objectives
- Learning resources and reference materials
- Teaching methods and techniques
- Observations/self evaluation
- Comments from school director (DOS)

In addition, the schemes of work shows the day when a specific lesson will be taught and how long it is intended to take.

- **Date** - refers to the exact date and

day when the lesson is carried out..

- **Key unit competency** - Gives the competence learners are expected to achieve at the end of the unit.
- **Lesson** - refers to the lesson being taught in that week e.g. lesson 1,2,3 and 4, etc. This shows which is a single and which is a double lesson.
- **Date** - the day when the lesson will be taught.
- **Sub-topic** - a subset of the topic which is a smaller component of the unit e.g. under the topic plants, one could have 'parts of a plant' as a sub-topic.
- **Objective** - what Learners are expected to achieve at the end of the lesson.
- **Learning resources** - any materials that will be used by the pupil and the teacher for learning and teaching.
- **References** - books or other materials that will be consulted or used in the teaching process. Books that Learners will use should also be shown here; indicating the actual pages.

Observations/self evaluation - this should be a brief report on the progress of the lesson planned in the scheme of work. Such reports could include: 'taught as planned'. 'Not taught due to abrupt visit by Country Director of Education.' 'Children did not follow the lesson, it will be repeated on... (specific date).

Below is a sample scheme of work for your familiarisation.

Scheme Of Work

Academic Year: 2016

Term: 1

School: Town School Kigali

Teacher's Name: Joseph Karubandikze

Subject: Physics

Number of periods per week: 4

Class: Senior 1

Combination

Date	Key unit competencies	Lessons/ Title and combination	Instructional objectives	Teaching methods and techniques	Resource and reference	Observations/ evaluation (including proposed dates assessment)
	-To be able to define, explain and describe forces and their effects.	Lesson 1: Definition of a force	Learners should be able to identify situations where push or pulling takes place in daily life with a view to defining a force.	Student's text book, charts, ropes, big stones	<ul style="list-style-type: none"> Group work Guided discovery 	The lesson was covered well and the learners were responsive.
Forces		Lesson 2: Types of forces (Friction force, tension force) Lesson 3 & 4: Types of forces (Action and reaction forces, normal reaction force, air resistance)	Learners should be able to identify friction and tension forces as contact forces. They should also explain friction and tension forces and their effects. Learners should be able to name action and reaction force, normal reaction force, and air resistance as contact forces. They should be able to describe these forces and their effects.	Student's text book, wooden block, springs, string, pail pencil, spring balances, umbrella, stopwatch, ½ metre rule, a ball, plastic ruler, dry piece of cloth, bar magnetic iron rod	<ul style="list-style-type: none"> Group activities Guided discovery Demonstration Individual work Pair work 	The lesson was covered well. Strategy: Gave the learners extra work on friction and tension forces and held a discussion on their findings. The lesson was not adequately covered due to time limitation. Strategy: Revised the areas not well understood by learners during remedial hours.

<p>Week</p> <p>9</p>	<p>Forces</p>	<p>Lesson 1: Types of forces (upthrust force)</p> <p>Lesson 2: Types of forces (Gravitational force)</p> <p>Lesson 3 & 4: Types of forces (Electrostatics and magnetic forces)</p>	<p>Learners should be able to name upthrust force as one of contact forces. They should be able to describe upthrust forces in fluids and its effects.</p> <p>Learners should be able to name gravitational force as a non-contact force. They should also describe the force and its effects.</p> <p>Learners should be able to name Electrostatics and magnetic forces as non-contact forces. They should also describe the forces and its effects.</p>	<p>Student's text book, marbles, beam balance, spring balance, metal and wooden blocks</p>	<ul style="list-style-type: none"> • Group work • Games • Individual work • Demonstration 	<p>Lesson well covered and learners were responsive. Strategy: Gave extra work on upthrust and discussed with learners their findings.</p> <p>Lesson was well covered. Learners enjoyed doing practical activities.</p> <p>Lesson well covered. Strategy: Gave extra work on electrostatic and magnetic forces. I used remedial hours to discuss with learners their findings.</p>
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Week 10	Forces				
-To be able to represent force as a vector, measure forces, explain the effects of balance and unbalance forces	Lesson 1: Vector diagram and measurement of force	Learners should be able to represent force using vector diagram. They should be able to identify different forces acting on a body. Learners should also be able to measure forces.	Student's book, a block of wood, spring balance, a ring, strings, plain paper	<ul style="list-style-type: none"> • Problem solving • Group work 	Lesson adequately covered. Strategy: Gave extra work. Set remedial hours to assist slow learners on areas they with challenges to them.
	Lesson 2: Effect of balance and unbalanced forces	Learners should be able to explain the effects of balance and unbalanced forces.			Lesson not adequately covered due to time.
	Lesson 3 & 4: parallel and non-parallel forces	Learners should be able to add parallel and non-parallel forces			Strategy: Discussed the concepts in the next lesson and set remedial hours to assist slow learners. Lesson well covered. Strategy: Gave extra work on parallel and non-parallel forces and discussed with learners.

(b) Lesson plan

A lesson plan is a detailed outline of how the teacher intends to carry out a specific lesson.

Important sub-headings of a Lesson Plan

- **Administrative details**

Date..... Subject.....
Class.....Lesson number
Unit

Time..... Term.....

School name

Teachers' name

Class size

- **Unit title**

Is the unit title as indicated in the syllabus.

- **Key unit competence**

This is/are the competence(s) that the learner is expected to achieve at the end of the unit.

- **Title of the lesson**

Is derived from the content area being taught in the lesson.

- **Instructions Objectives**

These represent what the teacher anticipates Learners to achieve by the end of the lesson. Objectives should be clear and specific. They should also be stated in behavioural terms, that is, in a way that the outcome can be seen, displayed or measured. In science, one should distinguish between knowledge, skill and attitude objectives.

- **Learning/teaching resources**

Any materials and apparatus that

the Learners and the teacher will use during the lesson.

- **References**

Any resources consulted or used by the teacher to prepare the lesson as well as any books that the Learners will use during the lesson.

- **Introduction**

This is the start of the lesson. The teacher should motivate the Learners by creating learning situations that interest Learners e.g. posing a problem, telling an amusing but relevant story or episode, showing an object or picture that arouse their interest. The introduction should link what the Learners have already learnt with what they are going to learn.

- **Presentation/lesson development**

This should mainly include the activities that Learners and the teacher will perform in order to achieve the stated objectives; as well as the questions that Learners will answer as they do the various activities.

It is convenient to distinguish between the Learners' and teacher's activities under two columns.

- **Summary/conclusion: (Consolidation)**

This is the step in which the lesson activities are tied up or consolidated to emphasize the main points, summarise the lessons or make conclusions. The summary should correspond to the objectives stated for that lesson.

- **Comments/self-evaluation:**

Teacher should write remarks on whether the objectives were achieved or not and what he or she intends to do to improve on the weak points noted during the lesson.

Competence based lesson plan

School name:

Term	Date	Subject	Class	Unit No.	Lesson No.	Duration	Class size
1	15/10/2016	Physics	S1	3	1 of 10	40 mins	36 students
Type of special educational needs to be catered for in this lesson and number of learners in each category.				Out of a class size of 36, two of the learners are physically challenged i.e his legs are disabled. He has to be involved actively in all activities carried out in this lesson.			
Unit title:		Force (I)					
Key unit competencies		By the end of this unit, the learner should be able to define, explain and describe forces and their effects.					
Title of the lesson		Effects of forces.					
Instructional objectives		By performing simple activities and discussing the observations in groups, the learner should be able to correctly describe and evaluate the effects of applied forces on objects.					
Plan for this class (location: in/outside)		To be done in and or outside the classroom.					
Learning materials		Soccer balls, tennis racket, balloon, saw-saw, football field, steering wheel					
References		Students book, newspapers, motor magazines, internet					

Timing for each step	Description of teaching and learning activities		Generic competences and cross-cutting issues
	Teacher activities	Learner activities	
Introduction (5 min)	Asking learners to: <ul style="list-style-type: none"> Recall and mention the types of force of they learnt in the previous lessons. Describe some effects of force in real that are caused by forces. 	<ul style="list-style-type: none"> Recalling, naming and describing different the types of forces learnt in the previous lessons. Describe some effects of force in real that are caused by forces. 	Effective communication. This will be practiced as learners name and describe types of forces and effects of forces.
Development (30 min)	Force and change in state of motion of a body <ul style="list-style-type: none"> Guiding learners in a activity on kicking and catching a ball in the field. Asking learners to name the effect of a force demonstrated when the: <ul style="list-style-type: none"> (a) stationary ball moves when kicked. (b) goalkeeper catches and stops the first moving ball. Note: the student whose leg is disabled can be made to catch a slow moving ball thrown to him	Working in pairs in the football field: <ul style="list-style-type: none"> One partner kicks the ball while the other partner catches it. Describing the effects of a force demonstrated in the activity in each case. 	Inclusivity in education - The learner who is disabled in the legs should be involved by making him to catch a slow moving ball thrown to him.
	Force and change in shape of a body <ul style="list-style-type: none"> Guiding learners in an activity on deforming a partially inflated ball by sitting on it. Asking learners to name the effect of a force demonstrated by the activity. 	Working in pairs. <ul style="list-style-type: none"> One partners sits on a partially inflated ball. The other partner observes the effect of the weight of the first partner on the shape of the ball. Both partners discuss and summarise in words the effect of force as demonstrated by the activity. 	Cooperative learning. This will be achieved as the learners work in pairs. Observation skills. This will be practiced as learners observe deforming effect of the force on the shape of the ball.
	Force and turning effect <ul style="list-style-type: none"> Guiding learners in an activity on swinging an improvised seesaw to produce a turning effect. Asking learners to name the effect of a force demonstrated by the activity. 	Working in pairs. <ul style="list-style-type: none"> Each partner sits on one side of an improvised seesaw and then they swing. Both partners discuss and summarise in words the effect of force as demonstrated by the activity. 	Cooperative learning will be enhanced and achieved as the learners work in pairs
Conclusion (3min)	Summarising the effects of forces learnt in the lesson and making clarification.	Writing down the effects of forces correctly in their exercise books.	Communication skills will be enhanced as learners answer questions.
Evaluation (2 min)	Evaluating the success of the lesson by asking learners to quickly name the effects of force.	Answering questions	Communication skills will be enhanced as learners answer questions.

3. Assessment and evaluation methods

Assessment is the process of evaluating the teaching and learning processes through collecting and interpreting evidence of individual learner's progress in learning and to make a judgment about a learner's achievements measured against defined standards. Assessment is an integral part of the teaching and learning processes. In the new competence-based curriculum assessment must also be competence-based; whereby a learner is given a complex situation related to his/her everyday life and asked to try to overcome the situation by applying what he/she learned.

3.1 Types of assessment

The two types of assessment that will be employed in the new curriculum is **formative** and **summative** assessment.

a) **Formative and continuous assessment (assessment for learning)**

Formative or continuous assessment involves formal and informal methods used by schools to check whether learning is taking place. When a teacher is planning his/her lesson, he/she should establish criteria for performance and behavior changes at the beginning of a unit. Then at the end of every unit, the teacher should ensure that all the learners have mastered the stated key unit competencies basing on the

criteria stated, before going to the next unit. The teacher will assess how well each learner masters both the subject matter and the generic competencies described in the syllabus and from this, the teacher will gain a picture of the all-round progress of the learner. The teacher will use one or a combination of the following:

- **Observation to judge the extent of skills acquisition**
- **Written tests**
- **Oral questions**
- **Project work**
- **Attitude change** – this can be done by asking probing questions and checking body language as learners respond to the questions.

(i) **Written tests**

Under this, learners are given questions or tasks and are required to respond in writing. Examples of written tests are: short answer type questions, structured type questions, filling blanks, multiple choice questions, true-false questions and matching items.

(ii) **Practical work or Activity**

In this category, learners are required to perform a task or solve a problem practically. The teacher then assesses the finished work by looking at the materials used, procedures followed, whether it works or not or whether it is

finished. He or she then awards marks accordingly.

(iii) Observation

This involves the teacher observing learners as they perform a practical task to assess acquisition of skills and attitude change. The teacher checks ability of the learner to measure, classify, communicate findings, etc. He or she also assesses the learner's curiosity, patience, team and co-operation spirit among others.

(iv) Oral questions or interviews

Asking learners questions which require a verbal response such as naming parts of human body, a system or short explanations of a process such as digestion can also be used to assess a learner's level of competence.

(v) Drawing

This involves asking learners to draw something they have observed or learnt about. They can also collect data and draw graphs and interpret the graph and give conclusions. This helps to assess their skills in communication through recording.

(vi) Project work

In a project, learners undertake a comprehensive study of something in real life over a period of time such as several weeks or even months after which they present a report. In project work, let learners begin from planning stage (come up with a schedule of events), execute the plan, analyse the results and look back (reflect on the challenges encountered during the project and come up with solutions to those challenges—problem-solving skills).

A teacher can use one or several of these assessment methods depending on the subtopic being studied or the purpose for which assessment is required.

When should the teacher assess learning progress?

The teacher should decide whether to assess learners at the end of the lesson or at any other appropriate time when enough content has been covered. The general criteria to use to gauge learner achievement in the various generic competency areas is given in the table below.

Name of Learner	COMM	I&C	CT	RS	LL	PS	C&I
A	Red	Blue	Yellow	Blue	Red	Green	Yellow
B	Yellow	Red	Blue	Yellow	Blue	Red	Blue
C	Green	Blue	Red	Yellow	Blue	Red	Yellow
D	Yellow	Green	Yellow	Red	Yellow	Yellow	Green
E	Red	Blue	Yellow	Blue	Yellow	Red	Blue
F	Blue	Yellow	Red	Yellow	Blue	Green	Red
G	Yellow	Green	Blue	Yellow	Red	Blue	Green

KEY: Red	–	Poor	COMM	–	Communication in English
Green	–	Good	I & C	–	Interpersonal skills & Co-operation
Yellow	–	Excellent	CT	–	Critical Thinking
Blue	–	Average	RS	–	Research Skills
			LL	–	Life long skills
			PS	–	Problems solving skills
			C & I	–	Creativity & Innovation

Allocate marks for each colour and calculate the marks that the learner has attained. Grade the learners based on how they have scored here and in the various tests given to assess skills acquisition and attitude change.

b) Summative assessment (assessment of learning)

When assessment is used to record a judgment of a competence or performance of the learner, it serves a summative purpose. Summative assessment gives a picture of a learner's competence or progress at any specific moment. The main purpose of summative assessment is to evaluate whether learning objectives have been achieved and to use the results for the ranking or grading of learners, for deciding on progression, for selection into the next level of education and for certification. This assessment should have an integrative aspect whereby a student must be able to show mastery of all competencies.

It can be internal school based assessment or external assessment in the form of national examinations. School based summative assessment should take place once at the end of each term and once at the end of the year. School summative assessment

average scores for each subject will be weighted and included in the final national examinations grade. School based assessment average grade will contribute a certain percentage as teachers gain more experience and confidence in assessment techniques and in the third year of the implementation of the new curriculum it will contribute 10% of the final grade, but will be progressively increased. Districts will be supported to continue their initiative to organise a common test per class for all the schools to evaluate the performance and the achievement level of learners in individual schools.

Item writing in summative assessment

Before developing a question paper, a plan or specification of what is to be tested or examined must be elaborated to show the units or topics to be tested on, the number of questions in each level of Bloom's taxonomy and the marks allocation for each question. In a competency based curriculum, questions

from higher levels of Bloom's taxonomy should be given more weight than those from knowledge and comprehension level.

Before developing a question paper, the item writer must ensure that the test or examination questions are tailored towards competency based assessment by doing the following:

- Identify topic areas to be tested on from the subject syllabus.
- Outline subject matter content to be considered as the basis for the test.
- Identify learning outcomes to be measured by the test.
- Prepare a table of specifications.

- Ensure that the verbs used in the formulation of questions do not require memorization or recall answers only but testing broad competencies as stated in the syllabus.

3.2 Structure and format of the examination

There will be two papers for Physics subject at ordinary level. Paper 1 consists of closed, semi-structured and open/ extended questions while paper 2 is practical. Time will depend on the paper's items and weight. Extra time will be given to learners with special education needs if found necessary.

Component weighting

Paper I	Component	Weighting
Paper 1	<p>The paper will measure both knowledge and understanding of the subject matter and acquisition of competences. The question items will be balanced as follows:</p> <ul style="list-style-type: none"> • Assessment of Knowledge and understanding (questions from low levels of Bloom's taxonomy) 30 % • Assessment of Skills and competences (questions from higher levels of Bloom's taxonomy :application, analysis, evaluation and synthesis) 40% 	70%
Paper 2	<p>Practical skills: The paper to measure practical/ experimental skills (Observation, Recording & report writing, Manipulation, Measurement, Planning & designing). The experiments should be drawn from different topic areas of the syllabus.30%</p> <p>This paper will consist of experiments drawn from different areas of the syllabus. Candidates will answer all questions</p>	30%

3.3 Record Keeping

This is gathering facts and evidence from assessment instruments and using them to judge the student's performance by assigning an indicator against the set criteria or standard. Whatever assessment procedures used shall generate data in the form of scores which will be carefully be recorded and stored in a portfolio because they will contribute for remedial actions, for alternative instructional strategy and feed back to the learner and to the parents to check the learning progress and to advice accordingly or to the final assessment of the students.

This portfolio is a folder (or binder or even a digital collection) containing the student's work as well as the student's evaluation of the strengths and weaknesses of the work. Portfolios reflect not only work produced (such as

papers and assignments), but also it is a record of the activities undertaken over time as part of student learning. The portfolio output (formative assessment) will be considered only as enough for three years of Advanced level. Besides, it will serve as a verification tool for each learner that he/she attended the whole learning before he/she undergoes the end of the term.

3.4 Reporting to parents

The wider range of learning in the new curriculum means that it is necessary to think again about how to share learners' progress with parents. A single mark is not sufficient to convey the different expectations of learning, which are in the learning objectives. The most helpful reporting is to share what students are doing well and where they need to improve.

Content Maps

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
	Unit 1 Laboratory safety rules and measurements of physical quantities	Unit 2 Qualitative analysis of linear motion	Unit 3 Force (I)	Unit 4 Newton's laws of motion	Unit 5 Centre of gravity
Number of periods	15	15	10	10	10
Introduction	<ul style="list-style-type: none"> Nature of Physics and the importance of studying Physics. Laboratory rules and precaution measures. Different instruments for measuring physical quantities 	<ul style="list-style-type: none"> Explanation for distance, displacement, speed, velocity and Acceleration. Draw and interpret graphs of motion. 	<ul style="list-style-type: none"> Types of forces and their effect on a body. 	<ul style="list-style-type: none"> Newton's laws of motion and their applications. 	<ul style="list-style-type: none"> Position of centre of gravity on regular and irregular objects and its application. Effects of the position of centre of gravity on states of equilibrium.
Classroom organisation	<ul style="list-style-type: none"> Whole class orientation Group work Individual work Pair work 	<ul style="list-style-type: none"> Whole class orientation, Individual work and then working in groups. 	<ul style="list-style-type: none"> Whole class orientation Group work Individual work Pair work 	<ul style="list-style-type: none"> Pair work Whole class orientation Group work Individual work 	<ul style="list-style-type: none"> Whole class orientation Group work Individual work Pair work

Equipment required	Sample scientific reports and laboratory safety rules manual, glass beakers, water, wood blocks, Vernier calliper, micrometer screw gauge, marbles, metallic weights, thread, stop watch, balance scales, eureka can, measuring cylinder, different objects to be measured, internet enabled computers	Charts Metre rule Stopwatch Surveyor tape measure Runway Graph papers Internet enabled computers	Charts, bench, wooden block, stopwatch, marbles. Internet enabled computers	Stopwatches, rulers, spring balance, string, body, inclined plane, beam balance and trolleys.	Conical, spherical and triangular objects, metre ruler, Bunsen burner, wooden blocks, plumb line, regular and irregular shaped lamina of cardboard, internet enabled computers and reference books.
Activities	<p>Activities on:</p> <ol style="list-style-type: none"> 1. Research on Physics as a science and its characteristics. 2. Group discussion on career opportunities in Physics. 3. Group discussion on science process skills in learning Physics. 	<p>Activities on:</p> <ol style="list-style-type: none"> 1. Internet research in the definition of distance, displacement, speed, velocity and acceleration. 2. Discussion of definition of motion and listing different types of linear motion. 	<p>Activities on:</p> <ol style="list-style-type: none"> 1. Internet research on the definition of forces. 2. Experimental representation demonstrating different types of forces. 3. Laboratory experiments to demonstrate the difference between contact and non-contact forces. 	<p>Activities on:</p> <ol style="list-style-type: none"> 1. Investigating Newton's first laws of motion. 	<p>Activities on:</p> <ol style="list-style-type: none"> 1. Investigating centre of gravity and centre of mass of a body.

<p>Competencies practised</p>	<p>4. Discussion on laboratory safety measures, first aid and hazards in the lab.</p> <p>5. Researching fundamental and derived quantities of measurements.</p> <p>6. Research on measuring instruments and using them in measuring.</p> <p>7. Determining volume of objects.</p> <p>8. Determining mass of objects.</p> <p>9. Determining density of objects.</p>	<p>3. Analysis on the differences between instantaneous and average speed, velocity and acceleration.</p> <p>4. Working in groups in analysing graphs on distance, speed, velocity, displacement and acceleration against time.</p> <p>5. Individually, formulating the linear motion formula and the measurements of the acceleration due to gravity.</p>	<p>4. Discussions in groups the representation of forces using vector diagrams.</p> <p>5. In groups, demonstrating addition of parallel and non-parallel forces.</p> <p>6. Performing experiments to demonstrate the effects of balanced and unbalanced forces.</p>	<p>2. Investigating Newton's second law of motion</p> <p>3. Investigating Newton's third law of motion.</p>	<p>2. Determining the centre of gravity of regular lamina and irregular lamina.</p> <p>3. Observe the effect of position of c.o.g on state of equilibrium.</p> <p>4. Conducting research on applications of centre of gravity.</p>	<p>Competencies practised</p>	<ul style="list-style-type: none"> • Teamwork • Communication skills • Research • Critical thinking • Creativity • Presentation of findings • Problem solving • Measuring 	<ul style="list-style-type: none"> • Critical thinking • Creativity • Presentation of findings • Problem solving • Communication skills 	<ul style="list-style-type: none"> • Critical thinking • Creativity • Presentation of findings • Problem solving • Teamwork • Communication skills • Research 	<ul style="list-style-type: none"> • Problem solving • Research • Critical thinking • Creativity • Communication skills 	<ul style="list-style-type: none"> • Teamwork • Communication skills • Research • Critical thinking • Creativity • Presentation of findings • Problem solving
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Language practise	<ul style="list-style-type: none"> • Writing rules • Organising information • Discussion in groups • Writing units for quantities 	<ul style="list-style-type: none"> • Discussions in groups ▪ Presentation of experimental findings, observation and results. ▪ Writing 	<ul style="list-style-type: none"> ▪ Writing observations ▪ Discussion in groups. ▪ Presentation of experimental findings, observation and results. 	<ul style="list-style-type: none"> • Writing observations. • Discussion in groups. 	<ul style="list-style-type: none"> • Presentation of experimental findings, observation and results. • Writing observations. • Discussion in groups.
Vocabulary acquisition	<ul style="list-style-type: none"> • Measurement terms • Names of instruments used for measurement • SI units 	Terminologies on linear motion	Terminologies on forces	<ul style="list-style-type: none"> • Terminologies used to describe motion e.g. inertia, moment etc 	<ul style="list-style-type: none"> • Stability terminologies
Numeracy	<ul style="list-style-type: none"> • Converting units from one form to another. • Calculating density, volume, mass, time, area and other quantities. 	Graphical representation of findings and the data collected. Solving numerical problems on distance, displacement, speed, velocity and acceleration.	Solving numerical problems on forces.	<ul style="list-style-type: none"> • Solving problems related to Newton's laws of motion. • Determination of acceleration due to gravity. 	

<p>Study skills</p>	<ul style="list-style-type: none"> • Correct measurement length and mass of objects. • Correct drawings • Ability to perform experiments • Correct observation of experimental results. • Using internet correctly • Proper note taking • Ability to compare and contrast for example, mass and weight. 	<ul style="list-style-type: none"> • Proper organisation of experimental results and observation for presentations. • Proper note taking • Ability to perform experiments correctly • Proper observation of experimental results. • Proper recording of observations in tabular form. 	<ul style="list-style-type: none"> • Ability to perform experiments correctly • Correct observation of experimental results. • Ability to organise experimental results and observation for presentations. • Proper note taking, recording and observations in tabular form. 	<ul style="list-style-type: none"> • Ability to perform experiments correctly • Correct observation of experimental results. • Ability to use the internet correctly • Correct note taking • Correct drawing • Problem solving skills 	<ul style="list-style-type: none"> • Proper organisation of experimental results and observation for presentations. • Proper note taking • Ability to perform experiments correctly • Correct observational results.
<p>Revision</p>	<p>Revision exercises provided(exercises and unit test 1)</p>	<p>Revision exercises provided (exercises and unit test 2)</p>	<p>Revision exercises provided (exercises and unit test 3)</p>	<p>Revision exercises provided(exercises and unit test 4)</p>	<p>Revision exercises provided(exercises and unit test 5)</p>
<p>Assessments</p>	<p>A formative assessment of performing experiments on measurements, laboratory safety rules and solving problems.</p>	<p>A formative assessment of drawing linear motion graphs from the data collected and interpreting them.</p>	<p>A formative assessment of performing experiments demonstrating the types of forces and their effects on a body.</p>	<p>A formative assessment of performing experiments and solving problems on Newton's laws of motion.</p>	<p>A formative assessment of performing experiments on centre of gravity.</p>

<p>Learning outcomes</p>	<ol style="list-style-type: none"> 1. Ability to explain Physics as a science. 2. Defining Physics correctly. 3. Ability to explain the relationship between Physics, other science subjects, society and technology. 4. Ability to describe the science processes skills use in learning. 5. Understanding Laboratory safety and safety rules. 6. Defining basic fundamental quantities correctly. 7. Correct use of instruments in measuring length, mass and time. 8. Ability to state and use derived quantities correctly. 9. Ability to state the SI Units correctly. 10. Ability to use metric prefixes in everyday use name symbols and factor. 11. Ability to perform experiments on density with ease. 	<ol style="list-style-type: none"> 1. Correct definitions of distance, displacement, velocity, speed, acceleration, and correct deriving their respective formulas. 2. Understanding the difference between instantaneous and average speed. 3. Ability to collect data, tabulate and correctly representing the findings graphically. 	<ol style="list-style-type: none"> 1. Ability to define different types of forces correctly. 2. Ability to explain practical and real life applications of forces and their effects on the daily operations on humans. 3. Ability to demonstrate different types of forces. 	<ol style="list-style-type: none"> 1. Ability to explain the relationship between mass and inertia. 2. Ability to explain Newton's First Law of motion. 3. Ability to explain Newton's Second Law of motion. 4. Ability to explain Newton's Third Law of motion 5. Ability to explain Newton's law of universal gravitation. 6. Ability to explain the application of newton's law of motion on frictionless horizontal surface. 7. Ability to describe and determine the acceleration due to gravity. 	<ol style="list-style-type: none"> 1. Correct definition of centre of gravity. 2. Ability to determine the centre of gravity of regular and irregular objects. 3. Ability to explain the effects of the position of centre of gravity on stability of objects.
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	Unit 6 Work, Energy and Power	Unit 7 Simple Machines (I)	Unit 8 Kinetic theory and states of matter	Unit 9 Heat and Temperature	Unit 10 Magnetism
Number of periods	14	10	10	9	10
Introduction	<ul style="list-style-type: none"> • Work done on carrying out a particular task, • Energy spent to complete the task and the rate at which the task was done (power). • Analyse the process of energy transformation. 	<ul style="list-style-type: none"> • Common simple machines and how they make work easier • Mechanical advantage, velocity ratio and efficiency of machines. 	<ul style="list-style-type: none"> • Physical properties of matter to temperature and their applications. 	<ul style="list-style-type: none"> • Different temperature scales and how to convert from scale to the other. • Types of thermometers and how to calibrate them. • Properties of thermometric liquids used in thermometers • Boiling point of different substances. 	<ul style="list-style-type: none"> • Magnetic and non-magnetic materials • Properties of magnets.
Classroom organization	<ul style="list-style-type: none"> • Whole class orientation • Individual work and • Group work 	<ul style="list-style-type: none"> • Individual work • Pair work • Whole class orientation 	<ul style="list-style-type: none"> • Whole class orientation • Individual work and • Group work 	<ul style="list-style-type: none"> • Whole class orientation, • Individual work and then working in groups. 	<ul style="list-style-type: none"> • Whole class orientation, • Group work, • Individual work, • Pair work

<p>Equipment required</p>	<p>Stop watch, weighing machine, tape measure Heavy bag with books, stairs, Internet enabled computers Plastic bottle, water Two pens, a stone Bunsen burner/candle, match box, a retort stand, a nail/metallic rod, An electric heater and a radio, water in a basin, A bob, a string, Tennis ball</p>	<p>Incline plane, wheelbarrow, hammer, spanner, trolley, pulley, piece of wood. Internet enabled computers</p>	<p>Piece of chalk or a piece of paper Internet enabled computers, water, alcohol Sand, iron fillings, a magnet Marbles and a transparent square bowl/tray</p>	<p>Source of heat, Clinical thermometers, internet access computers, laboratory access.</p>	<p>Permanent magnet, pieces of glasses, bar magnet, iron nails, plastics, wood, mercury(thermometer), coins, rubber, lead metal, graphite motors, mobile phone, steel nails, metals, cotton threads, pieces of wood, internet enabled computers, iron filings and reference books.</p>
<p>Activities</p>	<p>Activities on: 1. Individual work and then group discussion on when work is done in science. 2. Group work on finding work done in pulling an object a long a horizontal surface.</p>	<p>Activities on: 1. Research from the internet on the definition of simple machines. 2. Group discussions on the types and the different categories of simple machines.</p>	<p>Activities on: 1. Work in pairs what matter is 2. Individual work on what matter is made of. 3. Group work on physical and chemical properties of matter, categories of physical properties and their applications.</p>	<p>Activities on: 1. Research internet search on definition of heat and temperature. 2. Discussion and presentation of temperature as the degree of hotness and coldness.</p>	<p>Activities on: 1. Group discussion on definition of a magnet. 2. Identifying magnetic and non-magnetic substances. 3. Establishing properties of a magnet. 4. Testing for magnetism and types of magnets. 5. Drawing magnetic field patterns round a magnet.</p>

	<p>3. Group work on comparing time taken to do piece of work by a person and a machine.</p> <p>4. Group work on determining one's power.</p> <p>5. In pairs of two to discuss about energy and different forms of energy.</p> <p>6. A group discussion on energy –work relationship.</p> <p>7. Group work on solar energy.</p> <p>8. Individual work on sound energy.</p>	<p>3. Laboratory experiments on the demonstrations of the work output of machines and frictions in machines.</p> <p>4. Performance of experiments in groups on the determination of efficiency of simple machines.</p>	<p>4. Work in pairs to show the help of magnetism as a physical property to separate mixed substances</p> <p>5. Group work on introduction to kinetic theory</p> <p>6. Group work on properties of solids, and comparing the densities of homogenous and heterogeneous mixture</p> <p>7. Group work on properties of liquids and to show viscosity in fluids</p> <p>8. Group work on properties of gases and to show that a gas occupies</p>	<p>3. Discussion on the measurements of temperature and the conversion of different units of temperature measurements.</p> <p>4. Laboratory experiments on the melting and boiling points of different substances.</p>	
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Competencies practised	<ul style="list-style-type: none"> • Critical thinking • Problem solving • Communication skills • Co-operation, interpersonal management and life skill 	<ul style="list-style-type: none"> • Presentation of findings • Problem solving • Teamwork • Communication skills • Research 	<ul style="list-style-type: none"> • Teamwork • Research skills • Creativity and innovation • Critical thinking • Communication skills • Co-operation, interpersonal management and life skills 	<ul style="list-style-type: none"> • Team work • Presentation and findings • Communication skills • Research • Teamwork • Communication skills • Problem solving 	<ul style="list-style-type: none"> • Teamwork • Communication skills • Research • Critical thinking • Creativity • Presentation of findings • Problem solving
Language practise	<ul style="list-style-type: none"> • Discussion in groups and pairs. • Presentation of findings making/ writing notes. 	<ul style="list-style-type: none"> • Presentation of experimental findings, observation and results. • Writing observations. • Discussion in groups. 	<ul style="list-style-type: none"> • Discussion in groups and pairs • Presentation of finding • Making/ writing notes. 	<ul style="list-style-type: none"> • Discussions in groups • Presentation of findings • Writing notes in the booklets on observations. 	<ul style="list-style-type: none"> • Presentation of experimental findings, observation and results. • Writing observations. • Discussion in groups.
Vocabulary acquisition	<ul style="list-style-type: none"> • Energy conservation related terms. 	<ul style="list-style-type: none"> • Terminologies on simple machines. 	<ul style="list-style-type: none"> • Matter related terms. 	<ul style="list-style-type: none"> • Terminologies in heat and temperature. 	<ul style="list-style-type: none"> • Names of different types of magnets. • Magnetism terminologies

Numeracy	Solving numerical problems on work, power and energy.	Calculations on efficiency of machines.		Solving problem on temperature e.g in convert from one temperature scale to other.	
Study skills	<ul style="list-style-type: none"> • Proper estimation of kinetic and potential energy of bodies in different situations. • Solving problems related to work, power and energy correctly. • Ability to estimate the power of an individual climbing a flight of stairs. • Ability to describe ways of conserving energy. • Ability to explain the principle of energy conservation. 	<ul style="list-style-type: none"> • Proper organisation of experimental results and observation for presentations. • Proper note taking. • Correct recording of the observations in tabular form. • Ability to perform experiments correctly • Correct observation of experimental results. 	<ul style="list-style-type: none"> • Ability to classify materials using physical properties. • Ability to explain physical properties of solids, liquids, and gases using the kinetic theory of matter. • Ability to separate mixtures using physical properties. • Ability to perform an experiment to illustrate viscosity. 	<ul style="list-style-type: none"> • Proper note taking. • Correct organising of findings and information. • Proper organisation of experimental results and observations. • Proper observation of experimental results. • Ability to perform experiments. 	<ul style="list-style-type: none"> • Proper organisation of experimental results and observations for presentations. • Proper note taking. • Ability to perform experiments. • Correct observation of experimental results. • Proper recording observations in tabular form.
Revision	Revision exercises provided (exercises and unit test 6)	Revision exercises provided (exercises and unit test 7)	Revision exercises provided (exercises and unit test 8)	Revision exercises provided (exercises and unit tests 9)	Revision exercises provided(exercises and unit test 10)

<p>Assessments</p>	<ul style="list-style-type: none"> • A formative assessment of tasks termed as work and work related problems. • A formative assessment task on power and related problems. • A formative assessment task on energy, forms of energy, energy transformations and ways of conserving energy. 	<ul style="list-style-type: none"> • A formative assessment of performing experiments demonstrating simple machines and the types of machines. 	<ul style="list-style-type: none"> • A formative assessment on simple kinetic theory. • Formative assessment physical properties of mater. • A formative assessment on properties of solids. • A formative assessment on properties of liquids. • A formative assessment on properties of gases. 	<ul style="list-style-type: none"> • A formative assessment of performing experiments on magnetism. 	<ul style="list-style-type: none"> • A formative assessment of performing experiments on magnetism.
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<p>Learning outcomes</p>	<ol style="list-style-type: none"> 1. Understanding the different forms of energy. 2. Understanding transformation of kinetic energy to potential energy and vice versa. 3. Understanding the different sources of energy. 4. Understanding the different ways to conserve energy. 5. Understanding the law of conservation of mechanical energy. 6. Understanding the transformation of energy. 	<ol style="list-style-type: none"> 1. Correct definition of simple machines, ability to state different types, and giving correct examples. 2. Ability to explain the practical and real life applications of simple machines and how they make work easier. 3. Ability to determine efficiency of simple machines and their mechanical advantages. 	<ol style="list-style-type: none"> 1. Understanding Simple kinetic theory. 2. Understanding the physical properties of solids. 3. Understanding the physical properties of liquids. 4. Understanding the physical properties of gases. 5. Understanding the applicational properties of physical properties. 6. Understanding and recognising of physical properties of matter. 	<ol style="list-style-type: none"> 1. Correct definition of heat and temperature. 2. Correct determination of the boiling and melting points of different substances. 3. Ability to differentiate and state the advantages between mercury and alcohol temperatures. 4. Ability to correctly convert different temperature scales from one to the other. 	<ol style="list-style-type: none"> 1. Correct definition of a magnet. 2. Ability to identify magnetic and non-magnetic materials. 3. Ability to test for magnetism. 4. Ability to identify different types of magnets.
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	Unit 11 Electrostatic (I)	Unit 12 Current Electricity (I)	Unit 13 Rectilinear propagation of light
Number of periods	10	10	10
Introduction	<ul style="list-style-type: none"> • Types of electrostatic charges. • Charging conductors using different methods. • Distribution of charges on different conductors. • Effects of electrostatic charges on an object or a body. 	<ul style="list-style-type: none"> • Component of electric circuit. • Electric energy and power • Common devices for protecting electrical appliances. • Effect of any electric current. 	<ul style="list-style-type: none"> • Nature and sources of light . • Rectilinear propagation of light. • Reflected light on a plane mirror and its application.
Classroom organization	<ul style="list-style-type: none"> • Whole class orientation • Individual work and then working in groups. 	<ul style="list-style-type: none"> • Whole class orientation, • Group work • Individual work • Pair work 	<ul style="list-style-type: none"> • Whole class orientation • Group work • Individual work • Pair work
Equipment required	Internet enabled computers, reference books, gold leaf electroscope, polythene strips, glass rod, ebonite insulated conductor, a pen	Dry cells, connection wires, bulbs, internet enabled computers, reference books, car battery, ammeter, voltmeter.	Source of light, three pieces of card each with small hole in the centre, 1 metre of thread, plasticine, screen, torch, dry cells, dark room, opaque mirrors, soft board, optical pins, internet enable computers.

Activities	<p>Activities on:</p> <ol style="list-style-type: none"> 1. The bending water and attraction balloon to the wall due to charged bodies. 2. Performing different experiment on methods of charging conductors. 3. Discussion of the law of electrostatic. 4. Performing experiment to show how a gold leaf electroscope is charged and used to detect the type of charge on a conductor. 5. Research on charge distribution on different body shapes. 	<p>Activities on:</p> <ol style="list-style-type: none"> 1. Experimental representation of the simple circuit connection. 2. Discussion on the flow and the sources of electric current. 3. Group work experiments in the lab on the potential difference and the verifications of Ohm's law. 4. Discussions on effects of electric currents and the safety precautions to be observed when handling electrical applications. 	<p>Activities on:</p> <ol style="list-style-type: none"> 1. Research to find out nature of light. 2. Laboratory experiments to classify materials as transparent, translucent and opaque. 3. Laboratory experiments to investigate propagation of light. 4. Laboratory experiment on reflection of light 5. Observing characteristics of images formed by plane mirrors and pin hole camera 6. Project work on construction of pinhole camera.
Competences practised	<ul style="list-style-type: none"> • Teamwork • Communication skills • Research • Critical thinking • Creativity • Presentation of findings • Problem solving 	<ul style="list-style-type: none"> • Teamwork • Communication skills • Research • Critical thinking • Creativity • Presentation of findings • Problem solving 	<ul style="list-style-type: none"> • Teamwork • Communication skills • Research • Critical thinking • Creativity • Presentation of findings • Problem solving
Language practise	<ul style="list-style-type: none"> • Discussion in groups and pairs. • Presentation of findings. • Making/ writing notes. 	<ul style="list-style-type: none"> • Discussion in groups. • Presentation of experimental findings, observation and results. • Writing observations. 	<ul style="list-style-type: none"> • Writing observations. • Discussion in groups. • Presentation of experimental findings, observation and results.

Vocabulary acquisition	Terminologies on origin of charges, methods of charging a conductor, coulombs, Detection of charge etc.	Terminologies on current and electricity.	Terminologies used in the unit describing nature of light e.g rectilinear etc.
Numeracy	Calculation on coulomb's laws.	Calculation on current and electricity.	Calculating magnification of an image, number of images formed by plane mirror, angles of reflection.
Study skills	<ul style="list-style-type: none"> • Proper organisation of experimental results and observation for presentations. • Correct note taking. • Proper recording of observations in tabular form. • Ability to perform experiments correctly. • Correct observation of experimental results. 	<ul style="list-style-type: none"> • Proper organisation of experimental results and observation for presentations. • Correct note taking. • Ability to perform experiments. • Correct observation of experimental results. • Proper recording of observations in tabular form. 	<ul style="list-style-type: none"> • Ability to perform experiments correctly. • Correct observation of experimental results. • Ability to use internet for research. • Correct note taking. • Correct drawing.
Revision	Revision exercises provided (exercises and unit test 11.)	Revision exercises provided (exercises and unit test 12)	Revision exercises provided (exercises and unit test 13)
Assessments	Formative assessment of performing experiments on electrostatics and solve problems.	A formative assessment of performing experiments on current and electricity.	A formative assessment of performing experiments on light and solving problems.

<p>Learning outcomes</p>	<ol style="list-style-type: none"> 1. Correct definition of electrostatics. 2. Correct drawings of how charges are distributed in different shapes. 3. Ability to perform experiments on methods of charging a conductor with ease. 4. Ability to show practically how a gold electroscope works. 5. Ability to determine practically the factors that affect the magnitude of force between two charged objects. 	<ol style="list-style-type: none"> 1. Correct definition of current and electricity. 2. Ability to demonstrate practically Ohm's law and the effects of electric current. 3. Correct explanation of the applications of heating effect of an electric current. 4. Ability to highlight the measures and precaution to be taken when using electricity in our homes. 5. Correct explanation on the functions of fuses and the earthing connection in the electrical appliances. 	<ol style="list-style-type: none"> 1. Ability to state different sources of light. 2. Correct description of rays and beams. 3. Ability to classify materials as transparent, translucent and opaque. 4. Ability to carry out experiments on light propagation. 5. Correct explanation of rectilinear propagation of light. 6. Ability to state different types of reflection. 7. Correct description of formation of shadow and eclipses. 8. Ability to explain lunar and solar eclipses. 9. Ability to state the law of reflection. 10. Ability to describe the characteristics of images formed in plane mirrors. 11. Ability to use the ray diagrams to correctly locate the image of an object and numbers of images formed in inclined mirrors. 12. Ability to explain the applications of reflection of light on a plane mirror.
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Mechanics

Introduction to Physics

Unit 1

Laboratory Safety Rules and Measurements of Physical Quantities

Student's Book pages 1-59 (15 Periods)

Key unit competence

By the end of this unit, the learner should be able to explain the importance of Physics, measure physical quantities and express findings in appropriate units.

Learning objectives

Knowledge and understanding

- Explain the nature of Physics and its application.
- Discuss characteristics of physics.
- Discuss branches of Physics and their benefits to mankind's development.
- Identify career opportunities related to Physics.
- Explain the basic fundamental physical quantities.
- Differentiate between derived physical quantities and fundamental quantities.
- Introduce international system (SI) of measurements units.
- State and explain basic laboratory safety rules.
- State /recall $\rho = \frac{m}{v}$

Skills

- Explain the relationship between physics technology and society.
- Formulate scientific predictions.
- State and explain basic laboratory rules for conducting experiments.
- Write a simple scientific report of experiment carried out.
- Identify laboratory hazards and safety precautions to be taken.
- Choose an appropriate measuring instrument.
- Measure physical quantities: length, volume, mass, time and density and express findings in appropriate units.
- Relate Physics with observed phenomena.
- Predict body floats in water based on its density.
- Convert other metric units to SI units.

Attitudes and values

- Appreciate application of Physics in everyday life situations.
- Develop responsible behaviour towards environmental problems.
- Apply scientific method with all the rigor, intellectual honesty and critical thinking.
- Comply with laboratory safety rules.
- Behave as responsible citizens that are able to make decisions based on scientific attitudes and findings.
- Use of appropriate terminologies and simple mathematical formulae.
- Appreciate the importance of accurate measurements.
- Make a judgment of the usefulness of measurement obtained from experiments.
- Develop the skills of observation, recording, analysing interpretation and verification.

Generic competencies addressed in this unit

- Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
- Research and problem solving. The several practical activities within the learner's book.
- Critical thinking. The learners are involved in the group discussions, class examples and problems to be solved.

Links to other subjects

Science process and safety rules in Biology, Chemistry, Mathematics (measurements), Home science (measurements and precision) Geography (area of a given space), primary science.

Cross cutting issues addressed in this unit

- Comprehensive safety measures in everyday life activities. First aid measures are broadly elaborated, Activity 1.10.

Assessment criteria

The learner should outline the benefits of Physics to mankind, carryout experiments and report the results, can use various measuring instruments to measure physical quantities and express findings in appropriate units.

Teaching methodologies

- Group work.
- Class discussions.
- Question and answers.
- Class demonstrations.
- Role-play.

Background information

Most learners have encountered with different devices e.g. mobile phones, generators, computers etc. They have done measurement in their homes when cooking or in the field when playing. They have also estimated how long it takes to walk from their home to school. Build on these and other familiar experiences to introduce this unit.

Engage all the learners in all practical activities given in student's book.

Suggested teaching/learning activities

1.1 What is Science?

(1 Period)

By the end of this section, the learner should be able to define the term science and state its branches.

Information to the teacher

Learners already learnt the meaning of science in primary level. Start this section by reviewing the meaning of science and put more emphasis on the branches. As a teacher, you are required to read widely from internet and other relevant materials to equip yourself with sufficient knowledge in this section and others.

Suggested teaching/learning materials

- Reference books, Internet

Preparation

As a teacher you may ask learners to do individual research from the internet and reference materials a day earlier or during the lesson depend on availability of time.

Teaching guidelines 1.1

- Ask learners to form groups. Ensure that the group formed comprises of:

1. Learners of different abilities (slow learners and fast learners).
2. Different gender i.e. boys and girls in case it is a mixed class.
3. Disabled students in case they are there in your class and can be able to do activity.

This will enable learners to appreciate others and boost their self-esteem as they learn from each other.

- Ask them to choose a group leader and a secretary (preferably the disabled student if he/she can handle).
- Let the group leaders lead their members through the discussion of activity 1.1 given in student's book i.e. to describe science.
- Ask each group secretary or any other member of each group to report their findings to the whole class.
- Allow other members of the class to point out omissions or errors on each fact represented.
- Summarise the discussion by emphasizing on the key points:
 1. Science refers to a systematic study that uses observations and experimentation to describe and explain natural phenomena.
 2. Science may be divided into: social, natural and formal sciences. Social science deals with human behaviour and society e.g. psychology. Natural science deals with

natural phenomena e.g. lighting earthquakes etc. examples are physics, chemistry and biology. Formal science deals with mathematical concept and logics example is mathematics.

At this point it is a good idea to correct error in learner's discussion.

- Conclude the discussion by assessing whether the objectives of this section have been achieved. This can be done through question and answer method.
- This activity will promote in learner among other competencies:
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving. Through several practical activities given the learner's book.
 3. Critical thinking. The learners are involved in the critical thinking through group discussions, class examples and solving problems.
 4. Leadership and organizational skills as learners organise themselves in appropriate groups and lead by their leaders to do the activities.

1.2 Physics as a Science and its Characteristics

(1 Period)

By the end of this section, the learner

should be able to define the term Physics, give a brief history about Physics, highlight reasons why we should study Physics and state and explain its branches.

Information to the teacher

Read widely from internet, reference books and any other relevant reading material to equip yourself with sufficient knowledge to guide the learners.

Suggested teaching/learning materials

- Reference books, Internet

Preparation

Set and organise the required materials in advance. Ask the learners to do individual research. You may prepare and give the learners a questionnaire that will guide them during a research.

Teaching guidelines 1.2

- Organise learners into appropriate groups. Ensure that the groups comprise of students of different abilities and gender in case the class comprises of both boys and girls. Let them choose a group a leader and a secretary.
- Ask the group leaders to lead other members through a discussion of their individual research on activity 1.2 i.e. to define Physics as a science. Let the group secretary note the key points and harmonize them.
- Ask the groups secretaries or choose any other member at random from each group to give a report on their findings to the

- whole class.
- Allow other students to point out the omissions or errors on each presentation.
 - Summarise their discussion by pointing out the key points and correct the errors or omissions made in their discussion. Now, lead them through the discussion given in student's book and put more emphasis on the importance of physics to the Rwandan economy. At this point, it is important to note to the student about electric microwave machine which is used to carry out research on HIV and AIDS and other diseases. Take this opportunity to sensitize the learners on the spread of HIV and AIDS and how they can avoid being infected with the disease. Also educate them the need for caring for both the infected and the affected in the community.
 - Discuss with learners the branches of Physics and how different branches of Physics have contributed to the economy of our country, Rwanda.
 - Conclude this section by assessing whether the objectives have been met through question and answer method.
 - This part of the unit will promote in learners among other competencies:
 1. Cooperation and interpersonal relation. This is adhered through

the involvement of the learners in the numerous activities in the learner's book.

2. Research and problem solving. Through several practical activities within the learner's book.
3. Critical thinking. The learners are involved in the group discussions, class examples and problem solving.

1.3 Physics and other Subjects

(1 period)

By the end of this section, learners should be able to explain the relationship between Physics and other subjects.

Information to the teacher

This section of the unit is equally important, take sufficient time to show learners how physics is related to other subjects. Explain to them the career opportunities that physics opens for them. Note that at this stage of their lives, most learners are not sure of the career to pursue in life.

Suggested teaching/learning materials

- Reference books, internet

Preparation

Ask learners to do a group research on relationship between physics and other subjects.

Teaching guidelines 1.3

- Organise learners into appropriate groups. Ensure that the groups comprise of:
 1. Learners of different abilities (slow and fast learners).
 2. Learners of mixed gender (boys and girls) in case of any.
 3. Disabled students in case they are in the classroom.
- Ask them to choose a group leader and secretary. Ask the group leader to lead others in a discussion of activity 1.3 given in student's book i.e. to establish the relationship between physics and other subjects.
- Ask the group secretaries or choose at random any other group member to give a report on their finding and allow others to point out omissions and errors of the facts given.
- Summarise the discussion by pointing out the main points.
- Conclude this section by assessing the learners through question and answer method and whether the objectives have been achieved.

This section will promote in the learners among other competencies:

1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
2. Research and problem solving by provision of several practical activities in the learner's book.

4. Critical thinking. The learners are involved in the group discussions, class examples and given problems to be solved.

1.4 Career opportunities in Physics

(1 Period)

By the end of this section, the learner should be able to identify the career opportunities Physics opens up for them.

Information to the Teacher

This section is equally important to the learners. It is a section that can determine whether the learner will or will not continue with physics as a subject. As Physics teacher, guide them through various career opportunities in Physics. It is therefore your obligation to explain to them about career opportunities available for them in Physics.

Suggested teaching/learning materials

Preparation

It is a good idea to read widely on various career opportunities in physics to be in a position of guiding your learners appropriately in this section.

Teaching guidelines 1.4

- Ask learners to group themselves into appropriate groups.
- Let them do activity 1.4 given in the student's book i.e. to identify career opportunities in physics.
- Guide them through a discussion on their findings.

- Take learners through a discussion given in the student's book.
- This activity will promote in learners among other competencies:
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to solve.

1.5 Physics, Society and Technology

(1 period)

By the end of this section, the learner should be able to explain the contribution of physics to the development in the society.

Information to the teacher

This section is one of the crucial parts of this unit. It explains how physics has played a great role in the society. You are therefore advised to take adequate time to explain to the learners how physics has improved life in the society. This may be done through the practical activities and role-play given. The role-play given in student's book is meant to assist the learner to understand the concept clearly. You are therefore

required to guide them appropriately. It is a good idea to read widely from the internet, reference books or any other reading materials so that you are well equipped with sufficient knowledge.

Suggested teaching/learning materials

Two mobile phones, envelope, a bag

Preparation

The role-play given in the student's book requires two mobile phones and an envelope so that you can demonstrate the traditional and modern ways of communication. You are therefore required to avail them in advance. You may use your mobile phone or borrow from other teachers.

Teaching guidelines 1.5

- Ask learners to form groups of six. Ensure that the group formed comprise of:
 1. Learners of different abilities.
 2. Both gender i.e. boys and girls
 3. Disabled student if there is any.
- Guide them through the steps of role play provided in student's book activity 1.5 and ask them to role play. Let the sixth student record observations and allow them to discuss their observations after the role-play.
- Ask the group secretary to give a short report on their discussion to the class. Allow a debate on the report for a short time from other members.

- Now, summarise the discussion by helping learners to connect between the role-play and the importance of physics to the development of our society. Prompt the learners to think of other areas where technology through physics has improved the lives of people in Rwandan societies.
- Now, guide them through a discussion given in student's book.
- Conclude this section by assessing the learners through question and answer method whether the objectives have been met. Ask them to do exercise 1.1 in student's book.
- This section will promote learners among other competencies in:
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to solve.

1.6 Science processes skills used in learning of physics

(2 periods)

By the end of this section, the learners should be able to formulate scientific

predictions, write a simple scientific report related to physics and apply scientific method with all the rigor, intellectual, honest and critical thinking.

Information to the teacher

This section will enable learners to analyze, interpret and come up with a solution of a particular problem. It is therefore very important to take your time and guide the learners properly. You are also advised to equip yourself adequately with knowledge in the area by reading widely from other relevant materials e.g. internet and reference books.

Preparation

Ask learners to read from internet or reference materials in advance about scientific processes and skills used in learning of physics.

Teaching guidelines 1.6

- Organise learners into groups of different abilities and gender.
- Using the findings obtained from individual research let them do activity 1.6 given in student's book.
- Take them through the activity and hold a class discussion about their findings.
- Summarise the discussion by highlighting the key points i.e. scientific processes of learning physics, include observation, prediction, data reading and recording, data analysis, interpretation, decision-making and reporting.

- Guide them through the discussion of all these processes given in student's book and ask them to do activity 1.7 on student's book. Note that this activity will enable you to assess the learners whether they have understood the scientific processes learnt, therefore, ensure that you have marked and guided them accordingly. Take them through a sample given in activity 1.8.
- Conclude the discussion by:
 1. Assessing the learners through question and answer method whether they have understood this section. Note that you may choose to address any challenging areas during next lesson for some couple of minutes before or during remedial hours.
 2. Asking them to do exercise 1.2 given in the student's book.
- This section of the unit will promote in the learners:
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to solve.

1.7 Laboratory Safety measures

(1 period)

By the end of this section, the learner should be able to understand laboratory safety measures.

Information to the teacher

This section is very sensitive to both the learner and you as a teacher. This is because both of you use the laboratory and if the safety rules are not understood well, the mess done by a student will affect, you and the whole school at large. It is therefore very important to take this section very serious because it touches on the lives of learners, you as a teacher and the school community at large.

You must take sufficient time to guide the learners one step at a time on the safety rules and regulation so that they can understand them very well and apply them every time they are in the laboratory or even outside.

Suggested teaching/learning materials

First aid kits, charts.

Preparation

Prepare in advance a chart showing categories of safety rules and regulations and another one showing possible laboratory hazards and safety precautions need to be taken.

Teaching guidelines 1.7

- Organise learners into appropriate groups. Ensure that the groups formed comprise of:
 1. Learners of different abilities i.e. slow and fast learners.
 2. Both gender i.e. boys and girls in case it is a mixed class.
 3. Disabled students if there is any.
- Ask them to do activity 1.9 given in the student's book.
- Guide them through the activity and let them discuss among themselves before giving a summary of their discussion. At this point, correct the errors or any omission from the learner's discussion.
- Now, take them through table 1.4 given in the student's book and the chart on the categories of safety rules.
- Conclude the discussion by emphasizing the importance of keenly observing the laboratory safety rules whenever learners are in the laboratory. Explain how a small mistake like careless handling of a burning matchstick may be disastrous to him/her, others and the whole school.
- This activity will promote in learners among other competencies:
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.

2. Research and problem solving by provision of several practical activities within the learner's book.
3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to be solved.

1.8 First aid

(1 Period)

By the end of this section, the learner should be able to identify the items found in a first aid kit and state their uses.

Information to the teacher

Help your learners to name all the items in the kit. It is a good idea to read widely in advance to be able to guide your learners.

Suggested teaching/learning materials

- First aid kit

Preparation

Ensure that you have a full equipped first aid kit before the beginning of the lesson.

Teaching guidelines 1.8

- Organise learners into groups of three students. Ensure that gender balance is observed in case it is a mixed class of boys and girls. Also ensure that learners in each group are of different abilities i.e. slow and fast learners.

- Now ask them to do activity 1.10 given in student's book.
- Guide them through the activity and allow them to discuss the uses of each item in the first aid kit.
- Conclude the discussion by emphasizing to the learners how important it is for each and every learner to have first aid skills i.e. enabling them to deal with any emergency cases anywhere to save lives.
- Note: First aid skills are necessary to every learner including you as a teacher. It is therefore important to train learners on how to handle different situations. You may call an expert or any other teacher who is trained in first aid skills so that he/she can teach you and the learners these skills.
- This activity will promote in learners among other competencies
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to be solved.

1.9 Hazard symbols and their meaning

(1 Period)

By the end of this section, the learner should be able to categorize and identify hazard symbols and their meanings.

Information to the teacher

This section deals with hazard symbols and their meaning. Ensure that your learners understand them well.

Suggested teaching/learning materials

- Charts showing hazard symbols

Preparation

Ensure that you have a chart that shows hazard symbols before the beginning of the lesson.

Teaching guidelines 1.9

- Guide the learners through a chart that shows hazard symbols.
- Now, guide them through a discussion given in the student's book.
- Through question and answer method, ensure that learners have understood the hazard symbols.

1.10 Laboratory hazards and Safety precautions to be taken

(1 Period)

By the end of this section, the learner should be able to state the possible laboratory hazards and suggest the safety precautions to be taken.

Information to the teacher

Read widely from internet and reference book, this section to be in a position of guiding learners appropriately.

Suggested teaching/learning materials

- Chart showing a table of hazards and safety measures
- Reference books.

Preparation

Ensure that you have all the required materials to be used in this section in advance.

Teaching guidelines 1.10

- Organise learners into groups of two. Ensure gender balance and mix of different abilities (i.e. slow and fast learners).
- Ask them to do activity 1.11 given in student's book and report to the whole class.
- Guide them through table 1.5 on hazards and safety measures provided in the student's book or through a chart, summarise by pointing out the possible hazards in the laboratory, such as:
 1. Fire outbreaks.
 2. Electric shock.
 3. Suffocation.
 4. Breaking of equipment among others.
- Emphasize on the safety precaution to be taken incase of the hazards mentioned.

- Conclude the section by:
 1. Assessing the learners by use of question and answer method whether they have understood laboratory rules and safety measures/precaution incase of any laboratory hazards.
 2. Asking them to do exercise 1.3 given in the student's book. Note that you may also use this exercise to assess them.
- This section will promote in learners among other competencies:
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to solve in the learner's book.

1.11 Fundamental and derived quantities of measurement

(1 Period)

By the end of this section, the learner should be able to differentiate between derived physical quantities and fundamental physical quantities. Give examples on each and state their international system (SI) units.

Information to the teacher

This section builds a basis for measurement of physical quantities. It is important to read deeply from other reference books and internet so that you can come up with different approaches towards this section that can enable you and your learners to understand it better.

Suggested teaching/learning materials

- Reference books, Internet

Preparation

Ensure that you have enough reference books or internet enabled computers before the beginning of the lesson. It is a good idea to prepare a questionnaire in advance to assist learners in their research.

Teaching guidelines 1.11

- Ask learners to form groups. Ensure that the groups comprise of:
 1. Different abilities i.e. slow and fast learners.
 2. Gender balance i.e. boys and girls incase the class is mixed one.
 3. Physically challenged learners incase they are there.
- Ask them to choose a group leader and a secretary. Let the group leader lead the others to do activity 1.12 given in the student's book. Note that learners should have done individual research earlier.
- Let them discuss the individual research as the secretaries write down the main points from each research and harmonize them later.
- Ask the secretaries to give a short report on their findings and all the learners to point out omissions or errors on each fact presented.
- Summarise the discussion by pointing out the key points: -
 1. Fundamental quantities are those that cannot be obtained from any other physical quantities. Examples are length, mass, time etc.
 2. Derived quantities are those that are expressed in terms of the fundamental quantities e.g. area, force etc.
 3. Guide them through prefixes for SI units and take them through table 1.6 in student's book.
- Take them through the discussion given in student's book and guide them through the table 1.6 on fundamental quantities and SI units.
- Ask learners to do activity 1.13 given on student's book i.e to practise the use of prefixes.
- Guide them through prefixes for SI units in table 1.7 in student's book.
- Conclude this section by assessing through question and answer method whether the objectives have been achieved.
- This section will promote in learners among other competencies:
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners

- in the numerous activities in the learner's book.
2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and problem-solving.

1.12 Measuring Instrument

(1 Period)

By the end of this section, the learner should be able to use various instruments to measure length, mass and time of various objects and record in the measurements in a table.

Information to the teacher

As a teacher ensure that all learners are actively participating in all activities have in this section to achieve the objectives. Also ensure that the instruments given to learners are functioning and zero error. Read widely on this section from other sources of information to guide your learners appropriately.

Suggested teaching/learning materials

- Ruler, screw gauge, vernier callipers, balances, electronic balances, stopwatches, internet.

Preparation

Arrange and organise the instruments required for a particular activity in time. Correct any zero error in the

instruments e.g. vernier calliper and micro screw gauge if any before the students start using them. Ask learners to do their individual research in time and not during the lesson.

Teaching guidelines 1.12

- Organise learners into different groups. Ensure that the groups:
 1. Comprise learners of both gender i.e. boys and girls incase it is a mixed class.
 1. Have learners of different abilities i.e. slow learners and fast learners.
 2. Have learners with physical challenges incase they are among the class.
- Ask them to choose a group leader and a secretary. Let the leader lead others in their discussion as the secretary writes down the main points.
- Ask them to do activity 1.14 given in the student's book and report to the whole class.
- Ask the group secretaries to present their findings in a class presentation.
- Summarise their discussion by taking learners through the discussion given in the student's book. At this point, correct errors made by the learners in their discussion.
- This activity will promote in learners among other competencies:
 1. Cooperation and interpersonal relation as learners work together in groups.

2. Communication skills in English as they express their opinions in group discussion.
3. Research and problem solving as they do research based activities and answering different questions.

1.13 Measurement of length

(1 Period)

By the end of this section, the learners should be able to define length and state its SI unit. They should be in a position of measuring length using different instruments e.g metre rule

Information to the teacher

Guide your learners on how to use a metre rule and other measuring instruments to measure length of an object. You are advised to read widely on this area from various reference books.

Suggested teaching/learning materials

- Metre rule, metre stick, vernier calliper, micrometre screw gauge.

Preparation

Ensure that you have all the suggested teaching/learning materials before the lesson.

Teaching guidelines 1.13 (a)

- Organise learners into pairs.
- Ask them to do activity 1.15 given in student's book.
- Guide them through the steps of

the activity and allow them to brainstorm between them.

- Now ask any learner randomly to tell the class their findings and allow others to point out omissions or errors on the fact given by the learner.
- Summarise their discussion by pointing out key points i.e.
 1. Length is the distance between two ends.
 2. The SI unit of length is metres (m).
- Conclude by taking learners through table 1.9 given in learner's book. Assess them through questions to determine whether the objective has been achieved.
- This activity will promote in learners among other competencies:
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to solve.

Teaching guidelines 1.13(b)

- Ask learners to form groups and ensure that they have observed gender balance and the members of

each group are of different abilities. In case there are learners with physical challenges, ensure that they are also involved in the group.

- Ask them to do activity 1.16 given in student's book i.e. making and using metre stick to measure length.
- Guide them through the steps of the two activities and let them discuss among themselves.
- Allow them to determine the measurement of different objects within the class.
- Ask them to measure the length of the chalkboard and record their results. Note that the physically challenged learners (e.g. blind) can hold the metre stick as the other learners read the measurement.
- Ask each group to present their findings. Discuss with them the causes of error in measurement e.g. parallax error.
- Conclude the discussion by assessing the learner through question and answer method whether they have understood how to use the metre stick to determine the length of different objects.
- This activity will promote in learners among other competencies Cooperation and interpersonal relation.
 1. Critical thinking as they analyse their measurement.
 2. Communication skills as they express their opinion to the group.

Teaching guidelines 1.13 (c)

- Ask learners to do activity 1.17 in the student's book. Let them proceed to activity 1.18 later on i.e. to observe the metre rule, scales and demonstrate how to use it.
- Through the leadership of a group leader and the secretary, let them discuss their observations from the activity and record their findings in a tabular form as one given in student's book.
- Guide the learners through their findings and the discussion given on student's book on the challenges of using a metre rule to measure length.
- Conclude the discussion by assessing the learners through question and answer method whether the objective has been achieved.
- This activity will promote in learners the following competencies:
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to solve.

Teaching Guidelines 1.13(d)

- Ask learners to form groups. Ensure that:
 1. Student don't maintain to same groups they have been working with in the previous activities.
 2. The new groups comprise of both boys and girls incase it is a mixed class.
 3. The members of each group are of different abilities i.e. slow learners and fast learners.
- Ask them to do activities 1.19 and 1.20 given in the student's book.
- Ask the group secretary to present their findings to the class and allow others to point out omission and error in the fact given.
- Guide the learners on discussion of their findings.
- Summarise the discussion by pointing out that a vernier calliper was invented in 17th century by Pierre Vernier.
- Guide the learner through the discussion given in the learner's book and emphasize on using of a vernier scale.
- Ask learners to do activity 1.21 still in their groups, let each leader tell their class their finds.
- Guide them through the discussion given in the student's book.
- Now, guide them to do activities 1.22 and 1.23 given in the student's book i.e. how to read the vernier callipers scale when measuring

different objects.

- Guide them through the worked example 1.1 given in student's book.
- Conclude by asking them to do exercise 1.4 given in learner's book. Use this exercise to assess whether the learners have achieved the objectives.
- This section will promote learners in among other competencies:
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to solve.

Teaching guidelines 1.13(e)

- Organise learners into groups. Ensure that the groups comprise of:
 1. Learners of different abilities i.e. slow and fast learners.
 2. Learners of both sex i.e. boys and girls incase it is a mixed class.
 3. Learners with physical challenges incase there are any and can be able to do the activity.
- Let them choose a group leader and secretary. Allow discussion of individual research on micrometer

- screw gauge; history of micrometer screw gauge, features of micrometer screw gauge and how to read it.
- Summarise the discussion by guiding them through the discussion given in student's book.
 - Now, ask them to do activity 1.24 given in student's book i.e. to observe the parts of micrometer screw gauge.
 - Guide them through the steps in the activity and let them discuss.
 - Let the group secretaries present their discussion to the whole class and allow other learners to contribute to each presentation by pointing out omissions and errors in each.
 - Ask them to do activities 1.25 in the student's book and guide them through a discussion given thereafter.
 - Now, discuss with them example 1.2 given in student's book.
 - Ask them to do activity 1.26 in student's book page 37 in groups.
 - Demonstrate for them how to determine the diameter of a ball bearing. Afterwards allow them to try measuring the diameter of the ball bearing and also do example 1.3 plus exercise 1.5 in the student's book.
 - Go through learners work and guide them where they have challenges. Note all this exercise may be used to check whether the objectives have been achieved.

- Conclude this section by assessing learners through question and answer method whether the objectives have been achieved.
- This section will promote learners in among other competencies
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to solve.

1.14 Measurements of time

(2 periods)

By the end of this section, the learners should be able to define time, state its SI unit and measure how long it can take to do a particular task.

Information to the teacher

Read in advance from various reference books and internet to equip yourself well in case the bright learners ask you challenging questions you will be in a position of answering them appropriately.

Suggested teaching/learning materials

- Stopwatch
- Play ground
- Clock

Preparations

Ensure that you have enough required materials in this section in advance.

Teaching guidelines 1.14(f)

- Ask learners to organise themselves in pairs. Ensure gender balance, varied abilities among the group members.
- Ask them to do activity 1.27 given in student's book i.e. to describe the concept of time.
- Allow learners to discuss between themselves and let one of them from each group report their findings.
- Now, guide the learners through a discussion given in student's book putting more emphasis on table 1.11 on SI unit of time and its comparison given in student's book and discussing with them example 1.4 in the student's book.
- Guide them through activities 1.28 and 1.29 given in student's book.
- Discuss with learners worked example 1.5 given in student's book.
- Ask them to do exercise 1.6 given in student's book. Go through their work and let the fast learners who finish continue with the rest of the question as your guide slow learners and then join them in answering the

rest of the question.

- Conclude this section by
 1. Assessing learners through question and answer method whether the objectives have been achieved.
 2. Assessing learners by going through their work on the assignment from exercise 1.6 given in student's book and identify the challenging areas so that you can guide them accordingly.
- This section will promote in learners the following competencies:
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to solve.

1.15 Measurements of derived quantities

(2 Period)

By the end of this section, the learner should be able to measure physical quantities: area, volume, mass and density and state their SI units.

Information to the teacher

As a teacher, guide learners through worked examples and practical activities in student's book appropriately. To be able to do this, you are advised to read widely from other reading materials and the internet on the same area to enrich yourself with information.

Material

A ruler, square and rectangle shaped solids, beaker, water, measuring cylinder, rectangular containers, burette, pipette, a marble, irregular stone, eureka can, different types of balances, fresh and boiled eggs.

Preparation

This section consists of many practical activities, prepare in advance and engage them in all activities and guide them accordingly. Also involve them in a discussion of the worked examples given in student's book. Any research should be done in advance before the beginning of the lesson.

Teaching guidelines 1.15

- Ask learners to form groups. Ensure gender balance, varied abilities among the groups.
- Ask them to do activity 1.30 given in the student's book and guide them through the steps of the activity.
- Give them time to discuss their findings and let the secretary give a report to the whole class, allow other learners to point out any omission or error on the facts.

- Guide them through table 1.12 in student's book.
- Now, discuss with them example 1.6, 1.7, and 1.8 in the students' book.
- Summarise the discussion by pointing out the key points i.e. area is the measure of the extent of a surface. Its SI unit is m^2 .
- Now, guide them through tables 1.13 given in the student's book and involve them in a discussion of worked example 1.8 on finding area of regular objects.
- Summarise the discussion by pointing out the key points i.e. Area is the measure of the extent of a surface. Its SI unit is square metre m^2 .
- Conclude this section by asking learners to do exercise 1.7 given in the student's book Mark the student's work and use it to assess learner's weak areas so that you can assist them during remedial hours.
- This section will promote in learners among other competencies
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group

discussions, class examples and given problems to solve.

1.16 Measurements of volume

(1 period)

By the end of this section, the learner should be able to define volume, state its SI units and use various instruments provided to measure volume of various objects.

Information to the teacher

This section is equally important like other sections of this book, read widely on this area from various references. Ensure that all learners have participated actively in all given activities in the student's book.

Suggested teaching/learning materials

- Beaker, water, pipettes, burette, measuring cylinder, sphere ball, Eureka can

Preparation

Ensure that you have required materials in this section before the beginning lesson.

Teaching guidelines 1.16 (a)

- Organise learners into groups. Ensure that the groups comprise of
 1. Learners of different abilities i.e. slow and fast learners.
 2. Learners of different sex i.e. boys and girls in appropriate ratio.

3. Physically challenged learners if there are any. It also depends on their numbers in your class and whether they are able to do the activity.

- Now, ask them to do activity 1.31 given in student's book and allow them to discuss their findings among themselves before reporting to the whole class through their secretary.
- Summarise their discussion by pointing out that volume is the amount of space occupied by a substance. Its SI unit is cubic metre (m^3).
- Now, take them through table 1.14 example 1.9 given in student's book.
- Take them through the discussion given in the student's book about volume of regular shaped solids and the formulae of different shapes (objects) in table 1.15 .
- Ask the learners to do activity 1.32 given in the student's book. Guide them to measure length, height and width of rectangular container and allow them to measure the height and radius of the cylindrical container. Emphasise on the formula of finding the volume of the two and the reason of equating them i.e have equal volume of water.
- Guide them through activity 1.33 i.e. to identify instruments for measuring volume. Assess them through question and answer method to determine whether the objectives have been achieved.

- This part of the unit will promote in learners among other competencies
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to solve.

Additional activity to measure the area and volume of the classroom

Suggested materials: tape measure (surveyors). Explain why the metre rule is not an appropriate measuring instrument in this case. You may need a ladder or a tall chair/table for the pupils to be able to measure the height. The tape should be stretched when taking the length and the width. Divide the class such that when one group is taking one measurement say length the other groups are also taking the other measurements. Compare the results of each group. You need to have taken the measurements in advance. Let the students use the formulae given in the student's book on page 44 and 46 to calculate the area of each wall and the volume of the air inside the classroom. You may need to choose a room that is not very congested with desks.

Teaching guidelines 1.16 (b)

- Organise learners into groups. Ensure that the groups formed comprise of: -
 1. Learners of different abilities i.e. slow and fast learners.
 2. Learners of different sex i.e. boys and girls in appropriate ratio.
 3. Physically challenged learners if there are any and can be able to do the activity.
- Ask them to choose a group leader and a secretary. Let them discuss their individual research led by the group leader or the secretary. Note that learners should have done their individual research before the commencement of the lesson.
- Ask the group secretary to present their discussion about the use and identify measuring instruments to the whole group and allow other students to point out omissions and errors of each presentation.
- Summarise the discussion by taking them through the discussion given in student's book on how to use measuring cylinder, burette and a pipette.
- Now ask learners to do activities 1.34 and 1.35 given in student's book i.e. to determine the volume of regular and irregular solids respectively by displacement methods. Put more emphasis on how to determine volume of irregular solid using a Eureka can in student's book.

- Guide them through the steps and thereafter the discussion given in the student's book.
- Conclude the discussion by:
 1. Assessing learners through question and answer method whether the objectives have been achieved.
 2. Asking them to do exercise 1.8 in student's book. Note that this exercise can also be used to test whether the objectives have been achieved.
- This part of the unit will promote the following competences.
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and problems to solve.

1.17 Measurements of mass

(1 Period)

By the end of this section, the learner should be able to define mass, state its SI unit and use various instruments provided to measure mass of various objects.

Information to the teacher

Guide learner on different parts of a beam balance. It is a good idea to read widely on this area from various reference books or internet on this area.

Suggested teaching/learning materials

- Beam balance both analogue and digital
- Different masses

Preparation

Ensure that you have all and enough materials required and the beam balance are functioning well before the beginning of the lesson.

Teaching guidelines 1.17

- Ask learners to form groups. In their groups there must be
 1. Gender balance i.e. boys and girls in an appropriate ratio incase it is a mixed class.
 2. Different abilities i.e. both slow and fast learners.
 3. Inclusive education i.e. disabled student (if they can do activity) should be incorporated and engaged in the activity.
- Ask learners to do activities 1.36 and present their findings to the whole class.
- Guide them through table 1.16 given in the student's book.
- Lead the learners through example 1.10.
- Take them through the discussion given in student's book on different types of balances.

1.18 Density

(1 period)

By the end of this section, learner should be able to define density, state its SI unit and solve problems on density.

Information to the teacher

Introduce this part using experiments 1.37 and 1.38 in learner's book. It is good to read widely on density from other relevant materials to guide them appropriately.

Suggested teaching/learning materials

- Drinking glass, water, stone, fresh and rotten eggs

Preparation

Ensure that you have enough teaching/learning materials suggested on this section before the beginning of the lesson.

Teaching guidelines 1.18

- Ask them to do activities 1.37 and 1.38 given in the learner's book i.e. determining whether an object is denser than water or not when immersed in water.
- Allow learners to discuss their findings in their groups and let the secretaries give a report in a class presentation.
- Engage them in a discussion of their findings as a class and then take them through the one given in student's book.
- Summarise the discussion by

pointing out the key points i.e

1. An object is denser than water when it sinks in it.
 2. An object is less dense than water when it floats in it.
- Now, connecting to the discussion, define density as mass per unit volume i.e.

$$\text{Density} = \frac{\text{mass}}{\text{volume}} .$$

- Its SI unit is kilogram per cubic metre (Kg/m^3). Note to them that the symbol for density is 'rho'.
- Take the learner through table 1.18 given in student's book on densities of different objects. Guide them through worked examples in the student's book.
- Ask learners to do exercise 1.9 question 1. Mark the work of learners who finish faster and let them do the rest of the questions as you guide the slow learners before joining them to answer all the questions
- Conclude this section by
 1. Assessing learners through question and answer method to determine whether the objectives have been achieved. Note that the exercise in this section can be used to assess learners.
 2. Taking them through the unit summary.
 3. Asking learners to do unit Test 1. The unit test is very important to you as a teacher and your learner too. Ensure that they attempt all questions given.

Further exercises and their answers

Further exercises/activities

<i>Further exercises for slow learners</i>	<i>Further exercises for fast learners</i>
<ol style="list-style-type: none">1. What is physics?2. State two branches of physics.3. What is time? State its SI unit.	<ol style="list-style-type: none">1. Describe how to determine volume of irregular object.2. Discuss how physics has improved lives of many citizens in Rwanda.

Answers to further exercises/activities

<i>Further exercises for slow learners</i>	<i>Additional exercises for fast learners</i>
<ol style="list-style-type: none">1. Physics is the study of matter and its relation to energy.2. – Electromagnetism – Nuclear Physics3. Time is a measure of duration of an event. Its SI unit is seconds.	<ol style="list-style-type: none">1. Mark student's work and guide them appropriately. You may refer to student's book.

Answers

For non-numerical questions, the learners can get most of the answers from the discussions given in student's book or from the internet and any other reference books. Mark the student's work and use it to guide them appropriately.

Exercise 1.4

(Student's book page 34)

3. (a) 5.12 cm
(b) 3.00 cm

Exercise 1.5

(Student's book page 38)

1. (a) 10.63 mm (b) 6.63 mm

Exercise 1.6

(Student's book page 42)

2. 12.5 s
3. 13.5 s
4. 0.15 s

Exercise 1.7

(Student's book page 45)

3. 10 times
4. 31030 mm²
5. 1.273 cm²

Exercise 1.8

(Student's book pages 50-51)

2. (a) 600 l (b) 600 000 cm³
(c) 600 000 ml
3. (a) 200 cm² (b) 20 blocks
4. (a) 785.7 cm² (b) 707.2 cm²
7. (a) 1 cm³ (b) 50 cm³
8. 23 cm³

Exercise 1.9

(Student's book page 56)

2. (a) 6.4342 kg (b) 0.0046 kg
(c) 0.040065 kg
3. 1.12 g/cm³
4. 25 cm³

Unit Test 1

(Student's book pages 57- 59)

9. 40 000 μm
10. (a) 2700 mm (b) 269 mm
(c) 0.356 mm
12. 2 000 000 000 kg
15. (a) 5 cm³ (b) 12.5 s (c) 62.5 s
17. (a) 1000 cm³ (b) 37.04 cm³
18. 180 cm³
19. 400 kg
21. 3.3 cm
24. 646.5 kg

Mechanics

Unit 2

Qualitative Analysis of Linear Motion

Student's Book pages 60-94 (15 periods)

Key unit competence

By the end of the unit, the learner should be able to describe objects in motion in one dimension using the principles of kinematics.

Learning objectives

Knowledge and understanding

- Define and explain the terms: displacement, distance, velocity, speed, acceleration and trajectory.
- State the difference between velocity/speed and displacement/distance.
- Calculate speed.
- Recall formulae of speed/velocity and acceleration.

Skills

- Explain terms used in rectilinear motion.
- Calculate the time required to cover a certain distance if the average speed is given.
- Calculate displacement, velocity and acceleration.
- Plot and interpret a distance/time.
- Graph, displacement/time, a speed/time graph, velocity/time graph.
- Recognise from the shape of a

speed/time graph that a body is at rest, moving with constant speed moving with changing speed

Attitudes and values

- Appreciate trajectories of moving bodies.
- Appreciate effective ways of crossing roads using the shortest distance between two points.
- Adapt scientific skills in estimating the speed of approaching cars to avoid road accidents.

Generic competencies addressed in this unit

- Critical thinking through provision of discussions, activities and questions to answer.
- Problem solving by involving learners in solving problems and answering questions in the learner's book.
- Communication through discussion based activities in the learner's book.

- Co-operation, interpersonal management and life skills through group work activities and discussions.

Links to other subjects

Biology – blood circulation, reflex action, Mathematics – Moving bodies, arithmetical operations and use of equations and formulae in calculation
Entrepreneurship and business – transport.

Cross cutting issues addressed in this unit

- Learners with disability challenges are involved in the group work activities and discussions.
- Environment. This is by sensitising learners through provision of environment based activities, questions and discussions based on environment.
- Standardisation culture through sensitising learners on culture based activities and discussions.

Assessment criteria

Learner can explain the relation between distance, speed and acceleration, can solve and discuss problems involving distance, speed and acceleration.

Teaching methodologies

- Group work.
- Class discussions.
- Question and answers.
- Class demonstrations

Background information

In the syllabus, the word kinematics

means; the study of the motion of points (or massless particles). You should not consider the agent that causes the motion. Linear motion occurs frequently and can be described by Simple Mathematics. This topic is taught in S1 and S2. Only qualitative aspects should be considered in this unit.

Suggested teaching/learning activities

2.1 Distance and Displacement

(4 periods)

By the end of this section, the learner should be able to differentiate between distance and displacement.

Information to the teacher

Before you start this section, establish the depth of treatment for this level. You can do this by comparing what is in the syllabus for S1 and S2. Make sure you share your experiences with those of the learners about motion in general i.e. movement of various objects on the ground, air and in water, then zero down to linear motion.

Suggested teaching/ learning materials

Charts, playing ground, tape measure, a tennis ball, rigid wall, stopwatch

Teaching guidelines 2.1 (a)

- Ask learners to form groups of two. Ensure that they observe gender balance and mix of learners of different abilities. All learners

- whether disabled or other students should participate actively in the activity and discussion. For instance you can help those with sight problem to walk in a zigzag manner as the other student describes his/her motion.
- Use activity 2.1 in the introduction part of student's book to help the learner in describing different motions.
 - Help them to differentiate the motion of different bodies and come up with a definition of linear motion and the types of linear motions.
 - Let the learners know that in this unit they are going to study motion in one-dimension i.e. linear motion.
- Refer them to the discussion given in student's book to put more emphasis on your discussion.
- NB:** Those students who are disabled may act as group leaders if they are able to.
- Activities 2.1 and 2.2 in student's book will promote in learners among other competencies:
 1. Critical thinking as they answer questions.
 2. Cooperation and interpersonal relation as they work together.
 3. Communication and leadership skills as they air their views and lead others in discussion.
 4. Inclusive education as all student work together.

Teaching guidelines 2.1 (b)

- Take the learners out of class to a playing field.
- Organise them in groups of two students.
- Allow the learners to perform activity 2.2 in the learner's book.
- Visit the groups to make sure they understand the steps of the activity and whether they are doing the expected.
- Let the groups measure the distance i.e. the total length of the path.
- Go back to class and let the group leader or any other member of every group report their findings.
- Guide learners through a class discussion on the activity and help them to define distance and displacement.

Difference between distance and displacement

Teaching guidelines 2.1 (c)

- Guide learners to do activity 2.3 i.e to measure how far the ball is from its original position.
- Through probing question, let the learners discover that distance is the total length of the path travelled while displacement is the distance between final position and initial position.
- Summarise the difference between distance and displacement from their observation.
- Displacement = distance in a stated direction.
- Distance is a scalar quantity and displacement is a vector quantity.

- This activity will promote:
 1. Critical thinking as they answer questions.
 2. Cooperation and interpersonal relation as they work together.
 3. Communication and leadership skills as they air their views and lead others in a discussion.

Road safety

Teaching guidelines 2.1 (d)

This part of the unit is to help learners to apply the concept of displacement in their lives especially when crossing a road. It is a crucial section because it touches on life safety in our roads. Help learners to understand this part.

- Help learners especially the slow learners to draw a road in their exercise book.
- Let them discuss activity 2.4 i.e. between Peter, Jane and John, who took the shortest route from side B to A starting at P.
- Let them realise that Jane took the shortest route i.e displacement.
- Guide them through a class discussion on the importance of the shortest route when crossing the road.
- Summarise this section by taking them through a class discussion on safety measures they need to observe before crossing a busy road.

2.2 Speed

(2 Periods)

By the end of this section, the learner should be able to define speed, average speed and instantaneous speed.

Information to the teacher

- Ensure that learners have obtained their results from activities 2.5, 2.6 and 2.7.

Preparation

Familiarise yourself with activities 2.5 and 2.6 in advance to know exactly what is expected of your learners. Read widely on speed, average speed and instantaneous speed from different reference books to guide your learners appropriately.

Teaching guidelines 2.2 (a)

- Organise them in equal groups of different abilities and observe gender incase of a mixed class.
- Let them do activities 2.5, 2.6 and 2.7 given in student's book.
- Guide learners through the discussion of activity.
- Summarise their finding by defining speed and average speed.
- Use the same groups and ask the learners to go through examples 2.1 in their working emphasis and need to observe SI units and significant figures.

Instantaneous Speed

Information to the teacher

Activity 2.8 is particularly meant to help learners understand what both instantaneous and average speeds are. Guide them accordingly not to confuse instantaneous speed with average speed.

Preparation

In this activity you require a vehicle.

You may use any vehicle in the school compound if there is any or give learners assignment as a homework to observe and present their findings during a class discussion. You may organise with the owner of the vehicle before the time of the lesson.

Suggested teaching/learning materials

A vehicle.

Teaching guidelines 2.2 (b)

- Group learners into appropriate groups of two.
- Ask them do activity 2.8 given in student's book.
- Guide them in a class discussion on their findings
- Help them to define instantaneous speed and to differentiate it with average speed. You may refer to student's book for more information about the two concepts.
- Discuss with the learners Example 2.2 given in student's book.

2.3 Velocity

(2 periods)

By the end of this section, the learners should be able to define velocity and state its units. He/she should also be able to tell what uniform velocity is and solve problems on velocity with ease.

Information to the teacher

In this section learners must take into consideration the direction in activity 2.9. Insist that they should not turn when moving in a reverse direction.

Suggested teaching/ learning materials

Playing ground, surveyors tape measure, stopwatch.

Preparation

Ensure that you have prepared the required materials suggested in student's book on this section in advance.

Teaching guidelines 2.3

- Ask learners to organise themselves into appropriate pairs i.e. considering gender balance and different abilities.
- Ask them to do activity 2.9 given in student's book.
- Let the learners measure and then make steps from point A to C in a **forward direction (positive)** and in a **reverse direction (negative)** without turning to face point A till they reach point B.
- Let them add the two distance taking consideration of direction i.e. distance in a forward direction is **positive** and that in **reverse** direction is negative.
- Through question and answer method
- Establish that $\text{velocity} = \text{displacement} \div \text{time}$.
- Guide learners through a class discussion example 2.3 given in student's book.

NB: In both cases of speed and velocity, emphasise the term 'rate of' when distance or displacement and time are involved.

- Speed is the rate of change of distance.
- Velocity is the rate of change of displacement.
- Summarise this section by taking them through a discussion given in student's book.
- Conclude by asking them to do Exercise 2.1 given in student's book.
- As explained in the student's book ask the learners to distinguish between speed, velocity and average speed/velocity.

2.4 Acceleration

(1 period)

By the end of this section, the learners should be able to define acceleration and state its SI unit. They should also solve problems on acceleration with ease.

Information to the teacher

Familiarise yourself with activity 2.10 in the student's book on the determination of the rate of change of velocity in advance. Also read widely from different reference books on acceleration to guide your learners well.

Preparation

Ensure that you have the required materials in advance.

Teaching guidelines 2.4

- Ask learners to form groups. Ensure that the groups formed comprise of:
 1. Different abilities i.e. slow and fast learners.
 2. Different sex i.e. Boys and girls incase the class is mixed one.
 3. Disabled student incase they are there and can be able to handle the activity.
- Guide learners through Activities 2.10 given in student's book.
- Let them present their findings in class discussion and help them to define acceleration as the rate of change of velocity.
- Guide learners through examples 2.4 and 2.5 given in student's book.

Additional activity

- Take the students out in a horizontal ground.
- Organise them in equal groups of different abilities and observe gender incase of a mixed class.
- Ask them to mark a point A on the ground.
- Place a flag zoom in front of point A.
- Let them observe and record their results in a tabular form as follows in the tables in the next page.

Motion \longrightarrow increase

Movement	Walking	Increase pace	Running
Distance			
Time			
Time / Distance			

Movement	Running	Increase pace	Walking
Distance			
Time			
Time / Distance			

Motion \longrightarrow decrease

- Summarise their observations,
 - The significance of the flag – direction is towards the flag
 - Non-uniform and uniform motion.

2.5 Graphs of linear motion

(4 periods)

By the end of this section the learner should be able to draw and interpret graphs of linear motion.

Information to the teacher

It is necessary to review the drawing of graphs. Also to interpret graphs of straight-line and of curves. Emphasis should be on slopes of gradient, tangents and area under the graph.

Suggested teaching/ learning materials

Graph papers, student's book.

(a) Distance-time graph

Teaching guidelines 2.5 (a)

- Ask learners to organise themselves into groups depending on the availability of materials. Ensure that the issues of gender balance and different abilities (i.e. slow and fast learners) are observed.
- Ask the learners to do activity 2.11 given in student's book.
- In groups, ask the learners to describe the motion of the two bodies.
- Allow the group leaders to present their group findings.
- Summarise their findings paying attention to bodies at rest and moving of constant motion.
- Give student example 2.5 given in student book as a read assignment.
- Emphasise the need to have 0-0 origins.
- This part of the unit will promote in learners among other competences:

1. Cooperation and interpersonal relation as learners in the appropriate group. Let them do activity 2.13 in the student's book.
2. Problem solving skills as they answer questions on groups of linear motion.

(b) Displacement - Time Graph

Teaching guidelines 2.5 (b)

- Ask learners to do activity 2.12 given in student's book.
- Allow the secretaries to report their findings in a class discussion.
- Let the learners suggest real situations addressed by the graph.
- Summarise the interpretation.

(c) Speed - Time Graph

Teaching guidelines 2.5(c)

- Organise learners in the appropriate groups. Let them do activity 2.13 in the student's book.
- In the same groups, allow the learners to interpret graphs in figures, 2.18, 2.19, 2.20, 2.21 and 2.22 in the students book.
- Emphasis should be on; instantaneous speed, uniform motion, non uniform motion, area under the curve $d = vt$.
- Guide them through the example 2.6.
- Give exercise 2.2 as a take away assignment.
- Guide slow learners step by step for them to understand speed-time graph.
- Mark the assignment and discuss

with the learners areas with challenges.

Velocity-time graph, acceleration - time graph

Teaching guidelines 2.7(d)

- Ask learners to organise themselves into appropriate groups.
- Ask them to choose a group leader and a secretary (preferably the disabled students).
- Ask learners to do activity 2.14 given in student's book.
- In groups allow the learners to interpret graph in fig. 2.25, 2.26 and 2.27. 2.28.
- Summarise their findings and emphasise to acceleration, negative acceleration, uniform and non-uniform motion.
- Example 2.7 and 2.8 should be discussed in groups.
- Encourage the learners to attempt as many questions in exercise 2.43
- This activity promotes in the learners:
 1. Leadership and organisational skills as learners organise themselves into appropriate groups.
 2. Research and problem solving skills as they carry out research and answer questions given correctly.
 3. Communication skills as they express their opinions to the group among other competencies.

2.6 Acceleration due to Gravity

(2 periods)

Information to the teacher

The acceleration due to gravity is the acceleration experienced by an object in free-fall at the surface of the Earth, assuming air friction is negligible. It has the approximate value of 9.80 m/s^2 , although it varies with altitude and location. The gravitational acceleration can be obtained from theory by applying Newton's Law of Universal Gravitation to find the force between the Earth and an object at its surface. Guide your learners to understand the concept.

Suggested teaching/learning materials

A tennis ball, ticker tape timer, bodies of different masses, clamps and power source.

Preparation

Ensure that materials have been assembled in advance to different groups you want to work with.

Teaching guidelines 2.6

- Ask individual learners in those groups to do activity 2.15 provided in student's book.

- Guide them through a class discussion on their findings.
- Ask them to do activity 2.16 given in student's book.
- Help them to tabulate their results from the activity and ask them to plot a graph.
- Let them interpret their graphs.
- Guide them to find a gradient from the graph.
- Hold a class discussion on their findings.
- Ask them to do question 1 of exercise 2.4 given in student's book.
- Let them do the rest of the questions in exercise 2.4
- Select some questions in unit test 2 and administer a written exam. From this exam, you will know whether the key unit competencies have been achieved. If not prepare some remedial work on the learners.
- This activity promotes;
 1. Teamwork as learners work together in the discussion.
 2. Communication as learners express their opinion
 3. Critical thinking as learners answer question given critical and correctly

Further exercises and their answers

Further exercises/activities

<i>Further exercises for slow learners</i>	<i>Further exercises for fast learners</i>
<ol style="list-style-type: none">1. Differentiate between distance and displacement.2. What is instantaneous speed?3. Sketch a velocity time graph for a body moving with a constant acceleration.	<ol style="list-style-type: none">1. By giving an appropriate example, distinguish between instantaneous speed and average speed .2. Sketch and interpret a velocity-time graph for a body thrown upward and caught.3. Describe any experiment of determining gravitation due to gravity.

Answers to some further exercises/ activities

<i>Further exercises for slow learners</i>	<i>Additional exercises for fast learners</i>
<ol style="list-style-type: none">1. Distance is total length between two points . It is a scalar quantity whereas displacement is the distance in specified direction. It is a vector quantity.2. Speed at a particular point when a body is in motion.3. Mark learner's work and guide them accordingly. You may refer to student's book.	<p>Mark student's work and guide them appropriately. You may refer to student's book.</p>

Answers

For non-numerical questions, the learners can get most of the answers from the discussions given in student's book or from the internet and any other reference books. Mark the student's work and use it to guide them appropriately.

Exercise 2.1

(Student's book pages 70-71)

2. (a) 8.33 m/s (b) 30 km/h
3. (a) 2 hrs 12 min
(b) 5.5 km/h
4. (a) (i) 15 m/s (ii) 20 m/s
(iii) 35 m/s
(b) 22.5 m/s

Exercise 2.3

(Student's book pages 85-88)

2. (a) 18 m/s^2 (b) 1800 m
- 3 (b) 1 m/s^2 , 400 m
4. (a) 3 m/s^2 (b) 3 m/s^2 (c) 600 m
5. (a) 5 m, 20 m, 45 m, 80 m
(c) 10 m/s
7. (b) 4 m/s^2

8. 1 m/s^2
9. (a) 808 m (b) 52 m/s
(c) 2.6 m/s^2

Exercise 2.4

(Student's book page 85)

3. 2.94 kg

Unit Test 2

(Student's book pages 90-93)

2. B
3. 3 cm/s
4. 190 m
6. 8.33 m/s
7. (a) 5 m/s^2 (b) 10 m
10. (a) 2 m/s^2 (b) 15 s
(c) 120 m (d) 290 m
12. (b) 15 m/s (c) DE, 2 s
(d) 120 m
13. (a) 225 m
(b) 225 m
(c) 1 m/s^2
14. (a) 2 m/s, 2.86 m/s
(b) 0.21 m/s^2
(c) 3.2 s

Mechanics

Forces

Unit 3

Force (I)

Student's Book pages 95-127 (10 Periods)

Key unit competence

By the end of this unit, the learner should be able to define explain and describe forces and their effects.

Learning objectives

Knowledge and understanding

- Define and explain the concept of force.
- Identify different types of forces in nature.
- Represent a force as a vector.
- Combine parallel forces and non parallel forces using parallelogram method and scale drawing.
- Demonstrate the effect of balanced and unbalanced forces.

Skills

- Evaluate the effects of an applied force.
- Analyse and combine forces.
- Measure force using a spring balance.
- Explain natural phenomena depending on force concept and effects of an applied force.
- Analyse and combine forces.

- Choose instruments for measuring weight and mass.

Attitudes and values

- Appreciate effects of forces in nature.
- Appreciate the effect of gravity on bodies near the earth surface.
- Develop responsible behaviour based on the knowledge of effects of forces.
- Cooperate to demonstrate force combination.

Generic competencies addressed in this unit

- Cooperation and interpersonal relation through provision of group work activities.
- Lifelong learning.
- Critical thinking through involving learners in solving problems and discussion based activities.
- Communication skills by involving learners discussion based activities.

- Research and problem solving through provision of learner discussion based activities.

Links to other subjects

Geography (landform formation, ocean currents, solar system etc), Mathematics (vectors addition and scale drawing).

Cross cutting issues addressed in this unit

- Environment. This is through provision of environmental-based activities and discussions as explained in the learner's book. For instance, activity 3.12 learners are sensitized to plant more trees and plough across the farm to minimize soil erosion.

Assessment criteria

Learner can explain clearly the concept of forces, can solve problems involving combined forces, and can illustrate and report demonstrations related to combine forces effectively.

Teaching methodologies

- Group work.
- Class discussions.
- Question and answers.
- Class demonstrations

Background information

Force is a topic in the branch of physics called mechanics. The understanding of this topic is very crucial as it cuts across many branches in physics. You should engage the learners with practical activities in our daily life with a view to making the learners appreciate and

enjoy the effects and application of force in overcoming some common problems in our day to day activities.

Suggested teaching/learning activities

3.1 Force

(1 period)

By the end of this section, the learner should be able to define force.

Information to the teacher

In primary school, the learners covered magnetic force. Use this type of force and activity 3.1 to define force.

Teaching guidelines 3.1

- Ask learners to form groups of two students. Ensure that they observe gender balance and the groups to comprise learners of different abilities.
- Ask learners to displace a big stone within the school compound using a rope. Caution them to be careful while displacing the stone not to injure themselves.
- Let the learners study the pictures shown in figure 3.1 in student's book. Guide them to observe things being pushed or pulled.
- Through question and answer method, probe the learners to give other situations where pushing or pulling occurs.
- Guide slow learners to identify where there is a push or a pull. Help them to define force. Encourage

- them to participate in class discussions on their observations.
- Summarise their findings by defining force as a pull or a push.
 - Find out whether the learners know a scientist by the name Isaac Newton. Ask them to use internet to study more about this scientist and report their finding with a view to give the SI unit of force. The SI unit of force is newton (N). The word newton has a small letter n but its symbol is capital N.
 - This activity will promote in learners among other competencies
 1. Cooperation and interpersonal relation through group work activities.
 2. Critical thinking through solving problems.
 - 3 . Communication skills through group work discussions in the student's

3.2 Types of Forces

(2 periods)

By the end of this section, the learner should be able to name and explain types of forces.

Information to the teacher

In primary school, the learners have covered magnetic force as a type of a force.

Suggested teaching/learning materials

Wooden block , string, a pail with water, two identical springs, a rigid support, a bench, an umbrella, a stopwatch, a ball, a magnet, a rod, a piece of paper or cloth, different tyres.

Preparation

Ensure that you have the suggested materials before the start of the lesson.

Teaching guidelines 3.2 (a)

- Let learners organise themselves into groups. Ensure that they are of different abilities and gender (if any). All learners the disabled or the other learners should participate actively in the lesson and all activities.
- Use activities 3.2 to 3.14 to explain different types of forces. It will be a good idea to start with activities that the learners have already covered before covering the 'new' types of forces.
- Let the groups have a group discussion on their observation and ask the group secretaries to note the main points from their discussion.
- Ask the group secretaries or any other group member chosen at random to present their findings to the whole class and allow other members to contribute in pointing out errors and omissions to the fact presented.
- Summarise by highlighting different types of forces e.g friction, tension, gravitational, electrostatic.

- Ask learners to do exercises 3.1, 3.2 3.3 and 3.4 given in learners book. They may do those exercise that require research in groups depending on availability of materials and time.
- This activity will promote in learners among other competencies:
 1. Cooperation and interpersonal skills as they work in group.
 2. Communication skills in English as they express their points through a discuss.

Contact and non-contact forces (2 periods)

By the end of this section the learner should be able to state what contact and non contact forces are and give examples for each.

Information to the teacher

This section is mainly to help learners to distinguish between contact and non-contact types of force. It is therefore a good idea to read on the same from different reference books to guide your learners appropriately.

Suggested teaching/learning materials

All materials suggested under the types of forces on 3.2(a).

Preparation

Ensure that you have the materials for each activity in specific section in advance.

Teaching guidelines 3.3(b)

- Ask learners to organise themselves into groups. Ensure that the group formed are of different abilities and gender (if any). All learners whether disabled or normal should participate actively during the lesson and all activities.
- Review with the learners activities 3.2, to 3.14 to help them explain different types of forces that are referred to contact and non contact forces.
- Let the groups have a group discussion on their observation and ask the group secretaries to note the main point from their discussion.
- Ask the group secretaries or any other group member chosen at random to present their findings to the whole class and allow other members to contribute in pointing out errors and omissions to the facts presented.
- Summarise by emphasizing the key points that contact forces are friction, tension, action and reaction, air resistance and upthrust while non contact forces include: gravitational forces, electrostatic force and magnetic force. At this point, it is a good idea to differentiate between contact and non-contact forces i.e. Contact forces are those types of forces which result when the two interacting objects are perceived to be physically contacting each other while non-contact force is any force

applied to an object(or body) by another object that has no indirect contact with each other.

- This activity will promote in learners among other competencies:
 1. Cooperation and interpersonal skills through working in groups.
 2. Communication skills in English by expressing their points in a discussion.
 3. Research and problem solving skills as they carry out research to answer a given question.

3.3 Effects of Forces

(2 periods)

By the end of this section the learner should be able to list the effects of force.

Information to the teacher

Use common experience from local context.

Teaching guidelines 3.3

- Ask learners to form groups of two. Ensure that they observe gender balance and the groups comprise learners of different abilities and the disabled ones if there is any in your class.
- Ask them to do activities 3.11, 3.12, 3.13 and 3.14 and report back to the whole class.
- Guide them (especially slow learners) through the activities so that they can be able to explain the effects of forces on a body.

Encourage them to participate in class discussions on their observations.

- Use the activities in this section and the summary at the end of this section in student's book to summarise the effects of forces. You may assign slow learners different activities to demonstrate effect of forces and allow them to perform and report.
- This activity will promote in learners among other competencies:
 1. Cooperation and interpersonal skills through groups work activities.

3.4 Representation of Forces using Vector Diagrams

(1 period)

By the end of this section, the learner should be able to represent forces using vector diagram.

Information to the teacher

Use the concept thought in vectors in mathematics to show learners how forces can be presented using vector diagram.

Suggested teaching/learning materials

Marbles

Teaching guidelines 3.4

- Ask learners to form groups. Ensure that the group formed comprise of:
 1. Learners of different abilities (slow learners and fast learners).

2. Gender balance i.e. boys and girls in case it is a mixed class.
3. Disabled students in case they are there in your class.

This will enable learners to appreciate others and boost their self-esteem as they learn from each other.

Ask them to choose a group leader and a secretary (preferably the disabled students).

- Ask learners to do activity 3.15 given in student's book and let them hold a discussion on their observation.
- Choose randomly any member from each group to present their findings.
- Guide them through the discussion provided in student's book.
- This section will promote in learners among other competences:
 1. Communication skills in English in group work discussion.
 2. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.

3.5 Weight and Mass

(1 period)

By the end of this section, the learner should be able to name the instruments used for measuring weight and mass and distinguish the two quantities.

Information to the teacher

Learners learnt about measurement of mass in Unit 1, in this section review about mass but put more emphasis on how weight is measured and the difference between the two quantities.

Suggested teaching/learning materials

A spring balance, wooden and metal blocks

Preparation

Set the suggested materials at different groups in advance .

Teaching guidelines 3.6

- Ask learners to organise themselves into groups depending on the availability of materials. Ensure that the issues of gender balance and different abilities (i.e. slow and fast learners) are observed.
- Guide them to do activity 3.15, 3.16 and 3.17 given in student's book and give a report on their findings to the whole class.
- Lead them through a discussion and Example 3.1 given in student's book
- Ask them to do Exercise 3.6 in student's book.
- This section will promote in learners among other competencies:
 1. Communication skills in English in group work discussion.
 2. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.

3.6 Balanced and unbalanced forces

(1 period)

By the end of this section, the learner should be able to demonstrate the effects of balanced and imbalanced forces.

Information to the teacher

You should review vectors addition and scale drawing in Mathematics.

Teaching guidelines 3.6

- Ask learners to form groups. Ensure that the groups formed comprise of:
 1. Varied abilities i.e. slow and fast learners.
 2. Gender balance boys and girls incase the class is mixed one.
 3. Disabled student incase they are there.
- Guide learners through activities 3.18, 3.19, 3.20 and 3.21 to show the effects of balanced and unbalanced forces.
- Activity 3.20 in student's book demonstrates the addition of parallel forces.
- Allow learners to discuss their findings in their groups and let the secretaries or any other group member chosen at random to give a report to the whole class.
- Use example 3.2 given in student's book to show how the addition is done numerically.
- Ask learners to do exercise 3.7 question 1 and 2 in class and give question 3 as a take away assignment.
- Ask learners to do activity 3.20 given in student's book and use the activity to demonstrate the addition of non-parallel forces.
- Example 3.2 shows scale drawing as a method to add non-parallel forces.
- Give question 3 as a take away assignment.
- Conclude this section by:
 1. Assessing learners through question and answer method to test whether the objectives have been achieved. Also note also that the exercise in this section can be used to assess learners.
 2. Taking them through the unit summary.
 3. Asking learners to do unit Test 3. Note that this unit test is very important to you as a teacher and the learner. Ensure that they attempt all questions.
- This section will promote in learners among other competencies:
 1. Communication skills in English through group work discussion.
 2. Cooperation and interpersonal relation. This is achieved through the involvement of the learners in the numerous activities in the learner's book.

Further exercises and their answers

Further exercises/activities

<i>Further exercise for slow learners</i>	<i>Further exercise for fast learners</i>
<ol style="list-style-type: none"> 1. Define the term force. 2. Name two contact and non contact forces. 3. List three effects of forces. 	<ol style="list-style-type: none"> 1. Describe the effects of forces that you have encountered in your life. 2. Distinguish between contact and noncontact forces.

Answers to some further Exercises/Activities

<i>Further exercises for slow learners</i>	<i>Additional exercises for fast learners</i>
<ol style="list-style-type: none"> 1. Force is a push or a pull on a body. 2. Contact forces: friction, tension. Non-contact forces: magnetic, electrostatic. 3. Distorts a body, moves a body, changes the direction of a moving body 	<p>Mark student's work and guide them appropriately. You may refer to student's book or any other relevant materials.</p>

Answers

For non-numerical questions, the learners can get most of the answers from the discussion given in student's book or from the internet and any other reference books. Mark the student's work and use it to guide them appropriately.

Exercise 3.6

(Student's book page 116)

3. (a) 3 N (b) 7000 N
(c) 0.0000005 N
4. 0.2 N

Exercise 3.7

(Student's book page 120)

3. (a) 0 N (b) 30 N (c) 13 N

Exercise 3.8

(Student's book page 125)

3. (b) 210 N (c) 10 N

Unit Test 3

(Student's book pages 126-127)

4. 250 kg
6. (a) 3 N (b) 7000 N (c) 0.00005 N
7. 0.2 N
10. (a) 50 N (b) 200 N
12. (a) 66.7 N (b) 400 N
13. 11.4 N
14. (a) 100 N (b) 92.39 N
(c) 70.71 N (d) 38.27 N
(e) 0 N

Mechanics

Force

Unit 4

Newton's Laws of Motion (I)

Student's Book pages 128-149 (10 Periods)

Key unit competence

By the end of this unit, the learner should be able to state Newton's laws of motion and describe the effects of forces on objects.

Learning objectives

Knowledge and understanding

- Explain the effect of force on the direction and state of a body.
- Define Acceleration, action and reaction, inertia, net force, free body diagram.
- State Newton's three laws.

Skills

- Observe and interpret change of position of a body due to force acting on it.
- Conduct appropriate experiments on Newton's law illustrating laws of motion.
- Solve simple problems involving Newton's laws of motion.

Attitudes and values

- Appreciate applications of Newton's laws of motion.

- Appreciate the need to observe and report.
- Acquire ability to think logically and systematically in pursue of Generic competencies addressed in this unit particular thought.
- Recognize the value of applying the scientific method in solving problems.

Generic competencies addressed in this unit

- Communication skills in English through provision of group work activities in the student's book that requires individual learners to express their points.
- Cooperation and interpersonal relation through provision of group based activities that require learners to work together to solve a particular task.

- Critical thinking through provision of a variety of questions in the activities and exercise that require the students to think.

Links to other subjects

Linear motion, transportation in entrepreneurship, Sports (Running and jumping).

Cross cutting issues addressed in this unit

Inclusive education – all students including the disabled ones are actively involved in group's activities.

Assessment criteria

Learner can solve and explain problems that involve application of Newton's laws of motion in one dimension. Can perform simple experiments related to Newton's laws of motion.

Suggested teaching methodology

- Guided discovery
- Research
- Question and answers
- Discussion
- Role play

Background information

Most learners have experienced a forward lurch when a vehicle they are travelling in is suddenly stopped. They have seen or involved in a tug of war, they have seen objects falling from the sky or high levels to the ground. Build on these and any other common experience to guide the learners to understand Newton's laws of motion. By doing so

learners' curiosity to understand the laws in detail is boosted.

Suggested learning/teaching activities

4.1 Newton's first law of motion

(3 periods)

By the end of this section, the learner should be able to state Newton's first law of motion and explain the relationship between mass and inertia.

Information to the teacher

This section comprises a discussion of real life situations that learners have seen before. You may use school bus or any other vehicle in the school compound (if any) to demonstrate this section before engaging the learners in a discussion on Activity 4.1 in student's book.

Preparation

You may read any other materials e.g. reference books to equip yourself with wide knowledge on Newton's laws of motion. This will give you advantage over your learners so that you can be able to guide and respond to any question asked by them.

Arrange with the school driver or owner of individual vehicle in school in advance.

Teaching guidelines 4.1 (a)

- Ask learners to form groups of two and ensure that the groups formed comprise of learners with

different abilities (slow and faster learners) and gender balance. Let the **disabled** learners be actively involved in these groups for instance those with physical challenges of walking can be given a task to record down observations.

- Ask learners to do Activity 4.1 in student's book.
- Guide **slow learners** in a discussion of activity 4.1 in student's book. This can be done by listening to their experience while in a vehicle that stops suddenly. Use this opportunity to help them explain the term inertia.
- Let them brainstorm on their observations and ask the group secretaries or any other group member to present in a class discussion.
- Allow other learners to point out errors or omissions during classroom presentation.
- Summarise the discussion by taking learners through a discussion given in student's book and point out that inertia is when a body resists change to its state of motion.
- Conclude the activity by assessing them through question and answer method to test whether learners are able to explain what is meant by inertia.
- This activity will promote:
 1. Communication skills in English through provision of group work activities in the student's book that requires individual learners

to express their points.

2. Cooperation and interpersonal relation through provision of group based activities that require learners to work together to solve a particular task.
3. Critical thinking by provision of a variety of questions in the activities and exercise that require the students to think.

To demonstrate Inertia using a coin

Teaching guidelines 4.1 (b)

- Organise the students into groups of different abilities and gender (incase it is a mixed class). Let them choose a group leader and a secretary.
- Ask them to do activity 4.2 given in student's book i.e. to demonstrate inertia on a card being pulled slowly and then suddenly.
- Guide them (especially **slow learners**) through the steps and allow them to discuss their observations as the group secretary note down the main points.
- Ask the group secretaries to present their findings to the whole class and allow other students to contribute by pointing out omissions and errors in the facts given.
- Guide them through a class discussion and point out that the coin resists to change its state of rest thus falls into the beaker when the cardboard is quickly removed.

- At this point, correct the errors made by learners during discussion and conclude the discussion by assessing them to test whether the objective has been achieved.
- This activity will promote in learners among other competence:
 1. Communication skills in English through provision of group work activities in the student's book that requires individual learners to express their points.
 2. Cooperation and interpersonal relation through provision of group based activities that require learners to work together to solve a particular task.
 3. Critical thinking through provision of a variety of questions in the activities and exercise that require the students to think.
- Guide the learners through the steps and let them observe and explain their observations as the secretaries write down the points agreed upon. Encourage learners especially **slow learners** to ask any question while doing those activities.
- Hold a class discussion on their findings by pointing out that the upper part of the pile shows the resistance to motion when the lower block was pulled. Use this opportunity to correct errors made by learners in their discussion. Assess whether the objective has been achieved.
- This activity will promote in learners among other competence:
 1. Communication skills in English through provision of group work activities in the student's book that requires individual learners to express their points.
 2. Cooperation and interpersonal relation through provision of group based activities that require learners to work together to solve a particular task.
 3. Critical thinking by provision of a variety of questions in the activities and exercise that require the students to think.

To demonstrate Inertia using a wooden block

Suggested learning/teaching materials

Four wooden blocks, smooth surface, string.

Teaching guidelines 4.1 (c)

- Ask learners to form groups of different abilities and gender. Let them choose a leader and a secretary.
- Ask them to do activity 4.3 given in student's book i.e. to demonstrate inertia on a pile of wooden blocks pulled slowly and suddenly.

Forces that can bring a change

Teaching guidelines 4.1 (d)

- Ask learners to form groups of different abilities and gender,

- let them choose a leader and a secretary.
- Ask them to do activities 4.4 and 4.5 given in student's book i.e. to show that a body will continue in its state of motion unless compelled otherwise.
- Let them observe and give an explanation to their observation in their respective groups. Let the secretary note down key points.
- Ask the groups secretaries to give a report on their finding to the whole class and allow contribution from the class on omission or error made.
- Hold a class discussion on the result from the activity and help the learners to note the key point i.e.
 1. The wooden block will continue moving in the same direction.
 2. A wooden block is reluctant to stop moving.

These two points lead students to Newton's first law of motion i.e. a body will continue in its state of rest or uniform motion in a straight line unless compelled by some external forces to act otherwise.

- Help learners (especially the slow learners) to understand how to define Newton's first law of motion.
- Give slow learners remedial activity to demonstrate inertia and encourage them to seek for assistance from their fellow student or their teachers whenever they encounter any challenge.

- Conclude the discussion by emphasizing the key points and then assess whether the objective of the activity has been achieved.
- This activity will promote in the learners among other competencies:
 1. Communication skills in English through provision of group work activities in the student's book that requires individual learners to express their points.
 2. Cooperation and interpersonal relation through provision of group based activities that require learners to work together to solve a particular task.
 3. Critical thinking by provision of a variety of questions in the activities and exercise that require the students to think.

Mass and inertia

(1 period)

By the end of this section, the learner should be able to explain the relationship between mass and inertia.

Information to the teacher

This part is crucial, read widely from other sources e.g. reference book on mass and inertia so that you are well equipped to guide and assist learners accordingly

Suggested learning/teaching materials

A string, a heavy and light stones, hook

Preparation

Ensure that all materials required for this activity are available in time and arranged into groups depending on the availability of the materials and number of students.

Teaching guidelines 4.2

- Organise learners into groups of different abilities and gender. Ensure that the **disabled** are also involved in all activities. For instance, allow them to push the two stones in activity 4.6, student's book, as normal student note the observations. Remember **Disability is not inability!**
- Ask them to do activity 4.6 given in student's book i.e. to investigate relationship between mass and inertia of a body.
- Guide **slow learners** through activity 4.6 to enable them to see the relationship between mass and inertia i.e. *the greater the mass the low the inertia and vice versa*. Encourage them to participate in class discussions on their observations.
- Guide the learners through the steps and let them discuss the question on the activity. Remind the secretary to harmonize the points from all members and report to the class on your discussion. Note that any other member of a group can give a report to the whole class.
- Ask each group secretary to give a presentation on their report and allow other members to point out omissions and error in the facts presented.
- Summarise the discussion by emphasizing on the key points in Activity 4.6 student's book i.e. A body continue in its state of rest or uniform motion in a straight line unless compelled by some external force to act on them.
- Conclude this activity by:
 1. Assessing whether the objectives have been achieved. You may use question and answer method.
 2. Asking students to do Exercise 4.1 and hand in their work for marking. Ensure that you have marked learner's work and spend sometime to address areas with some challenges in the next reason or during remedial hours.
- This activity will promote in learners:
 1. Communication skills in English through provision of group work activities in the student's book that requires individual learners to express their points.
 2. Cooperation and interpersonal relation through provision of group based activities that require learners to work together to solve a particular task.
 3. Critical thinking by provision of a variety of questions in the activities and exercise that require the students to think.

4.3 Newton's second law of motion

(2 periods)

By the end of this section, the learner should be able to state Newton's second law of motion, express it mathematically, and use it to solve problems.

Information to the teacher

You are required to prepare widely before the lesson.

Suggested learning/teaching materials

A football

Preparation

Read and understand this section i.e. activity, discussion, worked example and all the questions in exercise 4.2 in student's book so that you are well prepared to guide the learners appropriately. Ensure that you have all materials required in these section i.e. footballs.

Teaching guidelines 4.3

- Organise learners into appropriate groups. Ensure that the **disabled learners** are actively involved in the groups formed. For instance, if they can, allow them to kick the ball in activity 4.7 in student's book as normal students note the observations down.
- Ask them to do activity 4.7 given in student's book i.e. to verify Newton's second law of motion.

- Guide them through the activity and let them answer and explain the questions asked. Let the group secretary write down the main points from the discussion and report to the whole class.
- Let the class contribute to each report presented and summarise the discussion by emphasizing the key points i.e.
 1. Newton's second law of motion states that the acceleration (a) of a body is directly proportional to the not (resultant) force(f) acting on it and inversely proportional to its mass(m) and the note to them that the acceleration takes place in the direction of the resultant force.
 2. It is mathematically expressed as $a \propto F/m$ implying $F = kma$.
 3. From $F = ma$, when resultant force is increased, acceleration produced is increased and vice versa. The force also produces a smaller acceleration on a body of a greater mass and vice versa. Use this chance to correct errors in learners' discussion and through question and answer method, assess whether the objectives have been achieved.
- Now guide the learners through the worked examples 4.1 to 4.5 given in the student's book and ask them to do Exercise 4.2 in student's book.

Go around and mark their work. Note that the **fast learners** will finish within

a short time, mark their work and let them do the remaining questions as you guide **slow learners**.

Note:

It is good to take advantage of remedial hours to discuss with learners their assignment after marking it since lesson time may not be sufficient.

Additional information to the teachers

We can also derive the equation $F = ma$ using momentum i.e.

Resultant force, $F = \text{Change of momentum} = \text{final momentum} - \text{initial momentum} = mv - mu$

Rate of change of momentum = change of momentum/time taken = $mv - mu / t$

Therefore, Force = $mv - mu / t$ but change in $\frac{v - u}{t} = a$. Substituting we obtain $F = ma$. However, this concept of momentum is not required at this level but at higher levels. Therefore, you **should not** use it.

This activity will help to promote in learners among other competencies:

1. Research and problem solving through provision of research based activities and variety of questions to be solved..
2. Communication skills in English through provision of group work activities in the student's book that requires individual learners to express their points.

3. Cooperation and interpersonal relation through provision of group based activities that require learners to work together to solve a particular task.
4. Critical thinking by provision of a variety of questions in the activities and exercise that require the students to think.

4.4 Newton's third law of motion

(2 periods)

By the end of this section, the learner should be able to state Newton's third law of motion and explain some of the common experiences due to it.

Information to the teacher

Newton's third law of motion is experienced in our daily activities. Therefore, as a teacher read widely either from the internet, reference book or any other relevant material to enrich yourself with knowledge on this section so that you can guide your learners appropriately.

Suggested learning/teaching materials

A rigid support, 2 pieces of string

Preparation

Assemble and organise all the materials required for the practical activities in this section prior to the lesson.

Teaching guidelines 4.4

- Ask learners to form groups of two.

- Ensure that all learners whether disabled or normal are involved actively in the lesson and all activities. For instance, allow them to pull springs in activity 4.9 provided in student's book as other student note the observations.
- Ask them to do activity 4.8 given in student's book i.e. to demonstrate Newton's third law of motion.
- Guide slow learners through activities 4.8 and 4.9 in student's book to demonstrate reaction and action forces. Activity 4.8 may be considered as normal activity by **slow learners** thus they may overdo it deviating from learning the main concept. Help them as they perform the activity to appreciate that *action and reaction are equal and act in opposite directions*. Encourage them to participate in class discussions on their observations.
- Let the learners brainstorm between themselves and give a reason of what happened to the girl in the activity.
- Guide them through a class discussion as the one given in the student's book .
- Summarise the discussion by pointing out that a force excited first by a body to another is called action force and the respond force from another body is reaction.
- Note to the learners that the two forces are always equal and act in opposite direction.
- Now ask them to do activity 4.10 given in the student's book to demonstrate action and reaction force.
- Guide the learners through the steps of the activity and let them record their observations. Allow them to discuss their observations before giving a report to the whole class through their secretaries.
- Let the other students contribute to each presentation given by pointing out errors and any omission.
- Summarise their discussion by pointing out the key point i.e.
 - 1) Action force and reaction force are equal in magnitude.
 - 2) The two forces (action and reaction) are acting in opposite direction.

Use this chance to correct errors made by learners. In their discussions and through questions answer method, assess whether the objective of the activity has been achieved.

- Now, guide the learners through some of the examples of action and reaction given in student's book. Note that some learners may demonstrate one of them e.g. the tag of war.
- At this point, you can now define newton's third law of motion which *states that whenever a body exerts a force on another body, the other body exerts an equal but opposite force on the first body or in short, to every action there is an equal but opposite reaction.*

- Conclude this part by taking learners through some common experiences due to Newton's third law of motion given in student's book. Ask them to do exercise 4.5 and hand in their work for marking.

Note:

It is important to mark student's assignment to identify some challenging areas and guide them appropriately.

This section will promote in the learners among other competence.

- 1) Research and problem solving as they try to answer questions in Exercise 4.3.
- 2) Cooperation and interpersonal relation as they work together in different activities.
- 3) Communication skills in English as they express their points during a discussion.

4.5 Newton's Universal Law of Gravitation

(2 periods)

By the end of this section, the learners should be able to state Newton's universal law of gravitation and use its equation to solve problems involving this law.

Information to teachers

As a teacher, you are required to refer to different books, including research on the internet to prepare yourself

adequately so that you are in a position of guiding and answering the questions from the learners sufficiently and satisfactorily.

Suggested learning/teaching materials

An internet and Reference books

Preparation

Make a questionnaire that will guide learners in a research and give them a day earlier. Set and assemble all the required materials before the material day of the lesson for a research and ask learners to do individual research.

Teaching guidelines 4.5

- Organise learners into groups of different abilities and gender balance. Let them choose a group leader and a secretary (preferably the disabled students if there is any).
- Guide learners (especially **slow learners**) through activity 4.11. Show them a quicker way of carrying out research from internet and reference books i.e. going for specific **relevant areas** on the internet and using **table of content** to locate required topics in reference books. Encourage them to participate in class discussions on findings.
- Ask the group leaders to lead others in a discussion and let individual students give a summary on his or her findings. Tell the group leaders to allow others to contribute to

each finding from the members and let the secretaries harmonize the main points. Learners with sight or auditory problems can be placed in front of the class or any other appropriate position for them to be able to learn during the whole class discussion.

- Ask the group secretaries to present their findings to the whole class and allow contribution from other students to point out omissions, additions and errors in each presentation. They can also be assist with reading and writing instructions.
- Summaries the presentation by pointing out the key points i.e. Newton's universal law of gravitation states that any two bodies in the universe attract each other with a *force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.*

1) The equation obtained from universal law is given by

$$F = \frac{Gm_1m_2}{r^2} \text{ where } G \text{ is the}$$

universal gravitational constant equal to $6.673 \times 10^{-11} \text{ Nm/kg}$.

At this point, correct errors made by the learners in their discussion and assess through questions and answers method whether the objectives have been made.

- Take the learners through the discussion then examples 4.6 to 4.9 given in student's book.
- Ask learners to do exercise 4.4. Go around the classroom and mark their work. Note that the fast learners will finish within a short time, mark their work and let them do the remaining questions.
- Guide the slow learners and let them also do the rest of questions.
- Take the student through the unit summary and ask them to do unit test S.

Note:

Ensure that you have marked learners work. This will enable you to assess whether the unit objectives have been achieved and identify challenging areas to the class and guide them accordingly.

Further exercises and their answers

Further exercises/activities

Further exercise for slow learners	Additional exercise for fast earners
<ol style="list-style-type: none">1. Define the term 'inertia'.2. For every _____ there is an equal and opposite _____.<ol style="list-style-type: none">A. reaction, actionB. action, actionC. reaction, reactionD. action, reaction3. How long will an object remain at rest, according to Newton's First Law of Motion?<ol style="list-style-type: none">A. It can't rest.B. Until noon.C. Until an unbalanced force occurs.D. As long as there are unbalanced forces acting on it.4. Which of Newton's Laws describes the amount of force applied to accelerate an object's mass?<ol style="list-style-type: none">A. Newton's First LawB. Newton's Second LawC. Newton's Third LawD. Newton's Fourth Law	<ol style="list-style-type: none">1. State Newton's laws of motion and give three examples from ordinary experience to illustrate each of these laws.2. Explain why a toy balloon filled with air and released it moves in the opposite direction to that of the air coming out of it.3. Explain why it is important to study Newton's laws of motion.

Answers to some further exercises/Activities

Additional exercises for slow learners	Additional exercises for fast learners
<ol style="list-style-type: none"> 1. Is the property of a bodies to resist change in state of motion. 2. D 3. C 4. B 	<ol style="list-style-type: none"> 1. - Newton's First Law of Motion: I. Every object in a state of uniform motion tends to remain in that state of motion unless an external force is applied to it. <ul style="list-style-type: none"> - The acceleration of an object is directly proportional to net force acting on it and inversely proportional to its mass; the acceleration takes place in the direction of the resultant force. - The newton's third law of motion states that for every action (force) in nature there is an equal and opposite reaction

Answers

For non-numerical questions, the learners should be encouraged to get most of the answers from the discussions given in student's book or from the internet and any other reference books. Mark the student's work to guide them appropriately.

Exercise 4.2 (Student's book page 138)

2. 15 m/s^2
3. (a) 60 N (b) 00.36 N
(c) 48 N
5. 160 N
6. 12.5 N
7. 5 m/s^2
8. 16000 N

Exercise 4.3 (Student's book pages 142 - 143)

4. (a) 3 m/s^2 (b) 180 N

Exercise 4.4 (Student's book page 147)

1. 460.9 N
2. 926320.0431 N
3. $1.3681 \times 10^{17} \text{ N}$
4. 2.6717 kg
5. 2.0876 m

Unit Test 4 (Student's book pages 148 - 149)

6. 7. 34232 m
7. (a) $3.5448 \times 10^{24} \text{ N}$
(b) $1.9876 \times 10^{20} \text{ N}$
8. 225. 8169 kg
9. 8.497×10^1 or 84.97

Mechanics

Force

Unit 5

Centre of Gravity

Student's Book pages 150-165 (10 Periods)

Key unit competence

By the end of the unit, the learner should be able to determine the position of centre of gravity of a body.

Learning objectives

Knowledge and understanding

- Differentiate between centre of mass and centre of gravity.
- Define centre of gravity and determine its position for objects of regular shape.
- Identify position of centre of gravity for bodies of different shapes.

Skills

- Predict the equilibrium of body based on position of centre of gravity.
- Apply knowledge of centre of gravity and centre of mass to state equilibrium of a body (stable, neutral, unstable).
- Describe the working of toys with in relation to equilibrium.
- Determine experimentally, the position of centre of gravity for bodies of different shapes (Regular and Irregular).

Attitudes and values

- Appreciate the role of centre of gravity in determining the stability of a body.
- Recognize that when there is no resultant force and no resultant turning effect, a system is in equilibrium. Accept that position of centre of gravity of a body determines its state of equilibrium.
- Recognise c.o.g (centre of gravity) of uniform triangular, circular or rectangular shaped bodies.
- Show concern about stability of bodies in particular positions.

Generic competencies addressed in this unit

- Lifelong learning. As learners keep on learning more about stability and effect of force of gravity in their daily lives
- Communication skills in English through provision of group work

activities in the students book that requires individual learners to express their points..

- Cooperation and interpersonal relation through provision of group based activities that require learners to work together to solve a particular task.
- Critical thinking by provision of a variety of questions in the activities and exercise that require the students to think.

Links to other subjects

Carpentry (stability of different furniture), design of racing cars and modern bus.

Cross cutting issues addressed in this unit

- Standardization culture-It is emphasized by cautioning learners that it is dangerous to stand on a moving vehicle thus in a moving vehicle.
- Communication skills in English through provision of group work activities in the students book that requires individual learners to express their points..
- Cooperation and interpersonal relation through provision of group based activities that require learners to work together to solve a particular task.
- Critical thinking by provision of a variety of questions in the activities and exercise that require the students to think.

Assessment criteria

Learner should explain the difference between centre of mass and centre of gravity, conduct and report on experiment to determine centre of gravity, and discuss the states of equilibrium in relation to the positions of centre of gravity.

Suggested teaching methodology

- Guided discovery
- Research
- Question and answers
- Discussion
- Role play

Background information

In Unit 3, learners were introduced to forces and their effect on a body. They were taught about balanced and unbalanced forces on a body. Actually ,when unbalanced forces acts on a body, its stability is affected. In this unit, learners are going to learn most interesting and commonly experiences they have ever met in their lives. For instance, overturned truck in our roads, balancing toy bird in the supermarket among other experiences. Therefore, you should use these common experiences to trigger learners' curiosity to understand the reason behind all these experience that they have ever encountered in their daily lives. This unit is full of practical activities, therefore, you should engage the learners in all activities so that the point you want them to understand is brought home. It

is a good idea to introduce this unit by a common practical activity i.e. Activity 5.1 in student's book of balancing a book using the finger.

Suggested teaching/learning activities

5.1 Centre of Gravity and Centre of mass of a body

(2 periods)

By the end of this section the learners should be able to differentiate between centre of gravity and centre of mass by their definition.

Suggested teaching/learning materials

- A thin rectangular card, an irregular lamina, table

Preparation

Assemble all the required apparatus for this activity into groups depending on the number of students and availability of materials.

Teaching guidelines 5.1

- Ask learners to pair up to do activity 5.2 in the Student's Book.
- Ask them to do activity 5.2 provided in student's book i.e. to investigate where the weight of a body acts from. All learners whether disabled or normal should participate actively in the lesson and all activities. For instance, they can hold a ruler as other student draw.
- Help them on how to determine

the point where the rectangular cardboard balances.

- Guide slow learners on how to locate the point where the weight of a body acts. You may use activity 5.2 given in student's book. Help them to define centre of gravity of a body. Encourage them to participate in class discussions on their observations.
- Let them discuss their observations in their groups and present their findings to the whole class through the secretary or any other group member. Allow other members to contribute by pointing out errors or omissions from their discussions.
- Guide them in class discussion on their result by pointing out the key points:
 1. Centre of gravity of a body is the point from which the whole weight of a body acts.
 2. Centre of mass of an object is the point where all the mass of the object is concentrated in different regular shapes (rectangular, square, triangular and circular) given on student's book.
- Ask the learners to do activity 5.3 on their own and present their observations and explanations during remedial hours.
- Assign slow learners remedial activity on determining centre of gravity of different regular bodies e.g. a square lamina so that they can catch up with others.

5.2 Centre of Gravity of a regular lamina

(2 periods)

By the end of this section, the learners should be able to determine experimentally the position of the centre of gravity of regular lamina.

Suggested teaching/learning materials

A pump line, drawing pins, an regular lamina.

Preparation

Assemble all the required apparatus for this activity into groups depending on the number of students and availability of materials.

Teaching guidelines 5.2

- Ask learners to form groups. Ensure that the groups are of different abilities and gender (if any).
- Ask them to do activity 5.3 given in the student's book i.e. to determine the centre of gravity of a regular lamina using a plumbline. Learners with sight or auditory problems can be placed in front of the class or any appropriate position for them to learn and be allowed to use their sense of touch to tell where the plumb line is passing through.

Remember: Disability is not inability!

5.3 Centre of Gravity of an irregular lamina

(2 periods)

By the end of this section, the learner should be able to determine experimentally the position of the centre of gravity of an irregular lamina.

Suggested teaching/learning materials

A pumpline, drawing pins, an irregular lamina

Preparation

Arrange all the required materials into groups according to the number of students and the availability of the apparatus

Teaching guidelines 5.3 (a)

- Guide the learners (especially slow learners) through activity 5.4 and help them to determine the centre of an irregular lamina using a plumbline.
- Ask them to present their findings through their secretaries and allow other members from different groups to balance a lamina at point 'M' to show whether the lamina is balancing.
- Guide them through a class discussion on how to determine the centre of gravity of an irregular shaped lamina using a plumb line. Use this chance to correct errors made in learner's discussion and

assess whether you have achieved the objectives.

- Summarise the discussion by emphasizing the steps taken to determine the centre of gravity of an irregular lamina given lamina, plumbline, a drawing pin and point out that when a body is freely suspended it rests with its centre of gravity vertically below the point of suspension.
- Give slow learners remedial activity on determining the centre of gravity of different irregular objects e.g. irregular cardboard. Encourage them to appreciate the importance of seeking guidance from their teachers whenever they encounter challenges in the process of learning.
- This activity will promote in learners; -
 1. Communication skills in English through provision of group work activities in the students book that requires individual learners to express their points.
 2. Cooperation and interpersonal relation through provision of group based activities that require learners to work together to solve a particular task.
 3. Critical thinking by provision of a variety of questions in the activities and exercise that require the students to think.

Teaching guidelines 5.3 (b)

- Organise learners into groups. Ensure that they are of different abilities and gender (if any). All learners whether disabled or normal should participate actively during the lesson and all activities
- Ask them to do activity 5.5 given in the learner's book i.e. to determine the centre of gravity of a lamina using a straight edge.
- Guide them as they do the activity so that they can be able to determine the centre of gravity using the edge of a prism.
- Let them discuss how to determine centre of gravity of different lamina and locate the point M (centre of gravity) on them.
- Provide to them different lamina and ask them to practice on them by determining their centres of gravity. Encourage them to participate in class discussions on their observations.
- Summarise the activity by having a whole class discussion and point out the steps to be followed when determining the centre of gravity and use this chance to correct errors on learner's discussion and examine whether the objectives have been achieved as you conclude.
- This activity will promote in learners among other competencies: -
 1. Communication skills in English through provision of group work activities in the students book that requires individual learners to express their points.

2. Cooperation and interpersonal relation through provision of group based activities that require learners to work together to solve a particular task.
3. Critical thinking by provision of a variety of questions in the activities and exercise that require the students to think.

5.4 Effect of position of centre of gravity on states of equilibrium

(4 periods)

By the end of this unit, the learner will be able to explain the effect of position of the centre of gravity to the stability of simple objects.

Information to the teacher

Effect of position of centre of gravity to the stability of body is a crucial part of this unit, therefore you should ensure that learners have understood this concept well. Make use of remedial hours to assist slow learners and explain to the class any other areas that they have not understood well.

Suggested teaching /learning materials

A plastic thistle funnel, a bench, internet, Reference books

Preparation

- Arrange the required materials into appropriate groups depending on availability of the materials and number of students.

- Ask learners to do a research for activity 5.6 prior to the lesson and present their findings during the lesson .

Teaching guidelines 5.4 (a)

- Organise learners into groups and ensure that they are of different abilities and gender (if any). Let them have a group leader and secretary to record down points from their discussion.
- Ask each group leader to lead a discussion on their research.
- Let the groups' secretaries present the harmonized points from their discussion to the whole class. Allow other members to point out omissions or errors on the fact presented if any.
- Guide them in a class discussion and point out the key points:
 1. The state of rest of a body is referred to as stability.
 2. Some bodies are in a more stable condition than others.
 3. The states of balance of a body is called the state of equilibrium. Use this opportunity to correct errors in the students research and discussion. You can assess whether the objectives of the research have been met.
- Summarise the activity by emphasising out that there are three states of equilibrium; stable, unstable and neutral. Activities 5.7, 5.8 and 5.9 will raise the curiosity of learners to know more about them.

- This activity promotes in the learners in
 1. Leadership and organizational skills in learners. Organise themselves in groups and choose leaders to guide them.
 2. Communication skills in English through provision of group work activities in the students book that requires individual learners to express their points..
 3. Cooperation and interpersonal relation through provision of group based activities that require learners to work together to solve a particular task.
 4. Critical thinking by provision of a variety of questions in the activities and exercise that require the students to think.
- by their group members. After that, let them do activities 5.7
- Ask the groups secretaries to give a report on their findings to the whole class and allow the class to point out the omission and errors from the facts given.
- Guide them in a class discussion as the one given in student's book * and emphasize the key point that a body is said to be in a state of equilibrium if given a slight push it will fall back to its original position to keep its centre of gravity as low as possible. Use the chance to correct the errors or omission from the discussion of the learners and assess whether the objectives have been made as you conclude the activity.
- This activity will promote
 1. Gender sensitive among the learners as mixed class is grouped with boys and girls being mixed in equal ratio.
 2. Communication skills in English through provision of group work activities in the students book that requires individual learners to express their points.
 3. Cooperation and interpersonal relation through provision of group based activities that require learners to work together to solve a particular task.

Three states of equilibrium

Teaching guidelines 5.4 (b)

- Organise learners into groups of different abilities and gender (if any). Prompt them to realize that they need a group leader and secretary. Ensure that those who have never been chosen as a leader or a secretary also participate.
- Ask them to do activity 5.6 given in the student book i.e. define and describe three states of equilibrium.
- Guide them through the activity and let the secretary record observations and explanation given

4. Critical thinking by provision of a variety of questions in the activities and exercise that require the students to think.

Unstable equilibrium

Teaching guidelines 5.4 (c)

- Ask learners to group themselves. Ensure each group is made of learners with different abilities and they have observed gender balance (if any).
- Ask them to do activity 5.8 given in student's book i.e. to demonstrate unstable state of equilibrium.
- Guide them through the activity and prompt them to explain why we have used plastic thistle instead of glass one. Use this chance to caution them to be careful not to break laboratory apparatus because they will affect finances meant for something else.
- Allow the groups to have a group discussion on their observation and let the group secretaries to note the main point from their discussion.
- Ask the group secretaries to present their findings to the whole class and allow other members to contribute in pointing out errors and adding omission to the fact presented.
- Summarise the activity to having a class discussion on the result of the learners. Point out the key point that a body is said to be unstable if it continue falling after a slight push to lower its centre of gravity. The body will occupy new position. At

this point, correct the errors made by learners in their discussion and examine whether the objectives have been made.

- This activity will promote in learners among other companies.
 1. Communication skills in English through provision of group work activities in the students book that requires individual learners to express their points.
 2. Cooperation and interpersonal relation through provision of group based activities that require learners to work together to solve a particular task.
 3. Critical thinking by provision of a variety of questions in the activities and exercise that require the students to think.

Neutral equilibrium

Teaching guidelines 5.4 (d)

- Organise learners into groups of different abilities and gender.
- Ask them to do activity 5.9 given in student's book page i.e. to show neutral state of equilibrium.
- Guide the learners through the activity and help them to understand that the position of centre of gravity of plastic funnel does not change when given a slight push.
- Let the learners have a discussion on their observations from the activity and present them to the whole class

through their secretaries.

- Allow participation from the whole class on each presentation and then have a class discussion to point out the key point i.e. a body is said to be in a neutral state when its position of centre of gravity remains at the same vertical position even when the object is displaced.
- Summarise the discussion by reminding learners the three states of equilibrium; stable, unstable and neutral and how to describe each of them. Lead them (especially slow learners) step by step through the three activities to describe the state depicted by the funnel when placed at different position and given a slight push. Encourage them to participate in class discussions on their observations by telling them not to fear giving wrong answers. By the way it is through giving wrong answers that we get to learn. Give **slow learners remedial activity** to place on.
- Help the special need student e.g. those with **sight problems** to use their sense of touch in those activities to tell when the funnel is in stable, unstable or neutral states of equilibrium when it is given a slight push from their initial position.
- The activity will promotes
 1. Cooperation.
 2. Communication skills.
 3. Critical thinking in learners among other competencies.

Relationship between position of the weight of the body and its stability

Teaching guidelines 5.6

- Organise learners into groups of two. Ensure that in each group there is a light student and heavy one. Note that in this activity 5.10 the group should be of the same sex i.e. a boy and a boy or a girl and a girl.
- Guide them through the steps given on the student's book.
- Caution the students to be careful with their partners when carrying them.
- Let the disabled students observe and record down all the observation. Remember that disabled students should always find part to participate in every activity. By doing so they will feel part of the activity and boost their self-esteem.
- **DISABILITY IS NOT INABILITY!!**
- Let the learner gather at one point of the field and give their observations and explanations. Prompt them to connect the activity to the states of equilibrium; stable and unstable and also connect it to the vehicle with heavy loads on its upper part.
- Have a discussion with them and point out the main points.
 1. A body is unstable if its upper part is heavy than lower parts.
 2. A body is stable if its lower parts is heavy than upper parts. Use this opportunity to correct

errors made by the learners during their discussion.

- Summarise the discussion by emphasizing the reason why it is not advisable to put heavy luggage on top of the vehicles i.e. the upper part becomes heavier than lower part hence rises the centre of gravity thus the vehicle becomes unstable.
- Ask them to do exercise 5.1 go around marking their work. Note that the quick learners will finish first, let them do the remaining questions.
- This activity will promote in the learners among other competencies:-
 1. Communication skills in English through provision of group work activities in the students book that requires individual learners to express their points.
 2. Cooperation and interpersonal relation through provision of group based activities that require learners to work together to solve a particular task.
 3. Critical thinking by provision of a variety of questions in the activities and exercise that require the students to think.

5.5, 5.6 Factors affecting the stability of a body and applications of position of the centre of gravity

(2 periods)

By the end of this section, the learners should be able to explain factors that affect stability and some of applications of position of the centre of gravity in real life.

Information to the teacher

Learners have seen different situations where position of centre of gravity is applied e.g. balancing bird, in supermarket, boat tilting etc. Capitalize these and other common situations to trigger the curiosity of learners so that they can understand the application of position of centre of gravity.

Suggested teaching /learning materials

- A plastic funnel, Balancing bird toy

Preparation

- Ensure that you have a balancing bird toy and plastic funnel before the lesson starts.

Teaching guidelines 5.5

- Organise learners into groups of different abilities and gender. **All** learners whether **disabled or normal** should participate actively in the lesson and in this activity.
- Learners have already done activities 5.7 and 5.8. Ask them to

repeat activity 5.6 and let them tell when is the body said to be in a stable equilibrium. And guide them to do activity 5.11 given in student's book.

- Allow learners to discuss in their groups the factors that affect the stability of a body and report their findings through the group's secretaries. At this point allow other students from different groups to contribute on each presentation.
- Summarise the discussion by pointing out key points that a body is said to be stable when: -
 - The COG is as low as possible.
 - Area of the base is as large as possible.
 - The vertical line drawn from the COG always fall on the base.
- Using these factors as a basis, lead the learners into some of applications of the position of the centre of gravity through activity 5.12.
- Demonstrate to them how the bird toy is balanced i.e. supported i.e. by supporting it at the peak where the weight of the bird is concentrated.
- Allow learners to balance the toy bird and let them explain why it balances when supported at the

peak i.e. is where the position of the centre of gravity is located thus its weight concentrates at the peak. Help them (especially the slow learner) to balance the toy bird provided and lead them in the discussion provided in the student's book. Encourage them to participate in class discussions on their observations by telling them not to be afraid of giving wrong answers. By giving wrong answers they can get to learn new concepts.

- Let them explain other life experiences e.g. one lean to the opposite side when carrying heavy loads i.e. so that the weight of the load and one carrying it are always balanced at the position centre of gravity.
- Summarise the discussion by taking learners through applications given in student's book.
- Ask learners to do unit Test 5 question one. Go round checking how learners answer and correct them. Note that the quick learners may finish fast, let them do question 5 and then include others after marking their work. Use this chance to emphasize the importance of observing traffic rules.

- Let learners do the rest of the questions as assignment to be marked then discussed during remedial hours. Give slow learners remedial assignment on application of position of centre of gravity. You may ask them to do questions 8 and 9 provided in student's book Unit 5.
- This activity will promote in the learners among other competencies:-
 1. Communication skills in English through provision of group work activities in the students book that requires individual learners to express their points.
 2. Cooperation and interpersonal relation through provision of group based activities that require learners to work together to solve a particular task.
 3. Critical thinking through provision of a variety of questions in the activities and exercise that require the students to think.

Further exercises and their answers

Further exercises/activities

<i>Further exercise for slow learners</i>	<i>Further exercise for fast learners</i>
1. Define centre of gravity and centre of mass. 2. Name apparatus used to determine the centre of gravity of irregular objects. 3. State three states of equilibrium. 4. List three applications of position of centre of	1. Describe how to find the centre of gravity of an irregular lamina. 2. Explain how a tight-rope walker maintains his/her stability on the rope. 3. A mechanical engineer considers various aspects when coming up with a plan for constructing racing cars. Name some of those aspects and their significance. 4. Discuss three states of equilibrium a body can be in.

Answers to some further exercises/activities

<i>Further exercise for slow learners</i>	<i>Additional exercise for fast learners</i>
<p>1. Centre of gravity of a body is the point from which the whole weight of the body appears to act on the other hand while centre of mass is a point in a body where all the mass of the object is concentrated.</p> <p>2. irregular lamina, plumbline, a drawing pin.</p> <p>3. stable, unstable and neutral state.</p> <p>4. Balancing bird toy, buses apartments are made below the passengers seat, a three legged stool its stands are placed far apart.</p>	<p>3. Wide-heavy base to lower the position of centre of gravity. This will increase stability of the racing car and thus cannot easily topple over when negotiating a corner at high speed.</p>

Answers

For non-numerical questions, the learners can get most of the answers from the discussion given in student's book or from the internet and any other reference books. Mark the student's work and use it to guide them appropriately.

Exercise 5.1.

(Student's book page 159)

2. (a)
- i) Stable
 - ii) Unstable
 - iii) Neutral
4. Neutral state. The position of centre of gravity remains the same even after given a slight push.

Unit Test 5

(Student's book pages 164-165)

1. Centre of gravity of a body is the point from which the whole weight

of a body appear to act from while on the other hand, centre of mass is a point in a body where all the mass of the body is concentrated.

5. a) Stable-when the marble is given a slight push, its centre of gravity is raised but it retains to its initial position.
- b) Neutral- The centre of gravity of the marble does not change even after given a slight push.
- c) Unstable- its centre of gravity changes from its initial position when a marble is given a slight push.

NB: Mark the correct answers given by students for exercises 5.1 and Unit Test 5.

Mechanics

Work, Power and Energy

Unit 6

Work, Power and Energy (I)

Student's Book pages 166-211 (14 Periods)

Key unit competence

By the end of the unit the learner should be able to analyse the process of energy transformations and conservation.

Learning objectives

Knowledge and understanding

- Explain the concepts of work, power and energy.
- Identify forms of mechanical energy.
- Explain transformation of energy.
- Illustrate how potential energy changes into kinetic energy and vice versa.
- State the law of conservation of energy.
- Enumerate types of energy and their sources.
- Identify ways of conserving energy.

Skills

- Estimate the kinetic and potential energy of bodies in different situations.
- Solve problems related to work, power and energy.

- Estimate power of an individual climbing a flight of steps.
- Calculate the work done on an object pulled along a horizontal surface using a spring balance.
- Analyse the process of energy transformation.
- Describe ways of conserving energy.
- Explain the principle of energy conservation.

Attitudes and values

- Appreciate the role of work, power and energy in our daily life.
- Use the terms work power and energy correctly in a scientific context.
- Optimize the Generic competencies addressed in this unit efficiency in relation to work, energy and power.
- Be aware of danger of high-speed objects or falling objects.

- Show concern about shortage of energy sources in our country.

Generic competencies addressed in this unit

- Critical thinking and problem solving through involving the learners in problem solving and discussion.
- Communication through provision of learners discussion based activities.
- Co-operation, interpersonal management and life skill through provision of group work activities.

Links to other subjects

Building construction, agriculture, engineering, aviation industry.

Cross cutting issues addressed in this unit

- Conservation of energy and the use safer sources of energy in both domestic and commercial use.
- Environment, climate change and sustainability

Assessment criteria

Learner should solve problems of energy transformation and energy conservation, can perform and report experimental work related to energy transformation.

Teaching methodologies

- Group work.
- Class discussions.
- Question and answers.
- Class demonstrations

Background information

In this unit, we will introduce learners to the concept of work, power and energy. Energy is an abstract concept that we only become aware of its presence when it's seen to do work. Use simple experiments to introduce the language of energy and go on to include more advanced terms. Quiet often students confuse work and energy so engage them in a number of activities to help differentiate between them. Field trips to energy production sites may help the learners to discuss energy concept with ease.

Suggested teaching/learning activities

6.1 Work

(1 period)

By the end of this section the learners should be able to define the term work, identify it's units and calculate work using the appropriate formula.

Information to the teacher

In this section, you will introduce the learners to the concept of work in science for the first time.

Suggested teaching/learning materials

Reference materials including books, piece of chalk, pen, chair, desk and a chart showing people doing different activities.

Preparation

Assemble all the required apparatus for this activity into groups depending on the number of students and availability of materials.

Teaching guidelines 6.1 (a)

- Ask the learners to work individually.
- Ask them to do activity 6.1 in the learner's book as they observe.
- Ask each one of them to walk from his/her desk to the chalk board and write the word work on the chalkboard.
- Ask them to collect litter in the class then carry their chair to the front of the class and sit on it.
- Ask them to try to push a wall then discuss in groups whether in the previous tasks given to them there was work being done.
- Let them discuss to the class their findings. All learners whether disabled or normal should be involved actively in the activity. For instance, those with sight problem can be helped to push the wall or to sit on a chair.
- Summarise the activity by helping the learners (especially the slow learners) know that for any work to be done, a force acting on a body must make it move (get displaced) in the direction of the force.
- Help them to understand why in activity 6.1 task (b) and (c) we say work is not being done.
- Discuss with the learners the derivation of the formula for work

from its definition. Guide them to formulate its SI units from its formula. Introduce the joule as $1 \text{ Nm} = 1 \text{ joule}$.

- Guide them through example 6.1 in the learner's book.
- Ask them to do question 1, 2 and 3 from exercise 6.1 given in the student's book.
- This activity promotes;
 1. Teamwork, values and enjoyment.
 2. Communication and critical thinking through discussions

6.2 Work done in Pulling an Object along a Horizontal Surface

Suggested teaching/learning materials

A block of wood, a spring balance, and a tape measure/ metre ruler

Preparation

Before the period, prepare a set of the materials mentioned above for each of the groups you will work with.

Teaching guidelines 6.1 (b)

- Organise the learners into convenient groups. Let each group appoint a secretary.
- Guide them to do Activity 6.2 given in the student's book on how to calculate the work done in pulling an object along a horizontal surface.
- Ask them to place block of wood on a horizontal surface and attach the spring balance on the block.

- Let them identify and mark the initial point of block then to pull it slowly.
- As one is pulling, another student should record the force being used to pull the block.
- Let the learners measure the distance through which the block has moved from the initial point using a meter rule or a tape measure. Record it down.
- Ask learners to calculate the work done using the formula (work = Fd)
- Summarise the activity by asking each group to give a presentation to the class.
- Prompt them to suggest reasons why different groups have obtained different values of work done. In case they do not give accurate reasons, let them know that this arose from the use of blocks that are not exactly of same weight, application of forces of different magnitudes, differences in the distances moved, and roughness of the surfaces.
- Guide the learners through examples 6.2 and 6.3 in the learners book.
- Ask them to do Exercise 6.1 in student's book.
- This activity will promote in a learner;
 1. Leadership and organization skills.
 2. Communications skills critical thinking.
 3. Problem solving competencies.

6.3 Power

(1 period)

By the end of this section the learners should be able to define the term power, identify the SI units of measurement, and calculate power using the appropriate formula.

Information to the teacher

The quantity that has to do with the rate at which a certain amount of work is done is known as power. It is the rate at which work is done. In other words, power is a measure of how quick work can be done. The unit of power is the watt = 1 joule/second. Bigger units of power are kilowatt (KWh) which is 1000 W, megawatt-1 million watts, giga watt- 1 billion watts, terawatts- 1 trillion watts.

Preparation

Assemble all the required apparatus for this activity into groups depending on the number of students and availability of materials.

Teacher's guidelines 6.2 (a)

- Organise learners into groups of different abilities and gender incase it is a mixed class of boys and girls. Ensure that the disabled are also involved in all activities.
- Ask each pupil to do Activity 6.3 given in the student's book.
- After the activity, let each member present their findings to the rest of the class.

- Summarise the results of the activity by guiding the learners to understand that a tractor does the work at a faster rate than the man due its higher power rating. Let them know that the rate of doing work is known as power.
- Lead the learners through the derivation of the formula for power. Ask them to formulate its SI units from its formula.
Guide them in a discussion on example 6.4 in the student book.
- Ask them to do questions 1 and 2 of Exercise 6.2.

Estimating one's own power **Preparation to the teacher**

Before the period, the teacher should check that he/she has enough stop watches, and weighing machines (scales). In case they are not enough, you can borrow from neighboring schools, or for weighing machines they can use them one at a time.

Note; this experiment will generate noise and discipline problems unless it is well organised. Student will wish to compete against one another to find the most powerful person; plan in advance where students will stand and how other staff and/or students can pass by whilst the experiment is in progress.

Safety; learners must be warned to take care on the stairs as they are running to avoid accident.

Suggested teaching/learning materials

Stop watch, stairs, and a weighing machine, and a tape measure.

Preparation

Assemble all the required apparatus for this activity into groups depending on the number of students and availability of materials.

Teacher's guidelines 6.2 (b)

- Organise learners into convenient groups of three or four.
- Provide each group with a stop watch, and let them use the weighing machine one group at a time if the machines are few.
- In case of any disabled, let them be the ones to time the others.
- Guide them to do Activity 6.4 in the student's book on how to estimate the power of an individual.
- Ask them to find stairs that they can use while walking and running. Let them count the number of stairs and measure the height of each, guide them on how to measure total height of the stairs in meters. (total height = height of one stair \times number of the stairs).
- Ask one member of the group to weigh him/herself in Newton, let the other member record the weight.
- Let them record the time in seconds it takes to walk and run up the stairs using a stop watch
- Ask them to calculate the work done using the formula (work = Fd)

- Ask them to finally calculate the power using the formula

$$p = \frac{\text{work}}{\text{time}}$$

- Summarise the activity by asking each group to give a presentation to the class on the work done while walking and that while running if it was the same. Let them deduce on where it needed more power and allow them to explain why they thought so.
- The teacher should discuss example 6.5 to the learners.
- Ask learners to do question 3 and 4 of Exercise 6.2 in the students book.
- This activities will promote in a learner;
 1. Leadership and organization skills,
 2. Communications skills,
 3. Critical thinking,
 4. Problem solving competencies.

Additional information to the teacher

In case of lack of stairs, another activity can be done which involves rising of measured weights to measure the power of learners arms.

Note; while raising the weights they should be carefully not to just drop them and they should be far from their bodies, like the head, and the foot.

6.3 Energy

(2 periods)

By the end of this section the learner

should be able to define the term energy, identify the different forms of energy, analyse energy transformation and conservation.

Information to the teacher

Energy is one of the most fundamental requirements of our universe; it moves motorcycles, cars along roads, airplanes through air, and boats over water. It warms and lights our homes and this is done through energy transformations.

Suggested teaching/learning materials

Reference materials including books heavy bags with book and stains.

Teacher's guidelines 6.3

- Organise the learners in pairs and ask them to do activity 6.5 in the student's book.
- After the discussion of at least 5 minutes let each member present the outcomes from their discussion to the rest of the class.
- From the discussion, help them define energy as the ability or capacity to do work. Then, give them various examples of everyday life situations, which need energy for them to happen.
- Engage the learners in discovering the relationship between energy and work by asking them to do activity 6.6 in the student's book. Through this discussion, conclude that work done = energy transferred and that the SI units of measurement of energy are the same as the SI units of work and are in joules.

- This activity will promote in a learner among other competencies;
 1. Research skills based on the numerous.
 2. Communications skills on group discussion.
 3. Critical thinking and problem solving skills.

6.4 Forms of Energy

(2 periods)

Let the learners remind themselves of the examples of the forms of energy they listed in activity (6.6) which may include, solar energy, heat energy, wind energy, sound energy, electrical energy, chemical energy etc.

Information to the teacher

- i) Solar energy; this is energy from the sun inform of radiant heat and light. Solar energy is used for heating water for domestic use (using solar heaters), space heating of buildings, drying agricultural products and generating electrical energy (electricity) using PV cells or solar panels.
- ii) Sound energy; sound is produced when stuff vibrates-like strings on an instrument. Sound travels when the vibrating stuff causes the stuff surrounding it to also vibrate. This happens in solid, liquid and gas. For sound to travel it must have a material media for its transmission (it can't travel in a vacuum because a vacuum has no atoms to transmit

the vibration. A vacuum is an empty space without anything like gas particles.

- iii) Heat energy; heat (thermal) energy is directly related to temperature (the measure of hotness or coldness of a body). When there is a difference between the temperature of the environment and the system within it, then heat energy is transferred between them. Heat flows from high temperature objects to low temperature objects that are near them until all objects are at the same temperature.
- iv) Electrical energy;
- v) Nuclear energy
- vi) Chemical energy
- vii) Mechanical energy.

Guide the learners in doing example 6.5

Guide them through the following activities;

Solar Energy

Suggested teaching/learning materials

plastic bottle, cold water, sunlight, convex lens, piece of paper

Teacher's guidelines 6.4 (a)

- Organise the learners into groups.
- Ask them to fill a plastic bottle with cold water then place it in the compound where there is no shade and observe what happens to the water after 30 minutes. Ask them to explain their observation.

- Ask them to try it again when the bottle is in a shade, and let them explain what they observe.
- Still in their groups, ask one member to hold a convex lens, put it horizontally where one surface is facing the sun and another one down.
- Ask the other member to put a thin paper just below the lens. Ask them to observe what happens to the paper after some 30 minutes or more.
- In case they don't give accurate reasons, let them know that in the first activity the water in the bottle becomes hot because of the heat from the sun, and if the bottle is put in a shade, nothing would change (the water will remain cold).
- In the second activity, the sun's rays are converged to one point on the thin paper and after some time the paper is seen to burn. The paper is burnt because the intensity of the sun rays is focused to one point which then burns the paper.
- This activity will promote in a learner;
 - Leadership and organization skills,
 - Communications skills
 - Critical thinking
 - Problem solving competencies

Sound Energy

(4 periods)

Suggested teaching/learning materials

Pens, stones

Teacher's guidelines 6.4 (b)

- Ask them to hit two pens and observe and follow the steps of activity 6.8.
- Ask them to lift a stone a meter above the ground, then release it and ask them to conclude on what happens whenever two things hit or collide with each other.
- In case they don't give accurate reasons, let them know that sound energy is always produced whenever two bodies hit each other.
- This activity will promote in a learner;
- Critical thinking
- Communications skills
- Problem solving competencies

Heat Energy

Suggested teaching/learning materials

Bunsen burner (a candle), lighter (match box), retort stand, nail (metal rod)

Teacher's guidelines 6.4 (c)

- Organise learners into groups of three or five.
- Ask them to light a Bunsen burner or a candle using a lighter or a match box as in activity 6.9 in the student's book.

- Ask them to clamp or put a nail on a retort stand and then bring it near the candle or Bunsen flame.
- Ask them to touch and feel at the other end of the nail or metal rod ask them to explain what they feel.
- In case they don't give accurate reasons, let them know after some time the other end of the nail is observed to become hot. This form of energy which moves from a hot place to a cooler one is called heat.
- This activity will promote in a learner;
- Leadership and organization skills,
- Communications skills
- Critical thinking
- Problem solving competencies

Electrical Energy

Suggested teaching/learning materials

Reference books, internet, bulb, electric wire, battery, switch, bulb holder and cell holder.

Teacher's guidelines 6.4 (d)

- Organise learners into groups of three or five.
- Ask them do research from the internet and give them reference names of books on electrical energy
- Ask them to majorly find out what electrical energy is and allow them to share and discuss their findings to the rest of the class.
- In case they don't give accurate reasons, let them know that electrical energy is the energy

made available by the flow of charges(electrons).

- Let the learners do activity 6.10 in the students book.
- This activity will promote in a learner;
 - Communications skills

Nuclear Energy

Suggested teaching/learning materials

reference books, and internet

Teacher's guidelines 6.4 (e)

- Organise learners into groups of three or five.
- Ask them do research from the internet and give them reference names of books on Nuclear energy, its advantages and disadvantages to the environment.
- Ask to them to share and discuss their findings to the rest of the class.
- In case they don't give accurate reasons, let them know that electrical energy is the energy, which is released when the nuclei are combined, or split apart.
 - This activity will promote in a learner;
 - Communications skills

Chemical Energy

Suggested teaching/learning materials

glass beaker, a small bowl, steel wool, white vinegar, thermometer.

Teacher's guidelines 6.4 (f)

- Organise learners into groups of three or five.
- Ask them to place a steel wool in a bowl and soak it in white vinegar for a couple of minutes.
- Ask them to squeeze out excess vinegar and wrap the steel wool around the thermometer such that it is still easy to read the temperature.
- Ask them to put the steel wool in the beaker, and then place a cover with a paper or small book on top
- Ask them to record the temperature immediately, then a gain in a minute's time or so, and again every minute for about five minutes. Ask them to write down their observation. Let them (each group member) discuss each group's findings.
- In case they don't give accurate reasons, let them know that soaking the steel wool in vinegar removes the protective oil and steel begins to rust. The chemical reaction generates heat energy, which increases the temperature, which is then measured by the thermometer. Therefore chemical energy is the energy stored in bonds of the atoms and molecules that make up the substance
- This activity will promote in a learner;
 - Leadership and organization skills,
 - Communications skills

- Critical thinking
- Problem solving competencies

Mechanical Energy

Suggested teaching/learning materials

Pen, fully piece of chalk

Teacher's guidelines 6.4 (g)

- Organise the learners in groups.
- Ask the learners to remind themselves of what happens to them whenever a driver applies brakes suddenly while stopping a car.
- In case they don't give good answers, explain to them that their bodies move forward because the car was in motion and so the person to and thus it possessed kinetic energy while the body had potential energy due to the position of the car relative to the ground. The body can have both potential energy and kinetic energy at the same time like an aeroplane, which has potential energy due to its height, and kinetic energy due to its speed. So the mechanical energy of a system is the summation of the potential and kinetic energy
- Let the learners do activity 6.13 in the student's book.

Potential Energy

Suggested teaching/learning materials

a catapult or a spring, a small stone

Teacher's guidelines 6.4 (h)

- Organise the learners in pairs.
- Ask each learners to raise a small stone or any object from the ground or any other resting place (a table) upwards to a particular height above the resting surface. Ask them the kind of energy the small stone has attained.
- Ask them to release the stone and observe what take place. Let them explain what they observe
- Ask each student to compress a spring (to stretch a catapult) to a particular size and ask them which kind of energy it has in its state. Ask them to release the spring and observe what happens and discuss with the fellow class mates each one's findings.
- Summarise the activity by discussing with the learners that a the stone had to move down when released to the ground which implies that it had stored energy due to its position which makes it to start moving down after it has been released. And it's called gravitational potential energy. Similarly when a spring or catapult is released it stretched to a bigger size and this implies that the spring had stored energy due to compressing or stretching for a catapult. This energy is called elastic potential energy. Potential energy is in two forms, that is gravitational potential energy and elastic potential energy

- This activity will promote in a learner;
- Leadership and organization skills,
- Communications skills
- Critical thinking
- Problem solving competencies

Gravitational Potential Energy

Suggested teaching/learning materials

bricks, meter ruler, beam balance, soft board (ply wood)

Teacher's guidelines 6.4 (i)

- Organise learners in pairs.
- Ask the learners to do activity 6.5 in the learner's book.
- Ask the learners to measure the mass of a brick using a beam balance and record it on a paper
- Ask them to support the Soft board Bridge on tow bricks, let the third brick be on top whereby that will be the height one (1).
- Ask another member to measure the heights using ruler let us say H 1 H2 H3 H4. H 1 being when the brick is on the soft board.
- Ask them to release the brick at each height to fall on the soft board bridge and observe what happens whenever it is released from each height.
- Ask them to calculate potential energy at each height and compare the effect done on the soft board and the potential energy related to it.

- Summarise the activity by discussing with the learners that a brick from a bigger height has more potential energy than one on from a shorter height, this is the same reason why it will break the soft board.
- Guide them through example 6.5 in students book: Then ask the learners to do exercise 6.3 in the students book.
- This activity will promote in a learner;
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to be solved.

Kinetic Energy

Suggested teaching/learning materials

trolley, table

Teaching guidelines 6.4 (j)

- Organise the learners in pairs.
- Provide each group with a trolley. Let them place the trolley on a table and give it a slight push. Ask them to observe what happens and explain their observation. Ask them

to observe other moving objects around and ask them to state the energy they will be having.

- Summarise the activity by discussing with the learners that the energy possessed by a moving object is called kinetic energy.

6.5 Sources of Energy

(2 periods)

Suggested teaching/learning materials

Reference materials including books, internet, stream of water/water tap.

Preparation

Assemble all the required apparatus for this activity into groups depending on the number of students and availability of materials.

Teaching guidelines 6.5

- Organise learners into groups
- Draw the attention of the students to the student's book. Ask them to do activities 6.17 using internet and reference books to tell where the water from the tap or steam comes from and define the meaning of a source.
- In case they don't give accurate answers, let them know that the stream starts from the mountain or hills.
- Summarise the activity by letting them understand that an energy source is that system that makes

energy in a certain way, and the sources can be primary or secondary sources.

- Ask them to conduct a research from internet and reference books on primary sources of energy
 - a) The type of primary sources
 - b) How each of them is used to make lives easier

The type of primary sources

- Still in groups, guide a discussion about the different examples of primary sources of energy.
- Ask learners to activity 6.18 in the students book.
- In case they don't give accurate answers, let them know that Primary source of energy occurs naturally and include; Flowing water, Wind, Sun, Geothermal (interior of the earth), Fuels, Minerals, Biomass (living thing and their waste materials).
- Let them do activity 6.19 on the production of biogas and allow them to discuss their findings.
- Ask them to conduct a research from internet and reference books on secondary sources of energy.

The type of secondary sources

- Organise learners in groups.
- Ask learners to do activity 6.20. On the identification of secondary sources of energy.
- Ask them to discuss their findings and present them to the whole class
- In case they don't give accurate answers, let them know that

secondary sources of energy are sources converted from primary sources. Secondary sources of energy are converted from primary sources. For instance electricity is secondary because it's converted from solar energy from the sun by solar panels or from flowing water turning the turbines to form hydroelectricity

- Examples include petroleum products, manufactured solid fuels, gases, electricity and heat, bio fuel and etc.
- This activity will promote in learners among other competencies
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to be solved.

6.6 Renewable and Non-renewable Sources of Energy

(1 period)

Suggested teaching/learning materials

Reference materials including books, match box.

Preparation

Assemble all the required apparatus for this activity into groups depending on the number of students and availability of materials.

Teaching guidelines 6.6

- Draw the attention of the students to the student's book.
Ask them to do activity 6.21 in the student's book.
- Ask them to take one match stick and light it. Ask them to leave it to burn for a few seconds and then put it off.
- Ask them to use the same match stick to light it again. Let them observe what happens and try explaining their observation.
- Ask them to research about renewable and non-renewable sources of energy. Ask them to discuss their findings to the class.
- In case they don't give accurate answers, let them know that a Renewable energy source is an energy source which can't be depleted/exhausted (they exist infinitely or never run out). They are renewed by natural processes. Examples include; the sun, wind, geothermal, trees

However they can also be depleted, like trees and animals if used too much more than the natural process can renew them. So it's advisable to take precaution while using them in other words they should be conserved.

Source of Non-renewable energy

These can be depleted because they are of a fixed quantity (they have finite amounts). So they will run out one day. Examples are coal, crude oil, natural gas, and uranium.

- This activity will promote in a learner;
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to solve.

6.7 Environmental Effects of the use of Energy

(1 period)

Suggested teaching/learning materials

Reference materials including books.

Teaching guidelines 6.7

- Organise learners into groups and guide them through the activity.
- Draw the attention of the students to the student's book .
- Ask them to do activity 6.22. Let them research on air and water pollution, climate change and

- global warming, deforestation, land degradation in relation to environment and the measures to be taken to ensure safe use of energy resources.
- Summarise the activity by discussing with them how air and water pollution, climate change and global warming, deforestation, land degradation relate to the environment as in the book.
 - Ask them to do exercise 6.4 in the student book.

6.8 Energy Transformations

Suggested teaching/learning materials

Reference materials including books, electric heater and radio, water in a basin.

Preparation

Assemble all the required apparatus for this activity into groups depending on the number of students and availability of materials.

Teaching guidelines 6.8

- Organise the learners in groups of between three and five.
- Ask learners to do activity 6.23 in form of research about energy transformations.
- Organise the learners into convenient groups. Let each group appoint a secretary.
- Guide them to do activity 6.23 given in the student's book.

- Ask them to place an electric heater in the basin with water and connect it to the socket. Let them put on the switch. Ask them to observe and explain what happens. Ask them to suggest the energy changes involved in that case. Let them disconnect the heater and connect a radio to the socket, let them turn on the radio and suggest the energy changes involved. Ask them to name some examples of energy transformations.
- Ask them to repeat the activity by connecting wires, battery, a switch and a bulb. Ask them to observe what happens when the switch is closed. Ask them to give a name to devices like a bulb, heater, and radio and battery that converts energy from one form to another.
- In case they don't give accurate reasons, they should have observed that the water in the basin boils, that is electrical energy has been converted to heat energy which boils the water. Electrical energy is turned to sound energy in the radio and the bulb lights because the circuit is completed. And that the energy changes are from chemical energy in the cell (battery) to electrical energy through the wires, then to light energy by the bulb and some heat. Let them know that a device that converts one form of energy to another is called a **transducer**.

- Ask the learners to look at Fig 6.10, Fig 6.11, Fig 6.12 and Fig 6.13 in the student's book to discover some other forms of energy transformation and guide them on some explanations.
- Ask them to do exercise 6.5 in the students book.
- This activity will promote in a learner;
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to be solved.

6.9 Law of Conservation of Energy

(3 periods)

By the end of this section, the learner should be able to state and understand the law of conservation of energy.

Information to the teacher.

In this section, you will introduce the learners to the concept of the law conservation of energy in science which they have heard about in their primary science.

Suggested teaching/learning materials

Reference materials including books.

Teaching guidelines 6.9

- Ask the learners to organise themselves in pairs.
- Ask learners to do research about the law of conservation of energy and how it is stated.
- Ask the learners to do activity 6.24 in the learners book.
- Ask the to identify :
 - a) The energy transformation starting from the sun as the main
 - b) Examples to demonstrate the law of energy conservation
- Ask each learner to present his/her finding to the class.
- Through their findings guide and let them know that the law of conservation of energy states that energy cannot be created or destroyed but is merely changed from one form into another. Energy can be inter converted among many forms, mechanical, chemical, nuclear, electric, and others but the total amount of it remains constant (the same).
- Discus with them the examples given in the student book .

6.10 The Law of Conservation of Mechanical Energy

(3 periods)

By the end of this section, the learner should be able to understand and state the law of conservation of mechanical energy.

Suggested teaching/learning materials

Internet enabled computers, reference books, meter rule, piece of chalk.

Teaching guidelines 6.10 (a)

- Organise the learners into pairs.
- Ask the learners to do research about the law of conservation of mechanical energy how it states and give four examples to demonstrate it.
- Ask the learners to do activity 6.25 in the learners book.
- Ask them to discuss their findings with their pairs in class.
- Guide them through the discussion and allow learners to point out omission and errors from their research.

To demonstrate the law of conservation of mechanical energy

a) A swinging pendulum

Suggested teaching/learning materials

Bob, a thread/string, retort stand

Teaching guidelines 6.10(b)

- Organise the learners into pairs.
- In pairs, let the learners do Activity 6.26 in the learners book as you guide them through.
- Provide each pair with a thread and a bob and ask them to tie the thread on the hook of the bob to make a simple pendulum (plumb line). Let them tie the other end on to the retort stand and allow it to settle in one position.

- Ask them to pull the bob to one side either to the right or left but at least the angle can be 60° from the rest position and then release it.
- Ask them to observe the movement of the bob and ask them to try and state the energy changes at different points as it is moving guiding them as in the students book Fig 6.94. And let them give reasons for their answers.
- In case they don't give accurate reasons, let them know, the bob will attain a maximum potential energy due to its height above the ground at point 1 but minimum kinetic energy because it's at rest (the point where it will be raised to), When it swings after letting it go, the bob will gain kinetic energy at point 2 because of its motion, and potential energy still because it's at a certain height from the ground until it's passing through the lowest point at point 3, where potential energy is minimum (because it can't move further down) and all has changed to kinetic energy. Because of its kinetic energy, it swings up to the other side and now its kinetic energy starts changing to potential at point 4 until when it reaches the maximum point and it stops moving momentarily at point 5. At that point, it has maximum potential energy but minimum kinetic energy.
- This activity will promote in a learner:
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners

in the numerous activities in the learner's book.

2. Research and problem solving by provision of several practical activities within the learner's book.
3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to be solved.

b) A body thrown upwards

Suggested teaching/learning materials

Tennis ball

Teaching guidelines 6.10(c)

- Ask the learners to work individually.
- Ask each student who is given the ball to throw it upwards and observe the movement up to the maximum point.
- Ask them to sketch the motion of the ball on a paper in three different interval's starting from the lowest when thrown upwards.
- Ask them to indicate the forms of energy at each stage (kinetic and potential)
- In case they don't give accurate reasons, let them know , that a ball thrown up vertically is thrown at a maximum speed so at the point of throwing it has maximum kinetic energy and minimum potential energy since it was on the ground(rest position). The

ball moves up with reducing speed because of the force of gravity acting on it downwards until it reaches the maximum point where it stops momentarily and then falls back. At that point it has maximum potential energy and minimum kinetic energy.

- Draw the attention of the students to the student's book analyse Fig 6.16
- Guide the learners through a discussion about Fig 6.16 by doing some examples using real figures to drive the point home of mechanical energy being conserved all the way through the journey of the body.
- Summarise the activity by helping the learners do Exercise 6.6 in the students book.
- This activity will promote in a learner;
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to be solved.

6.11 Conservation of Energy

(3 periods)

By the end of this section, the learner should be able to state various ways of conservation of energy.

Suggested teaching/learning materials

Reference materials including books.

Teaching guidelines 6.11

- Ask learners to form groups of two. Ensure that the groups formed are of different abilities, have observed gender balance in case it is a mixed class of boys and girls. Ensure that all learners whether disabled or normal are involved actively in the period and all activities.
- Ask the learners to do activity 6.28 in the learners book.
- Ask learners to do research about the conservation of energy and state some examples of how energy can be conserved and find out what energy efficiency is.
- Ask each learner to present his/her finding to the class.
- In case they don't give accurate answers, let them know that conservation of energy is the act of saving energy by reducing a service or cutting back on the usage of the service.
- Guide the learners through some examples and after ask open questions for them to give some other ways of conserving energy in our daily life.

6.12 Energy Efficiency

Suggested teaching/learning materials

Reference materials including books.

Teaching guidelines 6.12

- Ask learners to do research about energy efficiency and discuss how energy can be efficiently used.
- Ask each learner to present his/her finding to the class.
- In case they don't give accurate answers, let them know that energy efficiency is defined as saving energy but keeping the same level of service. For example. If you turn off the lights when you are leaving a room, that's energy conservation, if you replace an inefficient incandescent light bulb with a more efficient compact fluorescent bulb, you are practicing energy efficiency
- Ask learners to do exercise 6.7 in the student's book
- This activities will promote in a learner;
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to be solved.

Further exercises and their answers

Further exercises/activities

Further exercises for slow learners	Further exercises for fast learners
<ol style="list-style-type: none"> Define <ul style="list-style-type: none"> - Work - Energy - Power State two forms of energy. What is energy transformation? 	<ol style="list-style-type: none"> By giving appropriate example, distinguish between energy and power. Explain five ways of conserving energy. Discuss two examples of renewable and nonrenewable resources.

Answers to some further exercises/Activities

Further exercises for slow learners	Additional exercises for fast learners
<ol style="list-style-type: none"> Work is the product of force and distance moved in the direction of force. <ul style="list-style-type: none"> - Energy is the ability to do work. - Power is rate of doing work Electrical and solar energy Change of energy from one form to other. 	Mark student's work and guide them appropriately.

Answers

For non-numerical questions, the learners can get most of the answers from the discussions given in student's book or from the internet and any other reference books. Mark the student's work and use it to guide them appropriately.

Exercise 6.1.

(Student's book page 170)

3. 200 J

4. 1000 J

Exercise 6.2

(Student's book page 173)

1. 5 W

2. 220 W

3. Student B, 20 W

4. Machine C, 400 W

Exercise 6.3

(Student's book page 182)

4. 5000J

Unit Test 6

(Student's book page 209-211)

2. a) 1800 J b) 64.3 W

3. a) 4000 J b) 800 J

4. 400 W

5. a) 4000 N b) 9200 J

c) 1800 J

6. b) 300 W

7. 480 W

8. 266.7 N

9. a) 400 N b) 101.8 W

Mechanics

Work, Power and Energy

Unit 7

Simple Machines (I)

Student's Book pages 212-239 (10 Periods)

Key unit competence

By the end this unit, the learner should be able to analyse relationship among energy, work and power for simple machines.

Learning objectives

Knowledge and understanding

- Outline examples of simple machines.
- Explain the principles behind simple machines used in daily life.
- Define machine, work, energy, power and efficiency of machines.
- Determine output work of simple machines.

Skills

- Explain the working principles of simple machines.
- Explain efficiency of simple machine.
- Evaluate efficiency of simple machines.
- Use simple machine to perform a given task.
- Design and use simple machines.
- Solve problems on simple machines.

Attitudes and values

- Appreciate the importance of simple machines in our daily life.
- Recognize the work output of simple machines.
- Recognize the effect of friction on efficiency of simple machines.

Generic competence addressed in this unit

- Cooperation and interpersonal relation through group work and discussion based activities.
- Communication skills in English through group work and discussion based activities.
- Research and problem solving skills through provision of problems provision of problems and questions to answer in the learners book.

Links to other subjects

Chemistry (metal extraction), English (vocabulary), Agriculture (agricultural tools).

Cross cutting issues addressed in this unit

- Environment. This is through provision of environment based activities, discussions and knowledge. For instance wells have been discussed extensively i.e we cover wells or boreholes in our homes and after use.

Assessment criteria

Should explain working principles of simple machines; can solve problems on simple machines, can construct a simple machine and apply them.

Teaching methodologies

- Group work.
- Class discussions.
- Question and answers.
- Class demonstrations.

Background information

Simple machines helps us to do various tasks with ease. We unconsciously apply the use of machines in doing work. For instance, visit a construction site and identify the devices used in performing tasks. Perhaps you will see wheelbarrows, hammers, human beings walking and using hands, cranes, wheel and axles. These and many more are examples of machines. Once you study this unit, you will be able to choose the appropriate machine(s) for a given work.

Suggested teaching/learning activities

7.1 Definition of Simple Machines

(1 period)

By the end of this section, the learner should be able to define the term simple machine and give examples of simple machines.

Information to the teacher

This unit is not unfamiliar to the students as they were introduced to machines in primary 6. For instance

- Definition of simple machines on a tool that makes work easier.
- Types of simple machines; lever, inclined planes, screws, pulleys, wedges, wheel and axle.

Suggested teaching and learning materials

Closed soda bottle, bottle opener.

Preparation

Assemble all the required apparatus for this activity into groups depending on the number of students and availability of materials.

Teaching guidelines 7.1

- Ask learners to organise themselves into appropriate groups depending of the materials/apparatus/equipment available.
- Ensure that each group has a group leader and a secretary to record and report the group's findings.

- Ensure that they take into consideration of gender and those with challenges (i.e. the disabled).
- Review the definition and examples of machines done in P6 (syllabus page 61).
- Let the students do activity 7.1 given in student's book in groups and report their findings.
- Guide them in a whole class discussion on their findings.
- Take them through the discussion given in the student's book.
- Summarise by emphasizing on the safety precaution when using machine.
- This activity will promote in learners among other competencies:
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to be solved.

Additional information to the teacher

It will be advisable to ask the learners to list down where these machines are used in daily life as a take away assignment.

7.2 Terms used in simple machines

(1 Period)

By the end of this section, the learner should be able to define different terms used in simple machines, their formulas and solving problems based on these terms

Information to the teacher

This is first time the learners are encountering these concept as a way of measuring how good a machine is. Put them do research on this section.

Teaching guidelines 7.2

- Let learners organise themselves into groups. Ensure that they are of different abilities and gender (if any). All learners whether disabled or normal should participate actively during the lesson and in all activities.
- Ask them to do activity 7.2 given in student's book.
- Allow the students to report on their finding.
- Use the activity to guide them in a discussion of the terms. M.A, V.R and efficiency of machines.
- Summarise this information in a tabular form using student's book.
- Guide the student in groups discussion of Examples 7.1, 7.2 and 7.3.

- By use of question answer method, summarise this section to determine whether the objectives have been achieved.
- This activity will promote in learners among other competencies
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to solve.

Additional information

Not all the information on the internet is accurate. Verify whether the information the students research on is accurate.

7.3 Types of simple machines

(3 periods)

By the end of this section, the learner should be able to identify different types of simple machines according to their different groups.

1. Levers

Information to the teacher

Levers have been covered in P6.

Suggested teaching and learning materials

Internet, journals and student books, a nail, claw hammer, scissors, ground nut, piece of cloth, pliers.

Teaching guidelines 7.3 (a)

- Review what was done in Primary 6 on levers through question and answer method.
- Ask learners to organise themselves into groups. Ensure that they the group formed are of different *abilities and gender* (if any). All learners whether disabled or normal should participate actively in the period and all activities.
- Let the learners in groups perform activity 7.3 and 7.4 given in student's book on levers.
- Ask any member of the group to present their finding to the whole class.
- Allow the learners to point out omissions and errors on each fact given.
- Summarise their discussion by guiding them to classify levers into three groups as explain in student's books.
- Let the students draw levers and indicate the position of fulcrum (pivot), load and effort.
- Ask the students to give situations where levers are commonly used in daily life.
- Guide them in a class discuss on

- how M.A, V.R and efficiency of levers may be calculated.
- In groups let the learner discuss example 7.4 and 7.5 in the student's book
 - Give them Exercise 7.1 as an assignment.
 - This activity will promote in the learners
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to be solved.

2. Inclined plane

(1 period)

Information to the teacher

Example of inclined plane as a simple machine was given in P6. Review on those introduction to this section.

Suggested teaching and learning materials

A trolley, inclined plane, masses

Teaching guidelines 7.3 (b)

- Organise the learners into groups.
- Let the learners do Activity 7.5 on inclined plane.

- Choose any members at random to give a brief report on their findings.
- Through question and answer method, lead learners in a discussion to show that an inclined plane is a simple machine.
- Let the students research on the M.A., V.A & efficiency of inclined plane and report their finding.
- In groups, allow the learners to perform Activity 7.6 on how length of the inclined plane affects M.A.
- These activity will promote in the learner
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.
 3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to be solved.

7.4 Screws and bolts

(1 period)

By the end of this section, the learner should be able to demonstrate the working of screws and bolts as simple machines

Information to the teacher

Screws were mentioned in P6 as examples of simple machine.

Preparation

Ensure that you have enough screws and bolts for the groups you want to work with.

Suggested teaching and learning materials

A screw driver, a bolt, soft wood, screw driver

Teaching guidelines 7.4

- Ask learners to form groups of two. Ensure that they observe gender balance and the group to comprise learners of different abilities. Also, ensure that the disabled one (if any) are involved in all activities.
- Let the learner perform activity 7.7 on screws and bolts as a class experiment.
- Through and answer method let the learner define the term pitch.
- Follow this activity with Activity 7.8.
- In groups, allow the learners to research on M.A., V.R and efficiency of screws, bolt and screw jack.
- summarise this section by taking learners through the discussion given in student's book
- This activity will promote in learners among other competencies:
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.

2. Research and problem solving by provision of several practical activities within the learner's book.
3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to be solved.

Additional information to the teacher

Use the activity 7.7 to show how friction affects mechanical advantage but not V.R.

7.5 The Wheel and Axle

(1 period)

By the end of this section, the learner should be able to demonstrate the action of the wheel and axle.

Information to the teacher

From p6, the learner knows the wheel and axle is an example of a simple machine.

Suggested teaching and learning materials

Cylindrical rod, y-shaped braches, a stone with string tied to it

Preparation

Assemble all the require materials for this activity in advance for all groups you wished to work with.

Teaching guidelines 7.5

- Ask learners to form groups. Ensure that the group formed comprises of:

1. Learners of different abilities (slow learners and fast learners).
 2. Different gender i.e. boys and girls in case it is a mixed class.
 3. Disabled students in case they are there in your class.
- This will enable learners to appreciate others and boost their self-esteem as they learn from each other.
 - Ask them to choose a group leader and a secretary (preferably the disabled students)
 - Allow the learners to perform activity 7.8 on wheel and axle or a project to be done as a project, using locally available materials.
 - Let them demonstrate the working of the wheel and axle on a simple machine.
 - Use the project to guide learners to identify the wheel and axle.
 - Use the project to lead them in a class discussion to obtain expressions of M.A., V.R. and efficiency of this machine.
 - Ask them to do Exercise 7.2 given in student's book.
 - This section will promote in learners among other competence
 1. Cooperation and interpersonal relation. This is adhered through the involvement of the learners in the numerous activities in the learner's book.
 2. Research and problem solving by provision of several practical activities within the learner's book.

3. Critical thinking. The learners are involved in the group discussions, class examples and given problems to be solved.

Additional information

The wheel and axle may be used also as a simplified form of wheel and axle.

7.6 Pulleys

(2 periods)

By the end of this section, the learners should be able to describe the functioning of pulleys in making work easy.

Suggested teaching and learning materials

Reference books, internet, flag post

Teaching guideline 7.6

- Organise learners into groups. Ensure that the groups comprise of students of different **abilities and gender** in case the class comprises of both boys and girls. Let them choose a group leader and a secretary.
- Ask the group leaders to lead other members in a discussion of their individual research of Activity 7.9 given in student's book and let the group secretary note the key points and harmonize them.
- Ask the groups secretaries or choose any other member at random from each group to give a report on their findings to the whole class.
- Guide the learners through activity

- 7.9 and 7.10 given in student's book to determine the velocity ratio and mechanical advantage of a block and tackle.
- Help them (especially slow learners) on how to determine the M.A. and V.R. of a block and tackle.
 - Let the learners discuss examples 7.6, 7.7 and 7.8 given in student's book as you guide them through.
 - Ask learners to do exercise 7.3 given in student's book.
 - Encourage the learners to solve as many problems as possible in the unit Test 7.
- Set aside a period to help the learners to discussing the difficult problems.

Further exercises and their answers

Further exercises/activities

Further exercise for slow learners	Further exercise for fast learners
<ol style="list-style-type: none"> 1. Define the mechanical advantage of a machine. 2. Give a reason why a machine is not 100 percentage efficient. 	<ol style="list-style-type: none"> 1. Explain how to determine velocity ratio of an incline plane. 2. Describe an experiment to determine mechanical advantage of a block and tackle pulleys.

Answers to some further exercises/activities

Further exercises for slow learners	Additional exercises for fast learners
<ol style="list-style-type: none"> 1. Mechanical Advantage of a machine is the ratio of Force being moved W to the Effort. 2. Because of friction within the internal parts of the machine. 	<p>Mark student's work and guide them appropriately. You may refer to student's book.</p>

Answers

For non-numerical questions, the learners can get most of the answers from the discussion given in student's book or from the internet and any other reference books. Mark the student's work and use it to guide them appropriately.

Exercise 7.1

(Student's book page 221)

1. 73.3%
2. 3600 J
3. 83.3%, 421 J
5. 5.67

Exercise 7.2

(Student's book page 228)

3. (a) 439.8 (b) 6597 N

Exercise 7.3

(Student's book pages 235 - 236)

2. (a) 2 (b) 1.6

(c) 112.5 N (d) 78.75 J

(e) 15.75 J

3. 266.67 N 4. 79.78 %

Unit Test 7

(Student's book pages 237-239)

2. (c) 15m (d) 2250 J (f) 2550 J
3. (c) (i) 4 (ii) 75%
4. 69.23 %
5. (a) 2900 J (b) 16% (c) 100 N
6. (a) 85.69 (b) 114.25
7. (a) 1 m (b) 226 J
(c) 180 N (d) 79.65 %
8. (a) 1 (b) 88.89%
9. (a) 4 (b) 1.6
(c) 40 %
10. (a) 3 (b) 88.89 %
11. (b) 5 (c) 400 N
(d) 2000 J (e) 400 J
12. 1000 W

Thermal Physics

Basic Properties of Matter

Unit 8

Kinetic Theory and States of Matter

Student's Book pages 240-257 (10 Periods)

Key unit competence

By the end of this unit the learner should be able to relate physical properties of solids, liquids and gases to temperature.

Learning objectives

Knowledge and understanding

- Describe physical properties of matter.
- State physical properties of matter.

Skills

- Classify materials using physical properties.
- Explain physical properties of solids, liquids and gases using the kinetic theory of matter.
- Separate mixture using physical properties
- Determine boiling point and melting point of different substances.
- Perform an experiment to illustrate viscosity.

Attitudes and values

- Appreciate the application of properties of materials in daily life.
- Show concern on how to use

different materials in daily life

- Show concern on the use of solid materials based properties of stiffness, sharpness and softness.

Generic competencies addressed in this unit

- Problem solving through provision of problems to solve and questions to answer.
- Research skills through provision of research based activities in the learners book.
- Creativity and innovation through group work activities and discussions, answering and asking questions.
- Critical thinking through group work activities, discussions, answering and asking questions.
- Communication through group work activities, discussions, and answering and asking questions.

- Co-operation, interpersonal management and life skill through group work activities and discussions, answering and asking questions.

Links to other subjects

English vocabulary, Chemistry (chemical bonding, filtration and distillation).

Cross cutting issues addressed in this unit

- Environment, climate change and sustainability. Discussion of conservation measures of environment. For instance, activity 8.13 discusses about polythene bags and their effects in the environment. They should be disposed properly and recycled.
- Comprehensive sexuality education (the HIV/AIDS concern). This is through discussion of HIV/AIDS in some activities. For instance on page 241, learners are sensitized about HIV/AIDS. AIDS has NO cure and therefore they should abstain until marriage.

Assessment criteria

Learner should outline properties of the three states of matter, identify and explain physical properties of water, solid and gas. Give examples of materials with different physical properties of hardness, malleability, elasticity and conductivity.

Teaching methodologies

- Group work.
- Class discussions.
- Question and answers.
- Class demonstrations.

Background information

- In this chapter we will explore the states of matter and then look at the kinetic theory of matter. Matter is anything that has mass (weight) and volume (occupies space). All matter is made up of particles called atoms and exists in three different states; solid, liquid and gas.
- Matter being made up of small particles can be seen using diffusion for example.
- Diffusion is the movement of particles from a high concentration to a low concentration.
- Diffusion can be seen as spreading out of particles resulting in an even distribution of the particles. This can be seen if you place a drop of food colouring or crystals of purple potassium permanganate in water. The colour spreads out slowly through the water. If matter was not made of particles that are constantly moving then we would only see a clump of colour when we put the food colouring or purple potassium permanganate in water as there would be nothing that could move about and mix with the water.

Suggested teaching/learning activities

8.1 Matter and Its composition

(2 periods)

By the end of this section the learners should be able to define matter and state its composition.

Information to the teacher

Most learners have a rough idea about the state of matter from primary level. In this level we will learn more about the states of matter.

Matter comes in three states that are distinguished by the strength of the forces in their bonds that hold them together. The three states of matter are:

- **Solids:** The strong bonds between molecules make solids rigid and very difficult to deform.
- **Liquids:** The relatively weak bonds between molecules allow liquids to be deformed without effort. Liquids have a fixed volume, but the shape of the container holding them determines their shape.
- **Gases:** Virtually no bonds exist between gas molecules so that gases can spread into any available space. The volume of a gas is determined by the size of the container holding it.

Suggested teaching/learning materials

Reference materials including books, pieces of chalk or paper.

Preparation

Assemble all suggested materials for Activity 8.1 into different groups in advance .

Teaching guidelines 8.1

- Organise the learners into pairs.
- Draw the attention of the students to the student's book. Ask them to do activity 8.1 i.e define matter and give examples of matter.
- Summarise the activity by helping the learners to clarify on the definition they had in their primary that matter is anything that has weight (mass) and occupies space (volume). Guide them to give as many examples as possible.

Teaching guidelines 8.2

- Ask them to do activity 8.2 in the learners book individually.
- Provide each student with a piece of chalk and ask him or her to break it into two pieces. Ask them to continue breaking it until when they can't break it any further
- Ask them to compare and explain in regards to the size of the initial and final pieces of chalk. At this point, bring the attention of learners to tiny HIV virus that results to AIDS. Caution them that the disease has NO CURE. Inform them that the disease has killed millions of people around the world.
- Ask them to form groups and discuss about an element, a compound and a mixture.

- In case they don't give accurate reasons, let them know matter is made up of tiny particles called atoms, which cannot be broken down further. Matter can be made of particles (atoms) of the same kind or a mixture of particles of different kind. Matter that is made of particles of the same kind is called an element. While that made up of different kinds of particles can be a mixture or a compound.
- Guide them through a discussion about elements, compounds, mixtures, and ask them to give examples of each. Encourage slow learners to participate in class discussions on their observations.
- This activity will promote in a learner;
 1. Communications skills through expressing their opinion in the group discussion.
 2. Critical thinking through answering questions critically.
 3. Problem solving by answering given questions correctly among other competencies.

8.2 Physical Properties of matter

(2 periods)

By the end of the section, the learner should be able to state both the physical and chemical properties of matter.

Suggested teaching/learning materials

Water, alcohol (spirit) and two beakers, internet, reference books, sand, iron filings, a magnet, bunsen burner, match box, magnet, two stones, beam balance.

Preparation

Before the lesson, request the chemistry teacher to prepare for you alcohol like methane in the laboratory or use spirit. Give each learner a sample.

Teaching guidelines 8.3

- Organise the learners into convenient groups. Let each group appoint a secretary.
- Ask them to do Activity 8.3 i.e access the internet or reference books and do research on physical and chemical properties and give some examples.
- Ask them to discuss to the class their findings.
- Ask them to pour equal amounts of water and alcohol in two different beakers.
- Ask them to smell the odour of each one of them, ask them if after the activity one of the liquids changed to something else like porridge and juice or if even the odour changed. Let them try to explain their observation.
- In case they do not give accurate reasons, let them know that the two liquids have different odours that after smelling them, they don't change into other liquids. They remain alcohol and water.

They should know that such a property that is observed on matter that does not change its composition is called a physical property.

- This activities will promote in a learner;
 1. Communications skills through expressing their opinion in the group discussion.
 2. Critical thinking through answering questions critically.
 3. Problem solving by answering given question correctly among other competencies.

8.3 Simple kinetic theory of matter

(2 periods)

By the end of this section, the learner should be able to demonstrate motion of matter and the components of matter that are in contact motion.

Suggested teaching/learning materials

Two beakers, purple crystals of potassium permanganate, water, a Bunsen burner and perfume.

Preparation

Before the lesson, prepare a set of the materials mentioned above for each of the groups you will work with.

Teacher's guidelines 8.4

- Organise the learners into convenient groups. Let each group appoint a secretary.
- Guide them to do activity 8.4 given in the student's book.
- Ask them to pour water in a beaker to more than half way and allow it to settle. Let them drop crystals of potassium permanganate into the water in the beaker and observe what happens.
- With another beaker, ask them to repeat the same thing but this time after putting the potassium permanganate, let them apply heat to the bottom of the beaker using a Bunsen burner and observe what happens. Ask them to compare the two situations when heat is applied and when it is not.
- Ask one student in the class room to go into the corner in front of a class with a perfume and spray it.
- After five minutes, ask the class to tell what they smell and observe most especially students in the far corner of the class. Ask them to explain their observation.
- In case they don't give accurate reasons, let them know that the purple colour in the first place spreads throughout the water slowly but when heat is applied, it spreads very fast. This shows that matter is in constant random motion (moving) and the rate at which it moves depends on the temperature. When the temperature is low, it moves

slowly and when the temperature increases, the movement increases. And in 2, the scent of the perfume spreads to the other parts of the class including the far corner because particles have move from a region of high concentration to a region of low concentration.

- Guide them to know that the movement of these tiny particles is summed up in a model called *kinetic theory of matter*.
- Guide a discussion about the kinetic theory of matter, how it explains the three different states of matter and its relationship with temperature.
- These activities will promote in a learner;
 1. Communications skills through expression of their opinion in the group discussion.
 2. Critical thinking through answering questions critically.
 3. Problem solving by answering given questions correctly among other competencies.

8.4 Physical Properties of Solids

(2 periods)

Suggested teaching/learning materials

Transparent square bowl, marbles, test tube and internet enabled computers.

Preparation

Before the lesson, prepare a set of the materials mentioned above for each of the groups you will work with.

Teaching guidelines 8.5

- Organise the learners into convenient groups.
- Ensure that members on the previous groups in activity 8.6 are mixed up to form a new group. Prompt them to realize that they need a group leader and secretary who will record the group's findings.
- Ask them to do activity 8.5 i.e. physical properties of solids.
- Guide them to do a research on the properties of solids and their applications from internet or reference books. Let them discuss their findings in class.
- Ask them to put as many marbles into the squarer bowl as they can and after incline it a bit.
- Ask them to also put as many marbles into a test tube until it is full and then cover the test tube with a lid.
- Ask them if they are able to notice the pattern (arrangement) of the marbles in the square bowl and then draw it on a notebook.
- Ask them to shake the marbles in the test tube while touching the lid and explain the movement of the marbles in the test tube.

- Summarise the activity by helping the learners know it is very difficult for marbles to move because they are so much packed. That is how atoms are arranged in a solid state.
- Guide them through a discussion about the different properties of solids and drawing the real pattern of arrangement and help them to connect the kinetic theory to the properties of the solid state.
- These activities will promote in a learner;
 1. Communications skills through expression of their opinion in the group discussion.
 2. Critical thinking through answering questions critically.
 3. Problem solving by answering given question correctly among other competencies.

Kinetic theory of solids

Suggested teaching/learning material

Chocolate chip cookies, ruler, electronic balance (beam balance)

Preparation

Before the lesson, prepare a set of the materials mentioned above for each of the groups you will work with.

8.5 Physical Properties of Liquids

(2 periods)

Suggested teaching/learning materials

Water in a beaker, Bunsen burner, chalk dust

Preparation

Before the lesson, prepare a set of the materials mentioned above for each of the groups you will work with.

Teaching guidelines 8.6

- Organise the learners into convenient groups and ask them to do activity 8.6 in learner's book.
- Ask them to put chalk dust on the surface of the water in the beaker. Ask them to observe and explain the motion of the chalk particles.
- Ask them to heat the water until it boils and still observe the motion of the chalk particles.
- Ask them to draw the arrangement of particles in liquids.
- In case they don't give accurate reasons, let them know that the particles or molecules of liquids move freely and randomly.
- This activity will promote in a learner;
 1. Leadership and organization skills by leading others in a discussion.

2. Communications skills by expression of their opinion in a discussion among other competencies.

Viscosity in Fluids

Suggested teaching/learning material

Room temperature, water, honey, oil, a steel ball, 100 ml graduated cylinder, ruler, and a stop watch

Preparation

Before the lesson, prepare a set of the materials mentioned above for each of the groups you will work with.

Teacher's guidelines 8.7

- In their groups, guide them to do activity 8.7 given in the student's book on how to show viscosity in fluids.
- Ask them to measure equal amounts of the liquids to be tested and put them into graduated cylinders.
- Ask them to measure the depth of the liquids using the ruler.
- Ask them to copy the data chart into their notebook from the student's book.
- Ask them to place a sphere on the surface of the liquid and let another student use a stop clock to measure how long it takes for the sphere to travel to the bottom of the liquid.
- Ask them to remove the sphere

and repeat previous steps two more times for the same liquid.

- Ask them to rinse and dry the sphere, then repeat the two previous steps for two more liquids.
- From their data collected ask them, to conclude the liquid in which the sphere moved very fast and if it has a low viscosity or high viscosity. Ask them from their knowledge of viscosity to explain why.
- Ask the learners to do activities 8.8, 8.9 and 8.10 on solubility, evaporation and boiling point of liquids respectively.
- Let the learners follow all the steps and procedures stated in these activities.
- Guide learners through activity 8.14 on applications of physical properties of a liquid.
- Conclude this section by taking learners through the discussion on applications of physical quantities given in student's book.
- This activity will promote in a learner;
 1. Communications skills through expressing their opinion in the group discussion.
 2. Critical thinking through answering questions critically.
 3. Problem solving by answering given questions correctly among other competencies.

8.6 Physical Properties of Gases

(2 periods)

Suggested teaching/learning materials

Three marbles, transparent dish, a lid, reference books and internet.

Preparation

Before the lesson, prepare a set of the materials mentioned above for each of the groups you will work with.

Teacher's guidelines 8.12

- Organise the learners into convenient groups.
- Guide them to do activity 8.12 given in the student's book.
- Ask them to do research on the properties of gases and discuss their findings to the class.
- Ask them to put 3 marbles in a transparent dish, and try to move them separately from each other as possible and then cover it with a lid.
- Ask them to shake the dish and observe the movement of the marbles inside.
- Prompt them to give a reason for their observation.
- They should notice the pattern (arrangement) of the marbles and then draw it in a note book.

- Let them know that the activity done was an example of how gases behave and discuss with them other properties of gases.

Suggested teaching/learning materials

Polythene (plastic bag), a straw, cello tape

Teacher's guidelines 8.13

- Still in their groups, distribute a polythene bag (plastic bag), a straw and cello tape.
- Ask the learners to do activity 8.13 in the learners book.
- Ask them to pick one polythene, make a small hole where they will insert in a straw from leaving it to protrude and then seal it with a cello tape.
- Ask them to put a book on top of the polythene bag and in turns let them blow it into the bag and observe what is happening. Prompt them to explain their observation.
- In case they don't give accurate reasons, let them know that the activity done was to prove that a gas occupies a space and continue a discussion about the other properties of gases.
- Take the student through the unit summary and ask them to do unit Test 8.

Note:

Ensure that you have marked learner's work. This will enable you to assess whether the unit objectives have been achieved and also enable you to identify challenging areas to the student and guide them accordingly.

- These activities will promote in a learner;
 1. Communications skills through expression of their opinion in the group discussion.
 2. Critical thinking through answering questions critically.
 3. Problem solving by answering given question correctly among other competencies.

Additional activities

1. *Suggested materials:* beaker, provision for tap water, hand lens, bright source of light (if the day is not bright and sunny).

Collect fresh tap water in a beaker and focus sunlight on to the beaker. You can 'see' the movement of the suspended particles of solid matter. The water

molecules are moving at random inside the beaker. Though the solid dust particles have a tendency to settle down, the water molecules moving at random collide with these solid particles and force them to move in a haphazard manner.

2. *Suggested materials:* Toothpaste, glass slide and cover slip (can be collected from the biology laboratory), powerful source of light, a microscope and water.

Take a small trace of toothpaste mixed in water on a microscope slide and place a cover slip over the slide. Illuminate the slide with concentrated light from the side and observe the top with a powerful microscope. Concentrate on one tiny particle. Though the particle seems to be stationary in one position first, eventually you can see the random motion of the molecules of paste in the mixture, being displaced continuously in all the directions. As the molecular structure concept in gases, solids and liquids has been well established, the teacher should tell the students to draw a table and compare the spacing, ordering and the movement of the molecules in the three states of matter.

Further exercises and their answer

Further exercises/activities

<i>Further exercise for slow learners</i>	<i>Further exercises for fast learners</i>
<ol style="list-style-type: none">1. What is matter? Give three examples of matter.2. Name three states of matter and briefly explain the arrangement of their particles.	<ol style="list-style-type: none">1. Draw a well diagram showing arrangement of particles in solids, liquids and gases.2. Explain two applications of physical properties of the three state of matter.

Answers to some further exercises/activities

<i>Further exercise for slow learners</i>	<i>Additional exercise for fast learners</i>
<ol style="list-style-type: none">1. Matter is anything that has mass and occupies space.2. Solids, liquids and gases: Guide learners on their arrangement. You may refer to student's book for S1.	Mark student's work and guide them appropriately.

Answers

For non-numerical questions, the learners can get most of the answers from the discussions given in student's book or from the internet and any other reference books. Mark the student's work and use it to guide them appropriately.

Thermal Physics

Thermometry

Unit 9

Heat and Temperature

Student's Book pages 258-288 (10 Periods)

Key unit competence

By the end of this unit the learner should be able to explain principle of thermometry and compare different temperature scales.

Learning objectives

Knowledge and understanding

- Explain the difference between heat and temperature.
- Explain temperature as degree of coldness and hotness.
- Read temperature from different thermometers.
- Explain steps of calibrating a thermometer.

Skills

- Evaluate temperatures of different substances.
- Differentiate between heat and temperature.
- Describe different thermometer scales and thermometric liquids used.
- Convert temperature from one temperature scale to another.
- Determine the boiling and melting

points of candle wax, methylated spirit, water.

Attitudes and values

- Appreciate the applications of measuring body temperature.
- Appreciate that feeling cold and hot is subjective.
- Recognize the advantages of mercury over alcohol as a thermometric liquid.

Generic competencies addressed in this unit

- Co-operation, interpersonal management and life skills through the provision of group work based activities in the student book.
- Research skills. This is achieved through the numerous problems to be solved and group discussions.
- Problem solving and critical thinking. Achieved through

research based activities within the learners book.

Links to other subjects

Use of thermometers in medicine, geography, agriculture, and all sciences.

Cross cutting issues addressed in this unit

- Inclusive education and health issues in terms of temperature changes and heat.
- Environment, Climate change and sustainability.

Assessment criteria

Learner can identify, explain and describe different types of thermometers and liquids used in the thermometers. Can convert different temperature from one scale to another.

Teaching methodologies

- Group work.
- Class discussions.
- Question and answers.
- Class demonstrations.

Background information

Temperature is a measure of average kinetic energy of molecules. You should introduce kinetic energy of matter. Now that the students have covered kinetic theory you should use it to explain heat and temperature.

Suggested teaching/learning activities

9.1 Heat as a form of energy

(1 period)

By the end of this section the learner should be able to describe heat as a form of energy.

Information to the teacher

The learners were introduced to energy in Primary 6 and have covered kinetic theory in Unit 8. Build on this fact to explain heat as a form of energy.

Suggested teaching and learning materials

Ice, a bowl, hot water

Preparation

Make the following available, ice and immersion heaters.

Teaching guidelines 9.1

- Ask learners to organise themselves into appropriate groups. Ensure that:
 1. They observe gender balance incase it is a mixed class.
 2. The groups comprise of different abilities i.e. fast and slow learners.
 3. The disabled learners are included incase you have them in your class.
- Prompt learners to see the need to have a secretary and group leader in their group.

- In those groups, let the learners perform activity 9.1 given in the student's book.
- Let the group leader or any other member of each group to present their observations to the class.
- Summarise their findings by highlighting the important points in this section i.e. Heat is a form of energy which passes from a body of high temperature to a body of low temperature. The SI unit of heat is joules. It is measured using a thermometer.
- This activity will promote among other competence; communication skills in English and co-operation and interpersonal relation among learners.

Additional information

You should also let the learners know that feeling hot or cold is subjective.

9.2 Heat and temperature

(1 period)

By the end of this section, the learner should be able to differentiate between heat and temperature.

Information to the teacher

Although the learners are going to be exposed to other temperature scale, it will be advisable to use Celsius scale ($^{\circ}\text{C}$). Assist them to take reading, as they might not know how to read the temperature scale.

Suggested teaching and learning materials

Thermometer, water, oil, stirrers, test tubes.

Preparation

Set enough set-ups in advance as this set-up takes time to set and not easy as well.

Teaching guidelines 9.2

- Organise the learners into groups depending on the available set-ups.
- Ask students to do activity 9.2 in the learner's book
- Through probing questions, let the learners describe the various parts of the set-up.
- Let the learners record the temperature after heating the water and oil in the test tube.
- Ask the learners the use of water bath.
- Let them discuss their findings from the activity.
- Summarise their findings by pointing out that substances can gain equal amount of heat but are in different temperature.
- This activity will promote in learners among other competencies:
 1. Communication skills in English as learners discuss their points.
 2. Cooperation and interpersonal relation as learners work together in the activity.

- Let the learners use the formula given to convert temperature scales.

9.3 Temperature scales

(2 periods)

By the end of this unit the learner should be able to convert the magnitude of temperature from one scale to the other.

Information to the teacher

The three commonly used temperature scale include Celsius, kelvin and Fahrenheit. However in this unit we will also learn about Reaumur scale. As a teacher you should guide your learners to understand how to convert the magnitude of temperature given to any of these four temperature scales.

Suggested teaching and learning materials

Reference books including textbooks, Internet

Preparation

Ensure that you have all required materials for all groups you want to work with.

Teaching guidelines 9.3 (a)

- Ask learners to organise themselves into groups of different abilities and gender. All learners whether disabled or normal should participate actively in the lesson and in this activity.

- Ask learners to do activity 9.3 in student's book.
- Guide them especially the slow learners on how to do research from the internet and reference book i.e. searching for specific relevant areas only.
- Let each group present their findings through one of their members chosen at random.
- Summarise their discussion by taking them through a discussion given in student's book on different types of temperature scales.
- This activity will promote in a learner;
 1. Communications skills through expression of their opinion in the group discussion.
 2. Critical thinking through answering questions critically.
 3. Problem solving by answering given question correctly among other competencies.

Conversion of temperature from one scale to another

Teaching guidelines 9.3 (b)

- Organise the learners into convenient groups. Ensure that members on the previous groups in activity 9.3 are mixed up to form a new group. Prompt them to realize that they need a group leader and secretary who will record the group's findings.

- Ask them to do activity 9.4 given in student's book.
- Let one member from each group give a presentation on their findings.
- Hold a discussion a class discussion on their presentation and help them to see relationship from one temperature scale to the other.
- Summarise the discussion by guiding learners through Examples 9.1 to 9.9 given in student's book to show them how to convert given magnitude of temperature from one scale to other.
- Ask learners to do Exercise 9.1 given in student's book.
- This activity will promote in the learners among other competencies;
 1. Cooperation and interpersonal relation in learners.
 2. Communication skills in English.
 3. Research and problem solving skills.

Additional information to the teacher

- Let them see that $40^{\circ}\text{C} = 40^{\circ}\text{F}$
- The learner may be interested to know the meaning of the various temperature scales. Check from the internet.

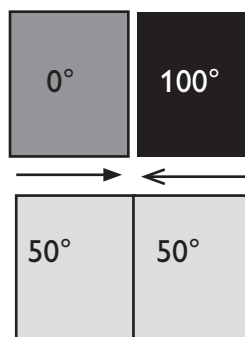
9.4 Thermal equilibrium

(1 period)

By the end of this section, the learner should be able to explain the meaning of thermal equilibrium.

Information to the teacher

Thermal equilibrium is a state when two objects connected by a permeable barrier don't have any heat transfer between them. This happens when the two objects have the same temperature. See the following figure.



Help your learner to understand what thermal equilibrium is. You may use the have figure to illustrate the concept.

Teaching guidelines 9.4

- Ask learners to group themselves appropriately.
- Let them do a research on thermal equilibrium and present they findings to the whole class.
- Guide learners through activity 9.5 in the learners' book
- Guide them through a class discussion on their findings.

- Use the illustration given above to help them understand the concept i.e. thermal equilibrium.
- This activity will promote research skills and cooperation among learners.

9.5 Measurement of temperature

(1 period)

By the end of the lesson, the learner should be able to measure temperature using different thermometers available.

Definition and discussion of temperature

Teaching guidelines 9.5

- Organise the learners into groups and ensure that learners are made up of different abilities and gender (in case it is a mixed school).
- Ask them to choose the group leader and secretary and ensure that learners who have been group leaders and secretaries are not chosen again. By doing so all learners will feel part of the group and thus promoting team work and leadership skills to all learners.
- Ask them to do activity 9.6 on the definition and discussion of thermometric substances used in thermometers i.e. mercury and alcohol.
- Let them present their findings in a class discussion.

- Guide them to understand the characteristics of the thermometric substances identified.

- Help them to note the advantages and disadvantages of the thermometric substances from their findings.

- Summarise this section by taking learners through the discussion given in student's book.

- This activity will promote in the learners among other competencies:

1. Research and problem solving skills as they access internet to do a research.
2. Cooperation as learners work together in groups.
3. Communication skills in English as learners discuss and defend their points.

9.6 Types of Thermometers

(1 period)

By the end of this section, the learner should be able to differentiate different types of thermometers according to their use.

Information to the teacher

Care must be taken when using mercury-in-glass thermometer. In case of breakage, use sulphur to engulf the droplets of mercury running everywhere.

Mercury causes cancer!

Suggested teaching and learning materials

Thermometers both mercury and alcohol

Preparation

Draw the various thermometers on a manila paper

Teaching guidelines 9.6 (a)

- Organise the learners into convenient groups depending on availability of materials.
- Arrange enough sets of mercury-in-glass clinical and minimum thermometers to fit the groups.
- Let the learners perform activity 9.7 in the learners book.
- Summarise the types of thermometer using the diagrams on the manila paper.

Additional information

Give the learners a graph paper to draw an accurate scale. Keep the graph paper it will be useful when calibrating a thermometer.

Working of thermometers

By the end of this section, the learners should be able to explain how the thermometers function.

Information to the teacher

Since the learners have not done thermal expansion of matter, it is prudent that you explain to them through simple activities i.e. ball and ring experiment, holding a round bottomed flask containing colour liquid and fitted with

a rubber band and capillary tube with your palms.

Suggested teaching and learning materials

Thermometers and hand lens.

Preparation

Borrow any of the thermometer(s) that you may be lacking. Before the activity of clinical thermometer make sure you shake the thermometer vigorously by stroking it so that all the mercury is in the bulb. For six's maximum and minimum thermometer, using bar magnet let the index 1 and 2 rest on the mercury surfaces of both sides.

Teaching guidelines 9.6 (b)

Laboratory thermometer

- Allow the learners in groups to perform activities 9.8 and 9.9 given in student's book.
- Let the group leaders present their findings.
- Let the learners summarise their findings.

Clinical thermometer

- Let the learners form groups and perform activity 9.9 given in student's book.
- Ask them to shake the thermometer to restore the mercury back into the bulb.
- Let them discuss the usefulness of the constriction.
- Allow other members in the same group to repeat the experiment.
- Summarise by noting that the

- temperature of a person who is not sick (normal) is about 36.9°C .
- Clinical thermometers are never sterilized by dipping in hot water (100°C) but use of other cold sterilizers.

Six's maximum and minimum thermometer

- Let the learners perform activity 9.10 in student's book.
- Allow them to present their observation.
- Summarise by pointing out the key points.
- This activity will promote in the learners among other competencies;
 - i) Cooperation and interpersonal skills.
 - ii) Communication skills.

9.7 Calibration of a Thermometer

(1 period)

By the end of this section the learner should be able to calibrate a thermometer.

Information to the teacher

Suggested teaching and learning materials

Thermometer, ice, stand and clamp, source of heat, beaker.

Preparation

Be sure there is enough ice for the group.

Teaching guideline 9.7

- Organise the learners into groups.
- Calibrate a lab thermometer – cover the thermometer with a white paper.
- Allow them to perform activity 9.11 in student's book.
- Summarise this section by taking the learners through the discussion given in student book.
- Ask the learners to do example 9.10 as you guide them through.
- Let the learners do exercise 9.2 in the learners book.

Additional information to the teacher

Apart from the liquid-in-glass thermometers which can be used depending upon the temperature range, sensitivity and accuracy needed.

1. Platinum resistance thermometers: -200°C to 1200°C . It has a wide range and is very accurate.
2. Thermo-couple thermometer: -250°C to 1500°C . It has a wide range, and is fairly accurate. This is used to measure the temperature of a point where there is a rapid change. It is also good for remote sensing and the temperature can be monitored with a Cathode Ray Oscilloscope (CRO) or a data logger device.
3. Pyrometers are used to measure temperatures greater than 1000°C .
4. Modern heat radiation 'non-touch' thermometers: -50°C to 3000°C .

The food industries use these non-touch thermometers for low temperatures (up to 300°C) and metal or glass industries use this for high temperatures 300°C to 3000°C.

9.8 Melting and Boiling points of substances

(1 period)

By the end of this section, the learner should be able to determine boiling and melting points of substances.

Information to the teacher

Use an immersion heater as it gives a constant quantity of heat that does not fluctuate with time.

Suggested teaching and learning materials

Ice, water, copper calorimeter, source of electric power, graph papers, stop watch.

Preparation

Make sure you have enough ice for all the groups.

Teaching guidelines 9.8 (a)

Melting point of ice

- Let the learners form appropriate groups.
- Let the learners perform activity 9.12 given in student's book.
- Provide the learners with a graph paper to draw the graph of temperature (°C) against times.
- Guide the groups on how to choose the suitable scale.

- The learners are aware of change of states of matter. Use this to establish the melting point of ice.
- Summarise by showing from the graph that the melting point of ice is 0°C.

Additional information

- The experiment by cooling water at room temperature in this case we have a freezing point at °C.
- Freezing point of ice = melting point of ice

Boiling point of water

Teaching guidelines 9.8(b)

- Perform this experiment on a class demonstration.
- Let the learners make a table of time and temperature as the one given in student's book activity 9.13 in their exercise book.
- With your guidance let some learners take the reading.
- Provide the learners with graph papers to draw the graph of temperature (°C) against times.
- Guide the learners to read the boiling point of water from the graph.

Boiling point of methylated spirit

Teaching guidelines 9.8(c)

- Organise the learners into groups of two and ensure that they are of different ability and gender. Ask them to choose a secretary who will note down their findings

- Ask learners to do activity 9.14 given on the student's book.
- Guide them in their discussion on determining the melting point of methylated spirit.
- Summarise the discussion by pointing out that the boiling point of methylated spirit ranges between 62 to 64 degrees Celsius.

Melting point of candle wax

Teaching guidelines 9.8(d)

- Allow the learners to do activity 9.15 in groups.
- Provide graph papers for them to draw a graph of temperature ($^{\circ}\text{C}$) against time (s).
- Guide the learners to obtain the melting point of wax.
- Summarise the activity by noting the temperature of candle wax as 80°C .

9.9 Effects of solutes on boiling point of liquids

(1 period)

By the end of this section, the learners should be able to determine the effects of solutes on boiling point of a liquid.

Suggested teaching and learning materials

water, sugar or salt, beaker

Teaching guidelines 9.9

- Organise the learners into two main groups.
- Let one group use salt as the solute and the other group uses sugar.
- Let them do activity 9.16 given in student's book.
- Lead them through a class discussion on their findings
- Summarise this section by pointing out that solute increases the boiling point of liquids.
- Ask them to do Exercise 9.3 and attempt all questions in unit test 9. Let them hand in their work for marking. Use this opportunity to ascertain whether the unit objectives have been achieved and identify challenging areas to be discussed with learners in the next lesson or during remedial hours.
- This activity will promote in the learners among other competencies;
 - i) Cooperation and interpersonal relations
 - ii) Research and problem solving
 - iii) Communication skills
 - iv) Critical thinking among other competencies.

Further exercises and their answers

Further exercises/activities

Further exercise for slow learners	Further exercise for fast learners
<ol style="list-style-type: none"> 1. Differentiate between heat and temperature. 2. State two characteristics of a good thermometric liquid. 3. Name two fundamental points of a thermometer 	<ol style="list-style-type: none"> 1. Explain how clinical a thermometer works. 2. Draw clinic thermometer and explain its features. 3. Describe how you can calibrate thermometers.

Answers to some further exercises/activities

Further exercises for slow learners	Additional exercises for fast learners
<ol style="list-style-type: none"> 1. Heat is a form energy that flows from a body of high temperature to a body of low temperature whereas temperature is the degree of coldness or hotness of a body or a place. 2. Should have a high temperature range. Should expand uniformly 3. Lower fixed point Upper fixed point 	<p>Mark student's work and guide them appropriately. You may refer to student's book.</p>

Answers

For non-numerical questions, the learners can get most of the answers from the discussion given in student's book or from the internet and any other reference books. Mark the student's work and use it to guide them appropriately.

Exercise 9.1

(Student's book page 266)

4. (a) 307 K (b) -98 K (d) 290 K
5. (a) 41 °C (b) -279 °C (c) 0°C
(d) -228 °C
6. (a) 93.2 °F, -635.8 °F, 62.6 °F, 105.53°F,
-470.47 °F, 31.73 °F, -378.67 °F
(b) 93.2 °F, -635.8 °F, 62.6 °F,
From Celsius to Reaumur

- 27.2°Re, -296.8 Re, 13.6 °Re,
From Kelvin to Fahrenheit
105.53°Re, -224.4°Re, 0.12°Re, 173.4°Re
From Kelvin to Reaumur
32.68°Re, -470.47°F, 31.73°F, 378.67°F

Exercise 9.2

(Student's book page 278)

4. (a) 18.59 cm (b) 23.6 °C

Unit Test 9

(Student's book page 287)

4. 310 K
5. (a) 31.73°F (b) 211.73 °F
(c) -279.67 °F (d) -459.67 °F
12. 54 °C
14. 20 °C
15. +5

Electricity and Magnetism

Magnetism

Unit 10 Magnetism

Student's Book pages 289-303 (10 Periods)

Key unit competence

By the end of this unit, the learner should be able to differentiate between magnetic and non-magnetic materials.

Learning objectives

Knowledge and understanding

- State properties of magnets.
- Identify the poles of a bar magnet.
- Draw magnetic field patterns around magnet.
- Identify the poles of a bar magnet.
- State and explain the basic law of magnetism (attraction and repulsion).

Skills

- Predict what happens when a magnet is brought near various solid materials.
- Distinguish between magnetic and non-magnetic materials.
- Identify the poles of a bar magnet using the earth's magnetic field.

Attitudes and values

- Appreciate application of magnetic materials.

- Recognize the importance of magnetism in lifting heavy magnetic materials in industries.
- Appreciate the use of magnets in separating magnetic materials from non-magnetic materials.
- Appreciate the existence of magnetic force of attraction and repulsion.

Generic competencies addressed in this unit

- Cooperation and interpersonal relation by engaging the learners in performing the various class activities provided in the learners book.
- Communication skills and critical thinking through group discussions.
- Research and problem-solving by involving the learners in performing the research based activities provided in the learners book.

Links to other subjects

Chemistry (Kinetic theory of gases, electrons, State of matter), Air and sea navigation, Geography (compass direction and bearing).

Cross cutting issues addressed in this unit

Inclusive education where learners with disabilities are grouped together with other learners to perform group work activities.

Assessment criteria

Learner should distinguish between magnetic and non-magnetic materials. Define terms related to magnetism and sketch magnetic field patterns.

Suggested teaching methodology

- Guided discovery
- Research
- Questions and answers
- Discussions

Background information

Most of the students have interacted with magnets in their daily lives. They also have a rough idea about magnets from primary school level. Therefore, build on the common experiences that the students are aware of in regards to magnets e.g. magnets in speakers of a radio, bar magnets etc. To introduce the unit. It is also a good idea to involve learners in a discussion on the origin of magnetism.

This unit is a highly practical unit, therefore as a teacher you should

ensure that all learners whether normal or physically challenged have been fully engaged in all practical activities. This will arouse their interest to learn more. Hence use this opportunity to help learners understand magnetism concepts.

Always check the number of magnets given out to the learners otherwise you are likely to lose a number of them.

Suggested teaching/learning activities

10.1 Definition of a magnet

(1 period)

By the end of this section, the learner should be able to identify a magnet from other materials and define the term magnet.

Information to the teacher

Learners were introduced to a simple definition of a magnet in primary school level. In this section, help them to come up with a comprehensive definition of a magnet.

Suggested materials and learning resources

Reference books, bar magnets, magnetic and non-magnetic materials.

Preparation

Assemble different materials, both magnetic and non-magnetic e.g. cooking stick, cock, spanner, steel nail and a bar magnet in different groups. You may use different materials in different groups.

Teaching guidelines 10.1

- Ask learners to group themselves into groups of three. Go round and reorganise them to avoid a tendency of fast or slow learners grouping themselves into one group. All learners whether disabled or normal should participate actively in the group.
- Prompt them to realize that they need a group leader and a secretary to record and report the group's findings.
- In their groups, guide them do activity 10.1 given in learner's book i.e. to identify a magnet and define it. Guide slow learners to identify a magnet during the activity and encourage them to participate in class discussions in defining what a magnet is.
- Let the group identify a magnet and come up with a correct definition of a magnet. Use this opportunity to inform learners the importance of respecting other people's opinion thus promoting peace among themselves.
- Ask them to present their findings in a class discussion through their secretaries and allow other members of the class to point out omissions or errors in the definition.
- Summarise their presentation by helping the learners to understand the accurate definition of a magnet as discussed in the student's

book. This is also your chance to emphasize the key points.

- This activity will promote in the learners;
 1. Communications skills through expression of their opinion in the group discussion.
 2. Problem solving through answering given questions correctly among other competencies.
 3. Critical thinking as they try to come up with a definition of a magnet among other competencies.

10.2 Magnetic and non-magnetic materials

(2 periods)

By the end of this section, the learner should be able to identify magnetic and non-magnetic materials.

Information to the teachers

In this section, you need to understand why some materials (metals) attract a magnet while others don't. They are full of tiny magnets (dipoles). Those tiny magnets twist about so that they align with the field of the larger magnet.

Suggested materials and learning resources

Bar magnet, cobalt, zinc, reference materials and textbooks, steel nails, Wood, Chalk board illustrations, Copper metal, Glass rod.

Preparation

Assemble magnetic and non-magnetic materials into different groups and provide a bar magnet to each group.

Teaching guidelines 10.2

- Organise the class into groups. Ensure that members on the previous groups in activity 10.1 are mixed up to form a new group. Prompt them to realize that they need a group leader and secretary who will record the group's findings.
- Guide the groups to do activity 10.2 given in the student's book i.e. to identify magnetic and non-magnetic materials and give examples on each.
- Guide **slow learners** on how to use a magnet to identify magnetic and non-magnetic materials provided in activity 10.2 in student's book. Help them to record their observations in tabular form. Encourage them to participate in class discussions on their observations.
- Let the groups present their findings in a tabular form on the chalkboard as the one given in the student's book through their secretaries or any other member of the group. Allow other members of the class to point out omissions or errors in the table.
- Summarise their discussion by guiding them in a class discussion.
- Through the discussion help the learners to understand that;
- Some materials are strongly attracted to a magnet and they are referred to us as *ferromagnetic materials* e.g. iron, cobalt, steel nail.
- Some ferromagnetic materials are made from alloys. This is a mixture of two or more metals e.g. al-ni-co which is the mixture of aluminium (Al) nickel (ni) and cobalt(Co).
- Some magnetic materials are used to make magnets. Those that are hard to make a magnet are called *hard magnetic materials* but once they become a magnet, they retain their magnetism for a long period of time.
- Materials that are easy to magnetise but losses their magnetism quickly are called *soft magnetic materials*. As you summarise their discussion, it is your chance to emphasize the key points that you want the learners to understand and possibly correct any erroneous as you conclude. Also use this opportunity to assess whether the objectives have been met.
- Give slow learners remedial activity to identify a magnetic and nonmagnetic materials catch up with others.
- This activity will promote in the learner among other competencies;
 1. Leadership and organization skills as they form their groups
 2. Communication skills as they discuss their points
 3. Cooperation as they work together in their groups.

4. Critical thinking as they analyze different situations in the activity.

10.3 Properties of magnets

(3 periods)

By the end of this section, the learner should be able to understand the poles and directional properties of a magnet. Identify the poles of a magnet by use of a colour paint.

Suggested materials and learning resources

- 1 metre thread, Iron filings, a bar magnet

Preparation

Assemble a bar magnet and iron filings into different groups. Cut 1 m long threads and give one each to those groups.

Pole Properties of magnets

Teaching guidelines 10.3 (a)

- Organise the learners into groups to do activity 10.3 given in student's book i.e. the pole property of magnets
- Guide them to identify the part of the bar magnet where iron filings are more concentrated.
- Let them explain why the iron filings are more concentrated to the ends of a bar magnet i.e. the force of attraction is strong at the ends.
- Let the groups present their findings in a class discussion through

their secretaries and allow other members to point out the omissions and errors in the facts presented.

- Summarise their presentation by helping the learners to understand that;
 1. The ends of a bar magnet where iron filings are seen to be more concentrated are called magnetic poles.
 2. The line that divides a magnet into two equal parts is called the magnetic axis.
- Take this advantage as you are summarizing their presentation to emphasize the main point i.e. poles of a magnets and correct possible erroneous made in the learner's discussion.
- This activity will promote in the learners;
 1. Communication skills when they are discussing their points
 2. Cooperation as they work together in their groups.
 3. Critical thinking as they figure out why iron filings are more concentrated to the ends.

Directional property of magnets

Teaching guidelines 10.3 (b)

- Ask learners to group themselves into groups. Go round the groups to ensure that slow learners or quick learners are not in one group. Mix them to enable the learners to share ideas when they are discussing. This will boost individual self-esteem and cooperation among the learners.

- Guide them to do activity 10.4 given in student's book i.e. directional property of a magnet.
- Help them to identify the north-south direction of the place where the school is i.e. when the sun rises from the east and sunset is the west thus north-south will be other parts of the place.
- Let the learners observe in which direction the magnet rests and guide them to see a connection between the ends of a bar magnet and the direction they are pointing to as they are discussing. Ask the secretary to note down the point.
- Ask the groups secretaries or any other group members to present their findings to the whole class and let other members from different groups point out omission and errors in the fact presented.
- Summarise their presentation by helping the learners to understand the key points
- The bar magnet rests in north-south direction
- The pole of a magnet that points to the direction of north pole of the earth is called north pole and the other which points to the direction of south pole of the earth is the south pole. Use this opportunity to point out the errors made in their discussion and the assess whether the objectives have been made as you conclude.
- This activity will promote in learners among other competence.

1. Cooperation as they work together in their groups.
2. Critical thinking as they discover the connection between the ends of a magnet and the north-south of the earth.

To identify the poles of a magnet by color

Teaching guidelines 10.3 (c)

- Organise learners into groups with different potentials i.e slow learners and fast learners. Ask the groups to do activity 10.5 given in student's book i.e to identify the poles of a magnet by use of a colour paint.
- Guide the learners to observe the colours i.e blue and red on the bar magnet and the direction they are pointing to. Help the colour blind students to identify the colours. Ask them to deduce the connection in relations to the poles of the earth, i.e red colour end of a bar magnet points to the north pole of the earth , it is the north of a magnet and blue end is the south pole. Use this chance to remind the learners what the blue colour in our national flag symbolizes happiness and peace. Let them understand why it is important to live happily with one another and keep peace in our country.
- Give them a chance to discuss their observations and report their findings to the whole class. Allow other members from different groups to participate and point

out mistakes or omissions from the facts given.

- Summarise their discussion by pointing out the key points i.e the red colour end of a magnet is the north pole and the blue end is the south pole.
- Point out the errors made in their discussion and then assess whether the objectives have been met and you conclude.
- This activity will promote in learners among other competencies;
 1. Cooperation as they realize the importance of working together in harmony and keeping peace among themselves.
 2. Critical thinking as they discover by themselves the connection between the earth poles and the colour on the ends of a magnet.

10.4 Test for magnetism

(2 periods)

By the end of this section, the learner should be able to discover that unlike poles attract each other while like poles repel i.e. the first law of magnetism. They should also discover that repulsion is the only sure way of testing for polarity of a magnet.

Suggested materials and learning resources

- 1 metre thread, 2 bar magnets

Preparation

Assemble 2 bar magnets, a nail and

a thread on tables according to the number of groups you want the learners to form.

To investigate the action of magnets on each other

Teaching guidelines 10.4 (a)

- Ask the learners to form groups. Go around to check any group with slow learners and fast learners in one group or too many boys or girls in one group and mix them so that learners can appreciate and support each other. Prompt them to have a group leader and secretary.
- Guide them to do activity 10.6 given in the student's book i.e. to investigate the action of magnets on each other.
- Let the group observe how the magnets behave when the two poles north pole are brought to each other and let the secretary record their observations in a tabular form as the one shown in student's book.
- Help students with sight problems to feel repulsion between two magnets using their sense of touch.
- Ask the group secretaries or any other members from each group to present their findings to the whole class and allow other members from other groups to point out the omission and errors if any in the facts presented.
- Guide them in a class discussion of their results of the activity. Through the discussion help them to understand that;

1. A south pole repels a south pole
 2. A south pole attracts north pole
 3. A north pole attracts a south pole
 4. A north pole repels north pole. Use this chance to correct errors made during the learner's discussion
- Summarise the discussion by pointing out the point that is unlike poles attract each other while like poles repel each other. Inform the learners that this is the basic or first law of magnetism.
 - This activity will promote in learners among other competencies;
 1. Cooperation as they work in groups with other learners in the activity.
 2. Communication skills and confidence among the learners as they discuss their points.

Testing Polarity of magnets using the basic law of magnets

Teaching guidelines 10.4

- Organise learners into groups to do activity 10.7 given in the student's book i.e. testing the polarity of magnets. Help ***students with sight problems*** to feel repulsion between two magnets using they hands.
- Let them discuss their observations and go around as you listen how they are defending their points. Ensure that all members including the disabled students are participating in the discussion to boost their confidence and communication skills let the secretary note the main point from their discussion.
- Ask the group secretaries to give a report on their discussions and allow other learners from different groups to point out any omission and error in the facts given.
- Guide them in a class discussion on their results from the activity by pointing out the key point that;
 1. There is attraction between a south pole or a north pole of a magnet and magnetic material e.g. the nail.
 2. There is attraction between one pole of a magnet and the other pole of another magnet and repulsion with the other pole of the another magnet. Use this opportunity to point out the errors made in their discussion.
- Summarise the discussion by point out the main point that repulsion is the only sure way of testing for polarity of a magnet and conclude the discussion s you assess whether the objective has been achieved.
- This activity will promote in learners among other competencies;
 1. Critical thinking as learners discuss and defend their points
 2. Cooperation as learners work in groups in the activity
 3. Communication skills and confidence as all learners participate in a discussion.

10.5 Types of magnets

(2 periods)

By the end of this section, the learners should be able to understand the two types of magnets; temporary and permanent magnets and their use.

Suggested materials and learning resources

- A large soft iron nail (3 inches), 1 m thin coated copper wire Iron filings, cello tape, fresh size dry cell, reference books, internet.

Preparation

Assemble all the materials into different groups and you may carry out activities as a teacher before the student do it to ascertain any challenges from the activity and address it e.g. one dry cell may not show the property of attraction thus you need to use two more.

Teaching guidelines 10.5

- Organise the learners into groups and ensure that learners are made up of different abilities and gender (in case it is a mixed school). Ask them to choose the group leader and secretary and ensure that learners who have been group leaders and secretaries are not chosen again. By doing so all learners will feel part of the group and thus promoting team work and leadership skills to all learners.
- Ask learners to do activity 10.8 to 10.10 given on the student's book i.e. types of magnets.

- Guide them to observe and discuss their observations as the group secretary write down their main points.
- Ask the group secretaries to present their findings to the whole class and allow others to participate in pointing out omissions and errors in the facts given.
- Guide them in a class discussion on their findings by pointing out the key points i.e. Soft magnetic materials e.g. iron nails becomes magnets when current pass through them but loses magnetism when is stopped thus they make temporary magnets called electromagnets which are used in loudspeakers, motors etc
 1. Hard magnetic materials e.g. steel nail become magnets when current pass through them but they retain their magnetism for quite a long time thus they make permanent magnets. Use this chance to also point out the errors the learners made in their discussion.
- Summarise the discussion by pointing out that there are two types of magnets, temporary and permanent magnets. Also guide the learners through the uses of each as discussed on the student's book and conclude by:
 1. Assessing whether the objectives have been achieved
 2. Asking learners to do a research

on exercise 10.1 in their free time and present them during remedial class (morning or evening preps).

- This activity will promote in the learners among other competencies:
 1. Research and problem solving skills as they access internet to find solution to exercise 10.1
 2. Cooperation as learners work together in groups
 3. Communication skills as learners discuss and defend their points

10.6 Magnetic field pattern around a magnet

(2 periods)

By the end of this section, the learner should be able to discuss magnetic field pattern on a round magnet.

Suggested materials and learning resources

- A magnetic compass, U-shaped magnet, Reference materials and textbooks, Paper
- Iron filings, 2 bar magnet

Preparation

Assemble all the materials into different groups depending on the number of student and availability of the materials.

Existence of magnetic field around a magnet

Teaching guidelines 10.6(a)

- Organise the learners into groups of two and ensure that they are

of different ability and gender. Ask them to choose a secretary who will note down their findings.

- Guide learners to do activity 10.11 given on the student's book i.e to show existence of magnetic field lines around a magnet.
- Let them note their observations and discuss them as the secretary write the main points.
- Ask the group secretaries to present their findings to the whole class and all other members in class to contribute.
- Guide them in a whole class discussion on their findings by pointing out that;
 1. The space around a magnet where attraction or repulsion is felt is called *magnetic field* which is represented by line of force called magnetic field line
 2. The field line forms a magnetic field pattern. Use this chance to correct the errors learners made in their discussion and drawing magnetic field lines.
 3. Summarise the discussion by comprising about magnetic field pattern and that they all originate from north-south. So as to raise the curiosity of learners on how to draw them.
- This activity will promote in the learners among other competencies;
 1. Cooperation
 2. Communication skills among other competencies

Drawing magnetic field pattern round a magnet

Teaching guidelines 10.6(b)

- Organise the learners into groups of two. Ensure that learners are of different ability and gender. Prompt them to have a secretary.
- Ask them to do activity 10.12 given on the student's book i.e. drawing of magnetic pattern found in a magnet. Assist the **disabled student** with reading and writing materials. Help them to draw magnetic field line on those materials.
- Guide them through the activity.
- Let learners observe how iron filings align themselves around a magnet. Help them to draw the magnetic field lines as observed on the paper. Student with **sight or auditory**
- Problems can be placed in front of the class or any other appropriate position for them to be able to learn comfortably.
- Let them discuss in their groups their observations and drawings as the secretary prepare the final findings to present to the whole class.
- Ask the group secretaries to present their findings to the whole class and all other members to point out errors and omissions in the facts presented.
- Guide them in a whole class discussion on their findings and point out the key point.

1. The pattern displayed by the iron filings represents the magnetic line of force.
 2. The magnetic line of force always originate from north to south pole of a magnet.
 3. The magnetic field line do not cross each other. Also use this opportunity to correct the errors made by the learners and check whether the objectives have been achieved.
- Summarise the discussion by taking learners through the unit summary.
 - Ask them to do all questions in Unit Test 10 and hand in their work for marking. Use this opportunity to ascertain whether the unit objectives have been achieved and identify challenges or areas to be discussed with learners during remedial hours.
 - This activity will promote in the learners among other competencies;
 1. Cooperation
 2. Research and problem solving
 3. Communication skills
 4. Critical thinking among other competencies.

Answers

For non-numerical questions, the learners can get most of the answers from the discussion given in student's book or from the internet and any other reference books. Mark the student's work and use it to guide them appropriately.

Exercise 10.1

(Student's book page 300.)

2.

Magnetic	Non magnetic
Steel	<ul style="list-style-type: none">• Aluminium• Plastic• Paper• Graphite• zinc

Unit Test 10

(Student's book pages 303)

1. a) Pole property
b) Directional property

2. Unlike poles attract while like poles repel each other.
3. U-shaped magnet, bar magnet, ceramic magnet, horse-shoe magnet
7. The poles of ceramic magnet are on its face while that of a bar magnet are at its end.
8. a) North pole
b) i) They will attract each other.
ii) They will attract each other.
iii) They will repel each other.

NOTE: Mark any other correct answers given by students.

Electricity and Magnetism

Unit 11

Electrostatics

Student's Book pages 304-342 (10 Periods)

Key unit competence

By the end of the unit, the learner should be able to explain charging of materials and distribution of electric charges on conductors.

Learning objectives

Knowledge and understanding

- Describe atomic structure of atoms.
- Identify types of charges.
- State the laws of electric charges.
- Describe methods of charging.
- Explain the principle of charge conservation.
- Explain effects of electric charges on a conductor.
- Differentiate between insulators and conductors.
- Explain factors that affect the magnitude of force between two charged bodies.
- Describe electrostatic phenomena, using, concepts, laws, theories and models.
- State Coulomb's law, electric field and potential.

Skills

- Explain the fundamental law of electrostatics.

- Differentiate between insulators from conductor.
- Discuss methods of charging bodies.
- Demonstrate and explain charge distribution on a conductor.
- Evaluate distribution of electrostatic charges on a conductor.
- Analyse and critically evaluate electrostatic related issues.

Attitudes and values

- Appreciate the application of static charges.
- Develop positive attitudes of curiosity, honesty, respect for evidence, and perseverance and tolerance in the study of electrostatics.
- Show concern on the danger caused by electrostatic charges and be aware of safety precautions to be observed during rainstorms.
- Show concern on the use of an electroscope.

Generic competencies addressed in this unit

- Research skills through provision research based activities.
- Creativity and innovation through involving learners solving problems and answering questions in the students book.
- Critical thinking through provision of discussion based activities and involving them in answering and asking questions.
- Communication. This is through provision of group work activities and group discussions in student's book.
- Co-operation, interpersonal management and life skill. This is through provision of group work activities and group discussion in student's book.

Links to other subjects

Structure of an atom (chemistry).

Geography (formation of clouds and lightning).

Cross cutting issues addressed in this unit

- Environment – learners are sensitized about danger during rains. That is; it is not safe to shelter under trees when its raining. This is because trees are good conductors of charges and touching a tree you risk of being electrocuted during rains.

Assessment criteria

Learner can explain electrostatic

phenomena and describe charge attraction and repulsion.

Teaching methodologies

- Group work.
- Class discussions.
- Question and answers.
- Class demonstrations.

Background information

The study of electrostatic is the study of the behaviour of electric charges, which are not in motion (at rest).

To understand the concept of a charge, think about an atom which is electrically neutral. Because it is composed of equal number of positive charges and negative charges in form of protons and electrons respectively (neutrons are electrically neutral). The structure of the atom is such that the protons and neutrons are tightly bound while the electrons encircling the nucleus are relatively easier to dislodge. Hence the addition or removal of electrons from a neutral atom will cause it to become either positively or negatively charged.

Suggested teaching/learning activities

11.1 Types of electrostatic charges

(1 period)

Information to the teacher

In this section, you will introduce the learners to the concept of existence and origin of charges by giving them examples in real life situations.

Suggested teaching/learning materials

Reference materials including books, a small stream of water, a comb (polythene strip)

Teaching guidelines 11.1

- Draw the attention of the students to the student's book to find out the existence of charges from real life situations.
- Organise the learners into convenient groups. Guide them to do activity 11.1 in the learners book.
- Ask them to take the comb near a stream of water. Ask them to state what they observe.
- Ask them to rub the comb (polythene strip) through hair or a cloth so much, and then slowly take it to the stream of water.
- As one is doing the practical work, another person should be writing down the observation.
- Ask each group to give a presentation to the class.
- Summarise the activity by helping the learners know that the comb was able to attract the stream of water because it was charged. But before, it was not able to do so because it was not charged. When a body is not charged, nothing happens when it is brought near another object but when an object is charged, it attracts other objects.
- This activities will promote in a learner;

1. Communications skills through expression of their opinion in the group discussion.
2. Critical thinking through answering questions critically.
3. Problem solving by answering given questions correctly among other competencies.

11.2 Origin of Charges

(1 period)

Suggested teaching/learning materials

A balloon, internet, reference books

Teaching guidelines 11.2

- Organise the learners into convenient groups.
- Guide them to do activity 11.2 given in the student's book on how to show the origin of charges.
- Ask them to blow air into a balloon carefully not to make it burst. Let them take it near the wall and try to stick it to the wall. Ask them to state what they observe.
- Ask them to rub the balloon against hair, and then try sticking it on the wall again. Ask them what they observe.
- Summarise the activity by helping the learners know that the balloon was able to stick on the wall on the second trial because it was charged by rubbing it against hair (charged by friction). The first time it was not able because it wasn't charged,

that is, both the balloon and the wall were neutral, but after it was rubbed against hair, it was able to attain a charge.

- Explain the reason as to why the balloon got charged by discussing with them the structure of an atom. Ask them to draw its structure from their Chemistry knowledge, where it is made up of two parts, one being the central core called the nucleus and the other part being made of orbits where electrons go around the nucleus. The nucleus contains protons and neutrons closely and tightly packed. Protons carry a positive charge; neutrons carry no charge while the electrons carry a negative charge. The number of protons in an atom is equal and hence an atom is always neutral. This is the same reason as to why the balloon in the first instance does not stick on the wall because both are neutral.
- These activities will promote in a learner:
 1. Leadership and organization skills.
 2. Communications skills.

11.3 Methods of Charging Bodies

(3 periods)

a) Friction method

Information to the teacher

The frictional charging process results

in a transfer of electrons between two objects that are rubbed together. Help learners in this section to understand this method.

Suggested teaching/learning materials

Pen made of plastic material and some small pieces of paper of tissues.

Teaching guidelines 11.3 (a)

- Organise the learners into convenient groups.
- Guide them to do activity 11.3 given in the student's book on how to charge a material by friction.
- Ask them to take the pen near the small pieces of paper and state what they observe.
- Let them rub the pen through hair and then take it to the small pieces of paper. Ask them to state what is observed again.
- Summarise the activity by telling them how the pen got charged. By rubbing it with hair, in some materials where the electrons are not tightly bound to the nucleus when rubbed (this is because they are far from the nucleus and the force pulling them to the nucleus weakens as the distance from the nucleus increases) with other bodies. The heat energy developed due to friction can possibly move some of the loosely bound electrons from the material and transfer them to the other. Materials like polythene gain electrons when rubbed with flannel

cloth (cotton wool) and therefore become negatively charged while the flannel cloth loses electrons and becomes positively charged as in Fig 11.3. Materials like glass loses electrons to materials like silk when rubbed together. Silk gains electrons and becomes negatively charged while glass which loses electrons becomes positively charged as in Fig 11.4.

- Ask students to utilize table 11.1 in the student's book to get to know that the nature of charge on a rubbed substance depends on the nature of the rubbing material and its level in the triboelectric series shown by table 11.1.
- Guide the learners in doing examples 11.1 and 11.2 in the student's book.
- Summarise the lesson by discussing with them the most important points to be noted when materials are charged by friction method which are:
 - i) The excess negative charges on one body are equal to the excess positive charges on the other. No new charges have been created. This explains the principle of charge conservation, as it will be discussed in the later part of this unit.
 - ii) During the rubbing process some materials acquire the same kind of charge where as some materials may acquire

either negative or positive.

iii) The quantity of charge produced in some cases may be small and in some cases the charges may escape before they are detected. Therefore a dry atmosphere and a clean dry state of the body are essential for the holding the electrical charges.

- These activities will promote in a learner:
 1. Leadership and organization skills.
 2. Communications skills through expressing their opinion in the group discussion.
 3. Critical thinking through asking and answering questions critically.
 4. Problem solving by answering given questions correctly among other competencies.

Additional activities

1. Blow up a balloon and rub it with a piece of fur or duster. Place the balloon on the ceiling or the wall and leave it. It stays undisturbed for some time.
2. Spread out a sheet of newspaper and press it gently against a wall or a looking glass. Rub the paper a number of times with your hand all over its surface. Try to gently pull up one corner of the paper and let it go. It is attracted to the wall or the mirror. If the day is hot, you can

also hear the crackling sound of the charges stored.

As the students may not have any idea of electrostatic charging of objects, the teacher should explain the Physics behind these observations. The polythene strip or a plastic ruler or the balloon gets 'charged' or 'electrified' when rubbed against materials like silk, duster, cat skin, rubber or wool. The charges developed on the materials are at rest and cannot move, i.e. static charges are developed. The study of static charges is called *electrostatics* (static electricity).

b) Charging a body by induction method

Suggested teaching/learning materials

Insulated uncharged conductor, glass rod, conducting wire and polythene rod.

Preparation

Before the lesson, prepare a set of the materials mentioned above for each of the groups you will work with.

Teaching guidelines 11.3 (b)

- Organise the learners into convenient groups. Let each group appoint a secretary.
- Guide them to do activity 11.4 given in the student's book on how to charge a body by induction method.
- Ask them to rub a glass rod with a silk cloth. Ask them to suggest the charge attained by the glass rod.
- Ask them to take the charged glass rod close to the insulated uncharged conductor but not touching it.
- Ask them to use the law of electrostatics to state what will happen to the charges in the uncharged body.
- Ask them to touch a conducting wire on the other side of insulated conductor away from the glass rod, while holding the glass rod near the conductor, let them withdraw the conducting wire first then followed by a glass rod.
- Prompt them to suggest what will happen to the charges in the conductor.
- Ask them to bring a charged polythene rod and glass rod close each at a time but not touching the conductor. Let them observe and explain their observation.
- Ask them to touch the conductor and bring a charged polythene rod and glass rod close each at a time but not touching the conductor. Let them explain their observation.
- In case they do not give accurate reasons, let them know that when the glass rod is rubbed through a silk cloth, it attains a positive charge (as from the table in the students book), and it's attracted to the conductor and repelled by the polythene rod. When the glass rod is brought near the conductor, positive charges are repelled away from the law of charges and negative charges attracted towards the side of the glass rod. On connecting the conducting wire to the side with positive charges, electrons flow

from the ground to the conductor and neutralize the positive charges. When the conducting wire is removed, the negative charges redistribute themselves throughout the conductor because of the force of repulsion between charges of the same kind so the body is negatively charged. There after the conductor is attracted by positively charged glass rod and repelled by negatively charged polythene rod. On touching the conductor after it has been charged, it gets discharged and hence attraction on both rods because it behaves like a neutral body.

c) Contact (conduction) method

Suggested teaching/learning materials

Insulated uncharged conductor, glass rod, conducting wire, polythene rod.

Preparation

Before the lesson, prepare a set of the materials mentioned above for each of the groups you will work with.

Teaching guidelines 11.3 (c)

- Organise the learners into convenient groups. Let each group appoint a secretary.
- Guide them to do activity 11.5 given in the student's book on how to charge a body by contact (conduction) method.

- Ask them to rub a glass rod with a silk cloth.
- Ask them to take the charged glass rod in contact with the insulated uncharged conductor and then after that remove it from the conductor.
- Ask them to bring a charged glass rod and a polythene rod close to the conductor and observe what happens. Prompt them to suggest a reason for their observation.
- In case they do not give accurate reasons, let them know that when a positively charged glass rod is brought in contact with the conductor, it neutralizes the negative charges on the conductor and repels the positive charges away from the side of the glass rod. When the glass rod is removed (contact broken) the positive charges on the conductor repel each other and hence spread throughout the body and therefore the conductor becomes positively charged. This is the reason why when the charged glass rod is brought near to it, it repels it and attracts the charged polythene rod when they are brought close to one another one at a time.

d) Separation method

Suggested teaching/learning materials

Two metal spheres (A and B), polythene rod.

Preparation

Before the lesson, prepare a set of the materials mentioned above for each of the groups you will work with.

Teaching guidelines 11.3 (d)

- Organise the learners into convenient groups. Let each group appoint a secretary.
- Guide them to do activity 11.6 given in the student's book on how to charge a body by separation method.
- Let them place the two spheres on insulating stands in contact to each other to form one conductor.
- Let them take the charged polythene rod and then bring it close but not touching sphere A.
- Ask them to move away sphere B while holding the charged polythene rod in position so as to break the contact.
- Ask them to remove the polythene rod.
- Let them test spheres A and B using a negatively charged polythene rod.
- Prompt them to suggest a reason for their observation.
- In case they do not give accurate reasons, let them know that before the polythene is brought near the conductors (A and B), charges, positive and negative are balanced hence the spheres are neutral. When the polythene is brought closer to the two spheres, charge separation occurs i.e. negative charges are repelled towards B and

positive charges towards sphere A. Separating the spheres when the polythene is still in place and then after separating the spheres leaves sphere A positively charged and sphere B negatively charged. Therefore, bringing a charged polythene to sphere A results into attraction and if brought near sphere B it results into repulsion.

- These activities will promote in a learner;
 1. Leadership and organization skills,
 2. Communications skills through expressing their opinion in the group discussion.
 3. Critical thinking through answering questions critically.
 4. Problem solving by answering given question correctly among other competencies.

11.4 The Law of Electrostatics

(1 period)

Information to the teacher

As mentioned in the introduction part of student's book, there are two charges in an atom of a body; a negative and positive charge.

In nature, unlike charges attract each other, and like charges repel each other. These fact is known as the First Law of Electrostatics and is sometimes referred to as the law of electrical charges. Learners should remember this law because it is one of the vital concepts in electricity.

Suggested teaching/learning materials

An ebonite rod, thread, silk materials, polythene rod

Teaching guidelines 11.4 (a)

- Organise the learners into convenient groups. Let each group appoint a secretary.
- Guide them to do activity 11.7 given in the student's book that is how to show the force of repulsion between two charged bodies using different materials.
- Ask them to rub an ebonite rod with silk and suspend the rod with a stirrup (support) and thread. Ask them to bring a charged polythene rod near one end of the ebonite rod and observe what happens.
- Ask each group through their secretary to explain to the class their observations in terms of attraction and repulsion and why this could be so?
- In case they do not give accurate reasons, explain to them that the force between the two charges is a repulsion force. This is because both the ebonite rod and the polythene are charged negatively when rubbed with the silk cloth. Because they are both higher in the list than silk and therefore repel each other (because they acquired the same charge).
- This activity will promote in a learner;

1. Leadership and organization skills.
2. Communications skills through expressing their opinion in the group discussion.
3. Critical thinking through asking and answering questions critically.
4. Problem solving by answering given questions correctly among other competencies.

Force of attraction between two charged bodies

(1 period)

Suggested teaching/learning materials

Glass rod, ebonite rod

Preparation

Before the lesson, prepare a set of the materials mentioned above for each of the groups you will work with.

Teaching guidelines 11.4 (b)

- Organise the learners into convenient groups. Let each group appoint a secretary.
- Guide them to do activity 11.8 given in the student's book i.e how to show the force of attraction between two charged bodies.
- Ask them to rub an ebonite rod with silk and suspend the rod with a stirrup (support) and thread. Ask them rub the glass rod and then take it near one end of the ebonite rod and observe what happens.
- Ask each group through their secretary to explain to the class their observations in terms of

attraction and repulsion and why this could be so?

- Explain to them that force between the two charges is an attractive force. This is because the ebonite rod and the glass rod have unlike charges. The ebonite rod is negatively charged because it is higher in the list while the glass rod is positively charged because it is lower in the list.
- Prompt them to conclude on what happens when different charges are brought near each other.
- This activity will promote in a learner;
 1. Leadership and organization skills.
 2. Communications skills through expressing their opinion in the group discussion.
 3. Critical thinking through answering questions critically.
 4. Problem solving by answering given question correctly among other competencies.

The force of repulsion between two similar charges using rods of the same material

(1 period)

Suggested teaching/learning materials

Two polythene rods, silk cloth, a thread

Teaching guidelines 11.4 (c)

- Organise the learners into convenient groups. Let each group appoint a secretary.
- Guide them to do activity 11.9 given

in the student's book on how to show the force of repulsion between two charges using rods of the same material.

- Ask them to rub two polythene rods with a silk cloth vigorously and suspend them with stirrups and thread.
- Ask each group to bring the two suspended rods close to each other and observe what happens.
- Ask each group to explain their observation.
- In case they do not give accurate reasons, let them know that the force between the two charged polythene rods is a repulsive force. This is because they have similar charges and therefore repel each other. It is now that the teacher can discuss with the learners that if the same activity was done using two glass rods rather than polythene rods, the same effect would be observed. The two glass rods would repel each other still.
- Prompt them to conclude on what happens when same charges are brought near each other.
- From activities 11.4,11.5 and 11.6 the teacher should guide the learners to conclude that:
 - i) The electric charges are of two types that is negative and positive charges.
 - ii) Unlike charges attract each other.
 - iii) Like charges repel each other.

The law of electrostatics states that like charges repel each other and unlike charges attracts each other

- This activity will promote in a learner:
 1. Leadership and organization skills.
 2. Communications skills.
 3. Critical thinking.
 4. Problem solving competencies.

To confirm that a body is charged

Suggested teaching/learning materials

Glass rod, ebonite rod, silk, thread, pieces of papers and a polythene rod.

Preparation

Before the lesson, prepare a set of the materials mentioned above for each of the groups you will work with.

Teaching guidelines 11.4 (d)

- Organise the learners into convenient groups. Let each group appoint a secretary.
- Guide them to do activity 11.10 given in the student's book on how to confirm that a body is charged.
- Ask learners to rub both a glass rod and ebonite rod with a silk cloth. Then bring one at a time to near the pieces of paper. Ask them to state what they observe?
- Ask them to bring them close to one another and state what is observed.
- Ask the learners to suspend the glass rod and the ebonite rod with

a stirrup (support) and thread separately.

- Ask them to Charge a polythene rod by rubbing it with silk, and then pass it over the pieces of paper, then bring it to near the ebonite rod and then to the glass rod. Let them write what they observe.
- In case they do not give accurate reasons, let them know that the ebonite rod and the glass rod both attract the pieces of paper and they each other because they have been charged oppositely, negatively (ebonite rod) and the other positively (glass rod). When in turn a charged polythene rod is brought near the pieces of papers, they get attracted to it, then to an ebonite rod it is repelled while for the glass rod it is attracted. So attraction is not a good test to confirm whether a body is charged or not because both the papers and the glass rod were attracted yet one is charged and another is not. No uncharged body is repelled by a charged body. *Therefore, repulsion is the best way to confirm that a body is charged.*

11.5 Coulomb's Law

(1 period)

Suggested teaching/learning materials

Internet and reference books

Teaching guidelines 11.5

- Ask the learners to form groups of two and do activity 11.11 by accessing the internet and reference books on research on coulombs law and how it states.
- In case they don't give accurate answers, let them know that coulomb's law of electrostatics states that two electrically charged bodies experience an attractive or repulsive force, F , which is inversely proportional to the square of the distance between them and directly proportional to the product of their electric charges Q_1 and Q_2 .
- Discuss with the learners the derivation of the formula of coulombs law from its definition. Guide them to understand how to remove the proportion sign and that it depends on the material media in between the charges.
- Guide them to know smaller and bigger units of charge as from the student's book .
- Guide them through the example 11.3 in the student's book.

11.6 Factors affecting the magnitude of the force between two charged objects

(1 period)

Effect of the quantity of charge

Suggested teaching/learning materials

Two identical polythene rods A and B, one Perspex rod C, and two clamps and stands

Preparation

Before the lesson, prepare a set of the materials mentioned above for each of the groups you will work with.

Teaching guidelines 11.6 (a)

- Organise the learners into convenient groups. Let each group appoint a secretary.
- Guide them to do Activity 11.12 given in the student's book on how to determine the effect of the quantity of charge on the magnitude of the force between two charged particles
- Ask them to charge a polythene rod A lightly by rubbing it with a piece of dry cloth and suspend it on a stand.
- Ask them to charge a polythene rod B strongly by rubbing it with a piece of dry cloth and suspend it on a stand.
- Ask them to charge a Perspex rod C strongly by rubbing it in a piece of dry cloth.
- Ask them to bring the charged Perspex rod in turns near the suspended rods A and B then observe compare the magnitudes of the force of attraction in both cases. Ask them to write down their observation.
- Prompt them to suggest a reason for their observation.

- In case they do not give accurate reasons, let them know that there is a strong force of attraction between rods B and C than between rods A and C. Guide them through a discussion that an electrostatic force between two charged objects depend on the quantity of the charge on the two objects. The greater the quantities of charge on the two objects the greater the force between them.

Dependence of the magnitude of force on the distance of separation

Suggested teaching/learning materials

Two identical polythene rods A and B, one Perspex rod C, and two clamps and stands.

Preparation

Before the lesson, prepare a set of the materials mentioned above for each of the groups you will work with.

Teaching guidelines 11.6 (b)

- Organise the learners into convenient groups. Let each group appoint a secretary.
- Guide them to do Activity 11.13 given in the student's book on how to show the dependence of the magnitude of force on the distance of separation
- Ask them to charge a polythene rod A lightly by rubbing it with a piece of dry cloth and suspend it on a stand.

- Ask them to charge a Perspex rod C strongly by rubbing it in a piece of dry cloth.
- Ask them to bring the charged Perspex rod C very close to the suspended charged polythene rod A. Ask them to observe the strength of the force of attraction between the two rods
- Ask them to bring the charged Perspex rod C close but far than in the previous step to the suspended charged polythene rod A. Ask them to observe the strength of the force of attraction and compare it with the first one in the first step.
- Guide them through a discussion that there is a strong force of attraction between rods A and C when the separation distance between them is short and weaker when the separation distance is wide.
- Lead them to conclude that the electrostatic force between charged objects depends on the separation between the charged objects, the greater the distance, the smaller the force and vice versa.
- It is now that you can summarise the two activities that the magnitude of the force between two charged objects depends on:
 - i) The quantity of charge i.e the greater the charge, the greater the force.

- ii) The distance of separation, i.e. the greater the distance, the smaller the force.

11.7 Conductors and Insulators

(1 period)

Suggested teaching/learning materials

A bulb in a bulb holder, connecting wires, a 1.5V dry cell in a cell holder, plastic pen, a steel nail.

Teaching guidelines 11.7

- Organise the learners into convenient groups.
- Guide them to do Activity 11.14 given in the student's book
- Ask them to connect wires to cell holder and a bulb holder as shown in Fig 11.15 in the student's book and observe what happens to the bulb.
- Ask them to make a gap between point A and B and connect a plastic pen between them. Ask them what will happen to the bulb. Ask them to suggest a reason for it.
- Ask them to repeat step 2 but with steel nail and observe what will happen to the bulb, and explain their observation.
- Ask them to group the materials that give the same result into groups. How many groups do you get? Let them suggest the general name for them.

- Ask them to discuss their observations in all cases and come up with a list of materials in each group named in step 5.
- In case they do not give accurate reasons why the bulb lights when it is connected to the cell in step 1 and when the steel nail is connected between points A and B in step 3. However the bulb did not light when a gap was made between points A and B and when a plastic pen was connected between them.
- Materials that allow the flow of charge are called conductors while those that don't allow the flow of charge are called insulators.

11.8: Electric Field and Electric Potential

(1 period)

Suggested teaching/learning materials

a pen, and pieces of paper, reference books and internet.

Preparation

Before the lesson, prepare a set of the materials mentioned above for each of the groups you will work with.

Teaching guidelines 11.8

- Organise the learners into

- convenient groups.
- Guide them to do activity 11.15 given in the student's book on electric field and electric potential.
- Ask them to rub a pen through a silk cloth many times.
- Ask them to lower it down at different heights towards the pieces of papers and observe at each point until it comes very close to the pieces of papers.
- Ask them to note down their observation at each height above the papers. Prompt them to give a reason for each of their observation.
- In case they do not give accurate reasons, let them know that the pen only starts attracting the pieces of paper when it is in a region called the electric field, the region in which a body experiences an electric force.
- Guide learners through a research about the meaning of electric field strength, its formula and units. Also find out about electric potential.
- Allow them to discuss their findings.
- After the discussion of at least 5 to 10 minutes, let each member present the outcomes from their discussion to the rest of the class.
- From the learners discussion help them to define electric field as the force per unit charge. It's given as, where is the charge, and is the force acting on the charge, and is the electric field strength.
- Engage the learners in discovering

the SI units from its formula.

From the learners discussion help them to define electric potential, the work done in bringing a unit positive charge from infinity to that point. It is given as, where is the charge to be moved, is the distance moved, is the permittivity, the medium which separates two charges. It can be a vacuum or an insulator. The material with a high permittivity is one which reduces appreciably the force between two charges.

- Engage the learners in discovering the SI units from its formula as C ask them to complete exercise 11.1

11.9 Distribution of charges on metallic conductors

(1 period)

Suggested teaching/learning materials

Spherical conductor, oval conductor, gold leaf electroscope, and a proof plane

Preparation

Before the lesson, prepare a set of the materials mentioned above for each of the groups you will work with.

Teaching guidelines 11.9

- Organise the learners into convenient groups. Let each group appoint a secretary.
- Guide them to do activity 11.16 given in the student's book i.e on how to show charge distribution

on a conductor. Ask them to access the internet and do research on distribution of charges on a conductor, a proof plane and its uses and the meaning of the charge density. Let them discuss their findings with other groups in the class.

- Ask them to charge both conductors by any one of the methods of charging (allow them to use one they desire).
- Ask them to press the proof plane into contact with the surface at various places of the spherical conductor and then transfer the charge to the electroscope and observe the divergence each time it is done.
- Ask them to do the same for the oval conductor, i.e. to press the proof plane into contact with the surface at various places of the oval shaped conductor and then transfer to the electroscope and observe the divergence each time it is done.
- Prompt them to suggest reasons for every observation they have made.
- In case they do not give accurate reasons, let them know that on each transfer, the gold leaf is seen to diverge, however the divergence of a leaf is seen to be more when the proof plane is initially pressed on the pointed end of the conductor. Lead them

to conclude that charge is mostly concentrated at places where the surface is sharply curved. This is particularly noticeable at the end point of the pear-shaped conductor. From that, discuss with them that charge density (surface density) is defined as the quantity of charge per unit area of a surface of a conductor.

- **Note**; there is even distribution of charge on evenly distributed bodies, like spheres, rectangles.

11.10 The law of conservation of charge

Suggested teaching/learning materials

Reference materials including books

Teaching guidelines 11.10

- In pairs, ask students to do activity 11.17.
- After the discussion of at least 10 to 15 minutes let each member present the outcomes from their discussion to the rest of the class.
- Guide them through the discussion. Let them know that if you rub a comb through your hair, it becomes negatively charged. The only way for this to happen is for your hair to also become positively charged. So the comb's charge becomes the charge in your hair.

- Guide them through examples of energy conservation given in student's book e.g rubbing a rubber rod with animals fur. Explain to them that at first the total charge of the system is zero (neutral, that is, it has equal numbers of electrons and protons) before rubbing. The system is made up of rubber rod and fur. When she rubs, the rubber rod will acquire negative charges, like ten (10) negative charges, because of the heat generated by rubbing leads to fur to losing its electrons, and thus it becomes positively charged and with ten positive charges. So the total charge of the system is zero.

Note:

The only way to change the net charge of a system is to bring in a charge from elsewhere or remove the charge from the system.

E.g. Two identical metal spheres are charged, sphere A has a net charge of sphere B. The spheres are brought together, and allowed to touch and then separated, what is the net charge on each sphere now?

When the spheres are touched the net charge will spread out evenly over the two spheres each sphere will have a net charge of on separation.

- Ask learners to do Exercise 11.2 given in the student's book.

- This activity will promote in learners among other competencies:
 1. Cooperation and interpersonal skills.
 2. Research and problem solving skills.

11.11 Effects and applications of electrostatics

Suggested teaching/learning materials

Reference materials including books, internet enabled computers.

Teaching guidelines 11.11

- Organise learners into groups of two students and task them, to do activity 11.18 that is to research and discuss about the effects and applications of electrostatic charges.
- After the discussion of at least 10 minutes let each member present the outcomes from their discussion to the rest of the class.
- From the learners discussion help them to know that electrostatics can be good and on the other hand bad because the buildup of charges on a body can be a nuisance. Engage the learners in a discussion about the following;
 - i) One gets a shock on touching the metal knob of the door of a car while getting out of the car. Electric charges build up on the

- surface of a car due to friction with the road as well as with the air molecules. When the metal knob is touched, charges flow from the knob to the earth through the person. The discharging of the charges on the surface of the car through the person gives a shock. If a metal chain is attached to the car on the outside, the charges can pass easily to the earth and the charges cannot build up. It is for this reason that metal chains are attached to a petrol tanker. If large charges are allowed to pile upon the tanker, even a small spark produced can cause a fire and the tanker can explode.
- ii) When a mirror is cleaned with a dry cloth, both the mirror and the cloth get charged due to friction. The charged mirror acquires the attractive property. Dust, thin hair or fluffs can therefore stick to the mirror.
 - iii) Cars are painted using a spray gun. The car is usually earthed and the paint droplets coming out of the spray gun are given a positive charge. The car attracts these charged droplets of paint uniformly.
 - iv) Dust and smoke particles are extracted from the inside of the chimney by electrostatic attraction. This reduces the air pollution which is a health hazard.
 - v) Electrostatic induction is used in the photocopying machines.
 - vi) Though rubber is an insulator, special materials called conductive rubber is used to make aero plane tyres. The conductive rubber tyres reduce the risk of an explosion during refueling the aircraft. When the metal sprout of the fuel pipe touches the petrol tank sparks can be produced leading to an explosion.
 - vii) Lightning arrestor
The discharge action of points is utilised in an important device called lightning arrestor or conductor used to prevent tall buildings and towers against the destructive effect of lightning. A lightning conductor is a thick metal rod. One end is attached to a metal plate and buried deep in the ground. The other end, which is pointed, sticks up above the building. The conductor provides a path for electrons to flow easily through it. If a positively charged cloud is above the building, a negative charge will be induced on the pointed edges of the lightning conductor. Electrons concentrate on these points and by the discharge action of the pointed edges, negative ions are sprayed into the air and are attracted by the positive charges on the cloud. Thus the charge on the

- base of the cloud is reduced. This prevents a large build-up of charges which otherwise would result in discharges to the earth in the form of lightning. If the neutralizing effect is insufficient and even if the lightning strikes, the huge electrical charge is conducted through the metal rod, to the earth. Thus the building is saved from any damage. In the absence of a lightning arrestor, lightning would strike the highest point of a building and a large current would pass to the earth through the building. The heat generated by the passage of this large current can set fire to the building.
- Conclude this part by assigning learners the project of constructing a simple leaf electroscope given in student's book.
 - Take the student through the unit summary and ask them to do unit Test 11. Ensure that you have marked every learner's work. This will enable you to assess whether the unit objectives have been achieved and identify challenging areas to the student and guide them accordingly.
 - These activities will promote in a learner:
 1. Leadership and organization skills.
 2. Communications skills through expressing their opinion in the group discussion.
 3. Critical thinking through answering questions critically.
 4. Problem solving by answering given question correctly among other competencies.

Further exercises and their answers

Further exercises/activities

<i>Further exercises for slow learners</i>	<i>Further exercises for fast learners</i>
<ol style="list-style-type: none">1. Name two types of charges.2. State the law of electrostatics.3. Name two methods of charging a body either positively or negatively.	<ol style="list-style-type: none">1. Describe a method of charging an electroscope positively.2. Explain why it is dangerous to carry an umbrella with a pointed top during a rainstorm when walking in an open field.3. An uncharged polythene rod brought close to but not touching the cap of a charged electroscope cause a decrease in the divergence of the leaf. Explain.

Answers to some further exercises/Activities

<i>Further exercises for slow learners</i>	<i>Additional exercises for fast learners</i>
<ol style="list-style-type: none">1. Positive and negative2. Unlike charges attract while like charge repels3. - Induction - Contact	Mark student's work and guide them appropriately. You may refer to student's book incase of any doubt.

Answers

For non-numerical questions, the learners can get most of the answers from the discussions given in student's book or from the internet and any other reference books. Mark the student's work and use it to guide them appropriately.

Exercise 11.2

(Student's book page 335)

5. $2.162 \times 10^{-5} \text{ N}$
6. 1.99 m
7. 0.2939 N

Unit Test 11

(Student's book pages 340-342.)

20. $1.764 \times 10^{-2} \text{ N}$
21. $9.235 \times 10^{-7} \text{ N}$

Electricity and Magnetism

Unit 12

Current Electricity (I)

Student's Book pages 343-391 (10 Periods)

Key unit competence

By the end of this unit, the learner should be able to explain different effects of electricity and safety precautions to observe while using electricity.

Learning objectives

Knowledge and understanding

- Outline simple electric circuit components and define them.
- Explain the functioning of cells and batteries.
- Illustrate the effects of electric current (heating, magnetic and chemical).
- Explain applications of earth wire, fuse, and circuit breaker in preventing electrical shocks and short circuits.
- State and describe different effects of electric current.

Skills

- Apply the knowledge of electric current in electrolysis.
- Set up simple electric circuits.
- Explain different effects of electric current.
- Distinguish between simple cells and batteries
- Apply knowledge of safety precaution to avoid overheating

of devices (uses of fuses and circuit breakers).

- Explain what would happen to a house without fuses or circuit breakers during electric circuit overload and short circuiting.
- Measure current, voltage and resistance.
- Verify Ohm's law.

Attitudes and values

- Recognize how to measure electric current and potential difference using ammeter and voltmeter.
- Appreciate the application of effects of electric current.
- Appreciate that chemical reactions produce current.
- Appreciate that if electrical circuit is not properly used and controlled, it can cause fires.

Generic competencies addressed in this unit

- Problem solving through provision of problems to solve and answering questions in the students book.

- Communication through involving learners in group discussions asking and answering questions in the students book.
- Research skills through provision of research based activities.
- Cooperation through provision of research based activities.

Links to other subjects

Electrolysis and chemical effects (Chemistry).

Cross cutting issues addressed in this unit

- Environment:— Learners are sensitized on conservation of environment. For instance they are advised not to cut trees because cutting trees leads to deforestation.

Assessment criteria

Learner can explain effects of electric current and safety precautions to be taken to avoid electric shocks and circuit overloading.

Teaching methodologies

- Group work.
- Class discussions.
- Question and answers.
- Class demonstrations.

Background information

Current electricity (1) deals with the basic ideas about electricity. The main point in this unit is how to operate a simple electric circuit. Since the learners have studied a simple electric circuit in

Primary 6, allow the student to do most of the activities in groups and report their findings to the rest of the class.

Suggested teaching/learning activities

12.1 Simple electric circuit and its component

(2 periods)

By the end of this section, the learner should be able to define simple electric circuit and its components.

Information to the teacher

Learners have been introduced to the concept of simple electric circuit. Review what they covered in Primary 6, see page 56 of the primary syllabus i.e. explaining the importance and production of electricity, identifying sources of electricity, identifying components of electric current, explaining the methods of controlling and danger of electric circuit, explaining danger of electric current. This can be done by assigning groups different concepts covered in PS in advance and allowing the groups secretaries to make presentation in class (see generic competence). Inform the learner the career opportunities e.g. electrical engineers, technologist, technicians etc.

Career opportunities students with visual impairments should be paired with the other learners to help them identify components and construct

simple circuit by the sense of touch. (inclusive education)

Suggested teaching/learning materials

Battery/cells, bulbs, connecting wire, plotting compass, insulated copper wire, ammeter, voltmeter, ohmmeter, resistor, electrolytic (voltammeter) switch, charts

Preparation

Since cells and batteries are consumable buy them a day before the start of this unit. In case of chargeable batteries have the charged properly before the unit starts. Make sure to alert the students to disconnect their circuit once they are through with the circuit. This will promote standardization culture of saving energy and waste management in disposing properly the used up batteries and cells.

Teaching guidelines 12.1

- Organise the class into groups depending of the materials/ apparatus/equipment available.
- Ensure that each group has a secretary to record and report the group; take care of gender and learners with challenges.
- Ask the group to do activity 12.1 given in the students book i.e. to set up a simple electric circuit.
- Let the group present their finding in a class discussion through their secretaries and allow other members of the class to point out

more information on the circuit connection.

- Helping the learners to differentiate an open and closed circuit as discussed in students book.
- Summarise their presentation by guiding them how to draw a simple electric circuit.
- This activity will promote in the learners leadership and organization skills and communication skills.

Additional information to teacher

Setting in electric circuit may be difficult for student at the beginning. You may have to demonstrate to the class how to set one. Then move to each group to check the circuit before switching on. The main source of discomfort in the lose connection at the cell terminals and at the component. Ask learners to attempt questions 1, 2 in class. Assign the question 3 to the fast learners.

12.2 Simple cells and batteries

(2 periods)

Information to the teacher

Arrange to have various chemical cells. You might have to borrow.

Suggested teaching/learning materials

Lemon, zinc and copper plates, connecting wires with clips, milliammeter/ galvanometer, knife.

Preparation

Assemble all required materials in this section into different groups in advance. Get a car battery in advance if it is not within school compound.

Teaching guidelines 12.2

- Have the learners organised in groups to do activities 12.2, 12.3, and 12.4 given in student's book.
- Guide them through those activities and let the group secretary note down their findings.
- Randomly pick any group member to present their findings to the whole class.
- Allow the learners to suggest the summary of their findings through question and answer method.
- Summarise their discussion by taking them through each discussion provided in student's book.
- Conclude this section by:
 1. Assessing learners through question and answer method whether the objectives have been achieved. Note that also the exercise in this section can be used to assess learners.
 2. Taking them through the each activity in a summarised form.
- This activity will promote in learners among other competencies;
 1. Research skills through provision of research based activities.
 2. Cooperation through provision of research based activities.

12.3 Electric Current

(2 periods)

Information to the teacher

In Primary 5, the students were introduced to electricity. Differentiate at this point between electricity and electric current. Emphasise to the learners that the cells/batteries are not the source of electrons.

Suggested teaching/learning materials

Straws, beaker (tins) and water

Teaching guidelines 12.3 (a)

- Allow the learners to perform activity 12.5 in groups. Guide them through the activity.
- Use the activity to show that: $I = Q/t$
- Let the learners understand and convert the unit of coulomb per second (c/s) to ampere (A).
- Discuss in class big and small units of current mA, uA etc.
- With the student's book closed. Give examples 12.1, 12.2 and 12.3 as practice exercise. When all the learners are through, ask them to check the solution in their textbook.
- This activity will promote in learners among other competencies
 1. Communication through involving learners in group discussions asking and answering questions in the students book.
 2. Cooperation through provision of research based activities.

Measurement of electric current

(2 periods)

Information to the teacher

Although the syllabus does not specify whether the measuring instruments are digital or analogue, it is advisable to consider both with more emphasis on the analog scale as it is more difficult to read.

Suggested teaching/learning materials

Dry cells, connecting wires, resistors, switch.

Preparation

In case you do not have the digital meters, borrow from your neighbouring school. Make sure that the batteries/cells are in good working condition.

Teaching guidelines 12.3 (b)

- Organise the learners in pairs to do activity 12.6 i.e. to identify parts of an ammeter.
- Avail the instructions to the groups and allow them to proceed to activity 12.7 and 12.8. Ensure that the groups are active and clarify any misconception scale reading to the groups where applicable.
- Insist on the drawing of the instrument scale to understand the various scale ranges i.e. 0.1.0 MA, 0-1A, 0-1.0uA etc. Then show now which terminals to use for a given range. This activity should

be followed by activity on how to use an ammeter to measure current in a in series. Explain and even demonstrate, what series connection mean i.e +ve to +ve and –ve to –ve or left to right and right to right (let the students hold their hands). Ref the learner to the 600 m on how to read ammeter.

- Go through example 12.4 with the students by first letting them work in their groups and referring to the activity and let the students attempt questions 2,3 and 4 in class. Assign questions 5,6, 7 and 8 as homework.
- This activity will promote in learners among other competencies
 1. Communication through involving learners in group discussions asking and answering questions in the students book.
 2. Cooperation through provision of research based activities.

12.4 Potential Difference (P.D)

(1 period)

Information to the teacher

Learners should read in advance the water model and volt in the students book.

Suggested teaching/learning materials

Reference book, internet

Teaching guidelines 12.4(a)

- Allow the students to report on the working of a water model.
- Guide them through activity 12.9 in student's book.
- Reinforce their report with the slide model in fig 12.14 in student's book.
- Through questions and answer method establish that;
at A, $p.E = 0$ B, $p.E = \max C$,
 $E = PE + IIE D$, $p.E = 0$
- Bring out the connection between work done (J) and voltage (V)
- This activity promotes in learners;
 1. Communication skills through group discussions asking and answering questions in the students book.
 2. Cooperation through provision group work activities.

Measurement of Voltage

Information to teacher

In case the school does not have a digital voltmeter borrow one or request for one.

Suggested teaching/learning materials

Voltmeter, cells/batteries, connecting wires, resistors , switch.

Preparation

Make sure the cells/batteries are working. Prepare a chart showing the various parts of a voltmeter.

Teaching guidelines 12.4(b)

- Ask learners to organise themselves into groups. Ensure that the groups formed are of different abilities and gender (if any). All learners whether disabled or normal should participate actively in the lesson and all activities.
- Ask the groups to do activity 12.10 given in student's book. i.e. to show how to measure voltage.
- Let the group's report their findings.
- Guide the learners through the activity and discussion in student's book.
- Summarise the groups finding.
 1. Emphasize on various scales and conversion of units Mv-V, V- Mv etc.
 2. How the voltmeter is connected in a electric circuit.
- This activity should be followed by activity on how to read a voltmeter.
- Learners to do exercise 12.3 questions 3,4 &7 in class. Select some learners to do them on chalkboard/white board.
- Give question 1, 6 as assigned.
- This activity will promote in learners among other competencies
 1. Communication through involving learners in group discussions, asking and answering questions in the students book.
 2. Cooperation through provision of research based activities.

12.5 Ohm's Law

(2 periods)

Information to the teacher

Ohm's law is to be done in both S1 and S2. Both quantitative and qualitative in S1, but applications in S2 i.e. resistors in parallel and in series.

Suggested teaching/learning materials

Cell/batteries, connecting wires, variable resistor, switch, voltmeter and ammeter, graph papers.

Preparation

Ensure the cell/batteries are in good working condition.

Teaching guidelines 12.5

- Organise the class into suitable groups preferably in pairs.
- Allow the learners to do activity 12.11 given in student's book .
- Allow the groups to present their finding.
- Make a summary of the student finding.
- Emphasise on directly proportional.
- Use their finding to do activity 12.12 on ohm's law.
- Guide the learners in drawing the graph and determining the slope of the graph.
- Through question and answer method, arrive at $V = IR$.
- Guide learners through example 12.5 to 12.7.

- Ask them to do all questions in exercise 12.4 as an assignment.
- These two activities promote in the learners the following:
 1. Communication through involving learners in group discussions asking and answering questions in the students book.
 2. Cooperation through provision of research based activities.

12.6 Electrical Energy and Power

(2 periods)

Information to the teacher

Learners have been introduced to heat in Primary 6 i.e

- Definition of energy
- Forms of energy
- Energy transformation/energy conversion
- Importance of energy
- Sources of energy
- Renewable energy

Quickly review the above concepts

Suggested teaching/learning materials

An immersion heater, bulbs stopwatch, power supply

Preparation

Ensure that all required materials are set in place in time.

Teaching guidelines 12.6

- Ask learners to form groups. Ensure that the groups comprise of:
 1. Different abilities i.e. slow and fast learners.
 2. Gender balance i.e. boys and girls incase the class is mixed one.
 3. Disabled students incase they are there.
- Allow the learners to do activity 12.13.
- Ask them to present their findings on the chalkboard using arrows to show how energy is transformed from one form to the other.
- Discuss with the class the outcome of their finding with a view to summarizing their findings.
- Guide them through activity 12.13 in the view of coming up with electric energy equation.
- Ask them to go through examples 12.5, 12.6 and 12.7 visit the groups and discuss with them the challenges they encounter.
- Ask them to do activities 12.14 and 12.15. Guide them on each step with a view of helping them to come up with an an equation of electric power.
- Take them through examples 12.8 to 12.14. At this point bring their attention to the need of conserveing energy by using energy saving bulb in order to save on energy consumption cost.
- Give Exercise 12.5 as a take way assignment.

- These two activities promote in the learners the following:
 1. Leadership and organization skills.
 2. Communications skills through expressing their opinion in the group discussions.
 3. Critical thinking through answering questions critically.
 4. Problem solving by answering given questions correctly among other competencies.

12.7 Earth Wire, Switch and Fuses

(1 period)

Information to the teacher

Most learners have interacted with switches, earth wire and fuses at home. Help them to understand how important these devices are in protecting a house and electrical appliances in our homes. Equip yourself with sufficient knowledge by reading widely from internet and reference books or any other relevant material so that you are able to answer any question asked.

Suggested teaching/learning materials

A 3-pin plug, screw driver

Preparation

Get a 3-pin plug and screw driver in advance.

Teaching guideline 12.7

- Learners to form groups. Ensure that the groups formed by learners

- are of different abilities and gender (if any).
- Let them do activities 12.16, 12.17, 12.18 and 12.19 given in the student's book
 - Let each group give a presentation of their discussion to the whole class.
 - Guide the learners through the discussion given in student's book and summarise by pointing key points on the importance of earth wire, switch and fuses. Advise learners to open the circuit when not in use.

12.8 Effects of an Electric Current

(1 period)

(a) Heating effect of electric current

Information to the teacher.

This section equips learners with knowledge on how the appliances at home e.g. iron box works. It is therefore important for you as a teacher to prepare well in this area to be able to guide learners accordingly.

Preparation

Ensure that you have all the required materials in time.

Suggested teaching/learning materials

Immersion heater, thermometer, variable resistors, water, switch and connecting wires water, a bucket

Teaching guideline 12.8

- Ask learners to group themselves into groups. Go around and reorganise them to avoid a tendency of fast or slow learners grouping themselves into one group. All learners whether disabled or normal should participate actively in the lesson.
- Prompt them to realize that they need a group leader and a secretary to record and report the group's findings.
- In their groups, let them do activity 12.20 to 12.22 given in student's book.
- Guide them through their discussion and summarise by pointing out factors that affect the heating effect of an electric current i.e. amount of current, time and resistance of the wire.
- Guide them through a discussion on application of heating effect of an electric current.
- Ask learners to do exercise 12.6 in student's book.
- Communication skills
- Cooperation among learners
- Critical thinking
- This activity will promote in the learners;
 1. Communication through involving learners in group discussions, asking and answering questions in the students book.
 2. Cooperation through provision of research based activities.

(b) Magnetic effect produced by current

(1 period)

Information to the teacher

The learners have been introduced to magnetism in Primary 6 in the following area;

- Types of magnets; natural/ artificial
- Composition of magnets
- Magnetic and non magnetic material
- Definition of magnetic field
- Magnetic compass and its uses
- Uses of magnets
- Making a temporary magnet

Review the above concept first.

Suggested teaching/learning materials

Batteries/Cells, connecting wires, along straight stiff conductor, stand and clamp, switch cardboard, iron filings.

Preparation

Prepare the set up as shown in students book in advance. Give activity 12.22 as a research.

Teaching guidelines 12.8

- Demonstrate activity 12.23. The student might not be able to set it up. Also as the current need is high it is risk for the student.
- Arrange the set up in an elevated position for all the students to make the observation at the same time. The student need to be arranged properly to avoid some blocking the view of others.

- Invite some students to help you carry out the demonstration.
- This activity will promote in the learners;
 1. Team work.
 2. Values through probing questions.
 3. Respect for others (make observation without blocking other).
 4. Critical thinking.
 5. Cooperation.

Additional information

The same concept may be demonstrated by activities 12.27 and 12.28, which can be done as a class activity. The student knows how a plotting compass works as it was covered in Primary 6.

12.9 Chemical Effect of an Electric Current

(1 period)

Information to the teacher

This being the first time the students are learning about this effect, it is a good idea to form groups with few students (2 students) for them to be able to directly participate in the activities.

Suggested teaching/learning materials

A 250 ml beaker, two carbon rods, a battery or d.c. source water, connecting wires and bulb.

Teaching guidelines 12.9

- Organise the learners in pairs to do activity 12.25.
- Care must be taken when handling dilute sulphuric acid, teacher should prepare acidulated water.
- Move round the group and check their observations.
- Allow the learners to report their finding.
- Ask them to do activity 12.26 in student's book.
- Summarise their observations.
- Give learner the project work given in student's book as an assignment to be marked after two weeks.
- Guide them through unit summary.
- Ask them to do unit test 12.

Additional information

The same concept may be understood by use of activity in student book. The word electrolysis should be avoided, as it will be done in S2. Avoid use of any chemical equation at this stage.

- This activity will promote in the learners;
 1. Communication through involving learners in group discussions asking and answering questions in the students book.
 2. Cooperation through provision of research based activities.

Further exercises and their answers

Further exercises/activities

<i>Further exercises for slow learners</i>	<i>Further exercises for fast learners</i>
<ol style="list-style-type: none">1. What is an electric circuit?2. Name two components of electric circuits.3. Define current and state its SI unit.	<ol style="list-style-type: none">1. Explain how a fuse protects electric appliances.2. Distinguish between a dry cell and battery.3. Explain five electric hazards and suggest the safety measures to be taken.

Answers to some further exercises/activities

Further exercises for slow learners	Additional exercises for fast learners
<ol style="list-style-type: none">1. It is a path through which electric charges flow.2. Cells/battery, bulb3. Is the rate of flow of charges. Its SI unit is Amperes.	Mark student's work and guide them appropriately.

Answers

For non-numerical questions, the learners can get most of the answers from discussions given in student's book or from the internet and any other reference books. Mark the student's work and use it to guide them appropriately.

Exercise 12.2

(Student's book pages 355-356)

2. 4500 C 3. 2.67 A
4. 6.25×10^{18} 5. 3 A
6. (a) 1.2 C
(b) 1.25×10^{19} electrons

Exercise 12.3

(Student's book pages 359-360)

4. 2.5 V
7. (a) (i) 69 mV
(ii) 170 mV
(iii) 1.7 V
(iv) 0.069 V
(v) 6.9 V
(vi) 17 V

Exercise 12.4

(Student's book page 364)

2. 8Ω 3. 6 V 4. 6 V

Exercise 12.5

(Student's book page 369-370)

1. (a) 135000 J (b) 4959000 (c) 9000 V
3. (a) 0.25 A, 960
(b) 8.33 A, 28.8
4. (b) 10800 KJ
6. 21600 kJ
7. 960 W
8. 0.625 A

Exercise 12.6

(Student's book page 377)

1. 2.4 kW

Unit Test 12

(Student's book pages 388-391)

2. 0.33 A
3. 324 C
6. 64.8 C
7. 2 A
9. 0.65 A, 53.5 A
13. 10 A
17. 58 000 J

Light

Nature of Light

Unit 13

Rectilinear Propagation of Light

Student's Book pages 392-432 (10 Periods)

Key unit competence

By the end of this unit, the learner should be able to explain the nature of light, rectilinear propagation of light and reflection at plane surfaces.

Learning objectives

Knowledge and understanding

- State sources of light.
- Explain the nature of light.
- Describe transparent, translucent and opaque materials.
- Explain how light travels in a straight line.
- Describe the formation of penumbra and umbra.
- State characteristics of images formed by plane mirrors.
- State laws of reflection.
- Explain applications of reflections at plane mirrors.
- Describe images formed by a pinhole camera.
- State characteristics of images formed by pinhole camera.
- Explain applications of light reflected at plane mirror surfaces.

Skills

- Identify sources of light.
- Show that light travels in straight lines.
- Analyze the formation of penumbra and umbra.
- Illustrate penumbra and umbra using a torch.
- Describe the nature of images formed by pinhole camera.
- Explain functioning of pin-hole.
- Verify experimentally laws of reflection.
- Solve problems involving pin-hole camera and mirrors inclined at an angle.

Attitudes and values

- Appreciate light is important for seeing and photosynthesis.
- Adapt the need to report scientifically and critical thinking in

performing experiments related to light.

- Recognize light travels in straight lines.

Generic competencies addressed in this unit

- Cooperation and interpersonal relation through involving the students in the numerous activities provided in the learners book.
- Communication skills in English. This is achieved through incorporating learners in group discussions.
- Research and problem solving skills achieved through research based activities and involving the learners in problem solving activities.

Links to other subjects

Organic and inorganic (chemistry), Mirror (use in saloon).

Cross cutting issues addressed in this unit

- Environment ,climate change and sustainability through appreciating the world sources of light and nature in general.

Assessment criteria

Learner can describe sources of light and explain its propagation.

Background information

Most of the learners have experienced the nature of light and its properties in their daily lives. For instance, they have observed a beam of light rays in a dark room from an opening on the roof top of a building, they have seen a reflection of their image on a mirror

and so on. Build on these and many more familiar experience so that the learner's curiosity to learn more is boosted. Make every lesson lively and interesting by engaging learners in all practical activities. These activities will enable them to understand different concepts in this unit with ease.

Most learners are aware of the story of creation as given in the bible or any other holy books. It is therefore a good idea to introduce this unit with the creation of light as told in these holy books (bible, Koran etc)

Suggested teaching/learning activities

13.2 Nature and source of light

13.1.1 Nature of light

(1 period)

By the end of this section, the learner should be able to define light and identify different sources of light.

Information to the teacher

Activity 13.1 is a discussion activity. Therefore, ensure that learners have access, to reference books and learning materials e.g internet to facilitate their discussion.

Suggested teaching/learning materials

- Reference books, internet

Preparation

- Ask learners, to do a research in advance on nature of light and its sources from reference books in the library.

Teaching guidelines 13.1 (a)

- Ask learners to organise themselves into groups. Ensure that the groups formed comprise:
 1. Learners of different abilities i.e. **slow** and **fast** learners
 2. Learners of **different sex** i.e. both boys and girls in case it is a mixed class.
 3. **Disabled learners** in case they are among the class.
- Prompt them to realize that they need a secretary and a group leader.
- Let them use their findings from individual research to do Activity 13.1 given in student's book on nature of light and its sources.
- Allow learners to discuss in their respective groups and come up with harmonised points and let the secretaries or any other group members from each group to give a report to the whole class on their discussion.
- Let other learners contribute to each report presented and summarise the discussion by pointing out the key points i.e.
 1. Light is a form of energy that enables us and animals to see surrounding objects.
 2. There are two sources of light, luminous and non-luminous sources of light
 3. Luminous source emits light on their own e.g. sun, stars, candle flame, electric bulb etc
 4. Non-luminous do not emit light

on their own but rather reflect it e.g. tree, people, animals, moon etc.

- At this point, note the errors the learners made in their discussion and correct them. Use this chance to assess whether the objectives have been made as you conclude this part.
- This activity will promote in learners among other competencies:
 1. Cooperation and interpersonal relation as they work in groups.
 2. Research and problem solving skills as they carry out research from internet and answer questions.
 3. Communication skills in English as they articulate their points in a discussion.
 4. Leadership and organizational skills as they organise themselves into groups and lead others in a discussion.

13.2 Rays and Beams

Teaching guidelines 13.1 (b)

- Ask students to organise themselves into two groups or more depending on the availability of materials. Provide each group with a torch and other materials suggested in activity 13.2 in student's book.
- Ask them to do activity 13.2 and guide them in answering the questions in the activity. Ensure that all students whether disabled or normal are actively participating in the activity. Ensure that all students disabled and other students are

- actively participating in the activity.
- For instance, student with sight problem can be given a torch and helped to switch it on as normal student make observations.
- Summarise the discussion by pointing out that.
 1. A ray of light is the path along which light travels in a medium.
 2. A beam of light is the streams of light rays.
 3. The rays of light that meet at a point (converge) are called divergent beam.
 4. Rays that are parallel to each other are called parallel beam.
 5. Rays of light that originate from a point of light source and spread outwards are called divergent beam.
- Use question and answer method to assess whether the objectives have been attained.

This activity will promote in learners among other competencies

1. Cooperation and interpersonal relation as they work in groups.
2. Communication skills in English as they express their points during a discussion.
3. Critical thinking as they think critically when answering questions in the activity.

13.3. Transparent, translucent and opaque materials

Teaching guidelines 13.1 (c)

- Organise learners into groups of different abilities and gender (if any).
- Provide learners with the teaching/ learning materials suggested in activity 13.3 in the student's book.
- Ask them to do activity 13.3 in student's book. Note that this activity involves using the sense of sight that is not any excuse not to involve students with **sight problems**. You may ask them to hold the materials i.e. oiled piece of paper, a cardboard etc. as the normal look through them. Warn learners who might make sensitive jokes on those who have the problem. Let them know that it is not their faulty to be the way they are.
- Let them discuss in their groups whether they were able to see through the materials and suggest the general name for each material.
- Ask the secretaries or any other members of each group to present their findings to the whole class and allow other class members to contribute.
- Summarise the discussion by pointing out the following keys points:
 1. Materials e.g. clear glass that allow all light to pass through them and we are able to see clearly through them are called **transparent materials**
 2. Materials like an exercise book that totally do not allow any light to pass through them are called **opaque materials**
- Conclude the activity by asking learners to give more examples

of transparent, translucent and opaque materials as a way of assessing whether the objective has been met.

- This activity will promote in learners among other competencies
 1. Cooperation as learners work together in groups.
 2. Communication skills as learners express their points in a group discussion.

13.4 Rectilinear propagation of light

(1 period)

By the end of this section, the learner should be able to show that light travels in a straight line.

Information to the teachers

This is one of the interesting part of this unit, therefore you should do a wide research on the same to equip yourself with appropriate knowledge and skills to enable you to answer learners questions and give appropriate guidance.

Suggested teaching/learning materials

- Soft board, a plane mirror, plasticine, white sheet of paper

Preparation

- Engage the learners actively for the first $\frac{1}{2}$ of the lesson, and the other $\frac{1}{2}$ discuss with them their findings.
- This is a practical section which should be taught in one lesson. You are therefore required to assemble

all required materials suggested in advance and group them according to the number of groups you need and availability of materials.

- It is worth noting that time is not sufficient, therefore ensure that learners are informed in advance to avail themselves in the laboratory to avoid wastage of time.

Teaching guidelines 13.2

- Ask student to organise themselves into groups of different abilities and gender. Let them choose a leader and secretary (preferably those with disabilities).
- Provide the suggested teaching/learning materials suggested for activities 13.4 and 13.5 to the learners.
- Ask them to do activities 13.4 and 13.5 given in student's book.
- Ask them to have a group discussion on their observation and let the secretary write the main points.
- Ask any member of each group to present their findings from the discussion to the whole class. At this point, you can allow other members of the class to contribute to each presentation in pointing out any error or omissions.
- Summarise the discussion by emphasizing the main point i.e. the property of light rays to travel in a straight line is called rectilinear propagation of light. Use this opportunity to correct the errors made by learners in their discussion
- Conclude the discussion by

assessing whether the objective has been achieved i.e. are learners able to show that light travels on a straight line?

- This activity will help to promote in learners the following competencies.
 1. Cooperation and interpersonal relation as they work in groups.
 2. Research and problem solving skills as they carry out research from internet and answer questions.
 3. Communication skills in English as they articulate their points in a discussion.
 4. Leadership and organizational skills as they organise themselves into groups and lead others in a discussion.

Additional experiment

Take an empty can and pierce a few holes (1 or 2 mm in diameter) on all sides. In a darkroom, cover a candle flame with the can. Blow smoke (use a burning straw) or smear fire chalk dust or talcum powder around the can. We can 'see' where the light comes from and also in what direction it travels. Now the teacher can also mention about the track of light in a room and the projector in a cinema theatre.

13.5 Formation of shadows and eclipses

(3 periods)

By the end of this section, the learner should be able to analyse the formation of penumbra and umbra and illustrate them using a torch.

Suggested teaching/learning materials

- A torch, a ball, white screen, a tennis ball, 2 cardboard with a large and narrow opening

Information to the teacher

Formation of shadows and eclipses is a common occurrence in everyday life.

Therefore, you are required to equip yourself with sufficient information from objective books and internet on shadows and eclipse formation so that you can explain adequately to the learners about them.

Preparation

This section involves practical activities, including a research from the internet. You are therefore required to avail and organise all required materials suggested in advance to save on time. Ask learners to do individual research a day before the material day of research activity.

Shadows

Teaching guideline 13.3 (a)

- Ask student to organise themselves into different groups of different ability and gender. Let them choose a group leader and a secretary.
- Ask them to do Activity 13.6 provided in student's book i.e. demonstrating formation of shadows. Involve learners with disability if in case they are they. For instance, let those with sight problem place required material in place as directed by other students.

- Ask any member of each group to present their findings to the whole class and allow others to point out omissions and errors in the facts given.
- Summarise the discussion by pointing out the main point from the activity i.e.
 1. A shadow is a shade cast by an object rays of light
 2. Umbra is the region of total darkness. It is formed when an opaque object blocks the light rays.
 3. Penumbra is the region of partial darkness. It is formed by extended source of light. At this point, correct learners errors in their discussion and asses whether the objectives have been achieved.
- This activity will promote in learners among other competencies:
 1. Cooperation and interpersonal relation as they work in groups.
 2. Research and problem solving skills as they carry out research from internet and answer questions.
 3. Communication skills in English as they articulate their points in a discussion.
 4. Leadership and organizational skills as they organise themselves into groups and lead others in a discussion.

Eclipses

Teaching guidelines 13.3 (b)

- Ask learners to pair up. Prompt them to see that they require a group leader and secretary.
- Ask the group leaders from each pair to lead others in a discussion or doing activity 13.7 given in the student's book then let them discuss their findings the secretary harmonize the points. Note that this activity may be done in class during the lesson or in advance during remedial hours. This will depend on availability of time and materials.
- Ask the secretary of each group to give a report in there findings to the whole class and allow the students to contribute by pointing out any omission or errors.
- Guide them through a discussion given in the student's book and at appropriate point correct the errors the learners have made in their discussion.
- Summarise the discussion by pointing out the key points:
 1. There are two types of eclipses: solar and lunar eclipse.
 2. Solar eclipse is formed when the moon blocks the sun rays from reaching the earths surface.
 3. Lunar eclipse is formed when the earth comes between the sun and the moon hence blocking light rays from reaching the moon's surface.

- Conclude the discussion by leading learner's through a discussion given in the student's book and then ask them to do question 1 and 2 of exercise 13.1 in student's book.

Note that the fast learners will finish first, ask them to do the remaining question as you guide the slow learners then later let all of them do all questions in exercise 13.1.

13.6 Pinhole camera

(2 periods)

By the end of this section, the learner should be able to describe the nature of images, explain the functioning and solve problems involving pinhole camera.

Information to the teacher

This section involves problem solving on magnifications. You should therefore engage learners in a variety of problems from other reference books apart from those given in the student's book.

Suggested teaching/learning material

Internet, reference books, a pinhole camera

Preparation

Ensure that all required materials for research are available and ready in time.

Teaching guideline 13.4

- Ask learners to form groups and ensure that they are of different abilities and gender incase it is a mixed class.
- Let them choose a group leader

and a secretary. A group leader should lead others in a discussion of individual research as they present while the secretary harmonises the points.

- Ask any member at random, from each group to present their findings of their research. This will enable you to monitor those learners with a tendency of copying other student's work. Allow students to point out omissions or errors if any.
- Guide them in the discussion given in student's book. Use the opportunity to warn students against water pollution that may lead to loss of aquatic life.
- Summarise the discussion by pointing out the key point such as
 1. Characteristics formed by a pinhole camera are:
 - i. Real
 - ii. Inverted
 - iii. Magnified
 2. A pinhole camera has limited field focus, when its pinhole is enlarged it forms a blurred images.
 3. Magnification produced by a pinhole camera is given by

$$\text{Magnification (m)} = \frac{\text{height of the image (Im)}}{\text{height of the object (ob)}}$$

$$M = \frac{Im}{ob} = \frac{v}{u}$$

- Take the learners through a discussion and worked examples 13.1 and 13.2 on pinhole camera given in student's book .
- And ask them to do exercise 13.2 in student's book as you conclude.
- This activity will promote in the

learners among other competence:

1. Research and problem solving.
2. Cooperation and interpersonal relation.
3. Communication skills in English.

13.7 Reflection of light at plane surfaces

(1 period)

By the end of this section, the learner should be able to identify different types of reflections and state the laws of reflection.

Information to the teacher

This section involves a lot of practical activities. Ensure that all learners whether disabled or normal are actively involved in all activities so that they can achieve the specified objectives. You are also advised to take advantage of remedial hours to assist slow learners and also the normal class hours.

Suggested teaching/learning materials

- A plane mirror, different reflecting surfaces, soft board, plasticine, protractor, white sheet of paper, drawing pins, optical pins, a ray box.

Preparation

As mentioned earlier, this section consists of many practical activities. Therefore, it is a good idea you prepare all materials required for each activity in advance. Learners should be informed

in advance so that they don't waste time as they shift from another lesson.

Teacher guideline 13.5 (a)

- Ask the learners to pair up to do activity 13.9 given in the student's book.
- Provide to them the required materials i.e plane mirror.
- Ask them to do activity given in student's book i.e. to show reflection of light on a plane surface
- Guide the learners to discuss the question in activity 13.9 and let the group secretary note down the main points from their discussion.
- Ask them to do activity 13.10 on different types of reflection and activity 13.11.
- Ask the group secretaries to present their findings to the whole class and all students to contribute by pointing out omissions or errors from the discussion presented.
- Summarise the discussion by highlighting the main points such as:
 1. **Reflection** is the bouncing back of light rays when they strike a surface
 2. A ray from the source is called **incident ray**, while those from the reflecting surface is called **reflected ray**. A line perpendicular to the reflecting surface and meets at the point where incident ray strikes the surface is called the **normal**.
 3. The angle between the normal line and incident ray is called

angle of incidence, while that between the normal and reflected ray is called the **angle of reflection**.

4. There are two types of reflections: regular and diffuse reflection. Regular reflection occurs on a smooth surface while diffuse on a rough surface.
- Use this opportunity to correct errors made from learner's discussion and assess them through question and answer method to test whether the objective has been achieved as you conclude.
 - This activity will promote in learners among other competence:
 1. Cooperation and interpersonal relation as they work in groups.
 2. Research and problem solving skills as they carry out research from internet and answer questions.
 3. Communication skills in English as they articulate their points in a discussion.
 4. Leadership and organizational skills as they organise themselves into groups and lead others in a discussion.
- Ask them to do activity 13.12 given in student's book i.e. to verify the laws of reflection using optical pins.
 - Guide the learners through all steps and let the secretaries record their findings and have final results.
 - Give them a chance to discuss their findings and have final results.
 - Ask learners to do activity 13.13 i.e. verify laws of reflection using a ray box.
 - Guide them through the steps of the activities to show them the relationship between the angle of incidence and the angle of reflection.
 - Let them record their observation through their secretaries.
 - Ask the secretaries or any at member from each group to report their findings to the whole class and allow learners to point out omissions or errors from the facts presented
 - Summarise the discussion by pointing out the laws of reflection of light which state that:
 1. The incident ray, reflected ray and the normal at the point of incidence all lies on the same plane.
 2. The angle of incidence is equal to the angle of reflection.

To verify laws of reflection using optical pins

Teaching guidelines 13.5 (b)

- Organise learners into groups of different abilities and gender incase it is a mixed class and let them have a group leader and secretary.

13.8 Image formation by a plane mirror

(2 periods)

By the end of this section, the learner should be able to state characteristics of images formed by plane mirrors.

Information to the teacher

- This section involves the nature of images and problem solving of images formed by plane mirror. You are therefore advised to refer to different references so as to equip learners with a variety of questions a part from one given in the student's book.

Suggested teaching/learning materials

- Plane mirror

Preparation

Go through the worked examples and solve problem in exercise 13.3 student's book so that you are in a position of guiding the learners well before you start the lesson.

Characteristics of images formed by a plane mirror

Teacher guidelines 13.6 (a)

- Ask individual learner to do activity 13.14 given in student's book. The disabled students may stand in front of the mirror and the normal observe their images.
- Guide them to answer all the questions in the activity.
- Let them brainstorm about the characteristics of images formed by plane mirror.
- Guide learners in a discussion given in student's book.
- Summarise the discussion by pointing out the characteristics of

images formed by a plane mirror i.e.

1. The size of the image is equal to the size of the object.
 2. The image is erect.
 3. The image is virtual.
 4. The image is laterally inverted.
 5. Distance of the image is equal to that of object.
- Guide the learners through discussion on worked examples 13.3 to 13.6 given in student's book.
 - Ask learners to do question 1 of exercise 13.3. Go around and mark their work. Note that the fast learners will finish first. Let them do the rest of the questions as you guide the slow learners.

Number of images formed by a plane mirror

Teaching guidelines 13.6 (b)

- Organise learners into groups of two and ask them to do activity 13.15 given in student book i.e. to observe the number of images formed by parallel mirrors.
- Let them discuss their observations and report to the whole class.
- Guide them through the discussion given in student's book and summarise by pointing out the applications of the principle of multiple reflections i.e.
 1. Beauty parlours
 2. Tailor and barbershop

Plane mirrors inclined at an angle of 90°

Teaching guidelines 13.6 (c)

- Organise learners into pairs.
- Ask learners to do activity 13.16 given in student's book and guide them through a discussion given in the student's book.
- Summarise the discussion by pointing out that when two plane mirrors are at 90° to each other, they form 3 images. At this point, correct any error made by learners in the activity and assess whether you have achieved the objective through question and answer method.
- The activity will help to promote among other competencies
 1. Cooperation and interpersonal relation as they work in groups.
 2. Research and problem solving skills as they carry out research from internet and answer questions.
 3. Communication skills in English as they articulate their points in a discussion.
 4. Leadership and organizational skills as they organise themselves into groups and lead others in a discussion.

Two plane mirrors inclined at angle of 60°

Teaching guidelines 13.6 (d)

- Ask learners to pair up to do activity 13.17.

- Let them do activity 13.17 given in student's book pages i.e. to determine the number of images when two plane mirrors inclined at angle of 60°.
- Allow them to discuss their results and you may ask them to determine the number of images with any other angle e.g. 30°, 10° etc.
- Let them come up with a general formula determining the number of images when plane mirrors are inclined at an angle.
- Let all the secretaries or any member from each group present their findings and all students to point out omissions or errors in each presentation.
- Summarise their discussion by pointing out that:
 1. When the plane mirrors are inclined at 60°, they form 5 images.
 2. The general formula of calculating the number of images formed when two mirrors are inclined at an angle is given by
$$n = \frac{360^\circ}{\theta} - 1$$
where n is the number of images.
- At this point, correct errors made by learners in their discussions.
- Take the learners through the applications of reflection at plane surface given in student's book.
- Conclude this part by

- Assessing whether the objectives have been made through question answer method.

13.9 Application of reflection at plane surfaces

By the end of this section, the learner should be able to explain the applications of reflection at plane surfaces in real life situation.

Information to the teacher

- Like other sections, this section is equally important to learners, guide them to understand the applications of reflections on a plane surface. It is a good to read widely from different reference books including the internet to be able to guide your learners appropriately.

Suggested teaching/learning materials

- Reference books
- Internet

Preparation

Ensure that the materials required by learners to do their research are enough and ready in advance.

Teaching guidelines 13.7

- Organise learners into appropriate groups.

- Ask them to do activity 13.18 given in the student's book.
- Guide them on the discussion given in the student's book on periscope.
- Let the learners suggest other applications of reflection on the plane surface.
- Conclude this section by summarising their discussion and ask them to do exercise 13.4 given in the student's book.
- Conclude this part by
 1. Assigning learners the project work given in student book to be completed within two gives. You may provide any materials that they cannot access.
 2. Taking the learners through unit summary and ask them to do unit Test 13. Ensure that you mark their work and guide them accordingly.
- This unit will promote in the learners among other competencies
 1. Research and problem solving
 2. Cooperation and interpersonal relation
 3. Communication skills in English
 4. Critical thinking as learners come up with formula
 5. $n = \frac{360^\circ}{\theta} - 1$

Further exercises and their answers

Further exercises/activities

Remedial exercises for slow learners	Additional exercises for fast learners
<ol style="list-style-type: none"> 1. State two characteristics of images formed by a plane mirror. 2. Define reflection. 3. Name two non-luminous bodies 	<ol style="list-style-type: none"> 1. describe experiment to verify that light travel in a straight line. 2. Explain how periscope works

Answers to some further exercises/Activities

Remedial exercises for slow learners	Additional exercises for fast learners
<ol style="list-style-type: none"> 1.- image is erect - image is virtual, a drawing pin. 3. moon, stone 	

Answers

For non-numerical questions, the learners can get most of the answers from discussions given in student's book or from the internet and any other reference books. Mark the student's work and use it to guide them appropriately.

Exercise 13.2 (Student's book pages 407)

5. (a) 0.045 (b) 2 m
6. 9 cm 7. 50 cm

Exercise 13.3

(Student's book pages 418-420)

2. (a) 30° C 6. 60°

Exercise 13.4

(Student's book pages 424 - 425)

3. (a) (i) 2 (ii) 3
(iii) 5 (iv) 11

Unit test 13

(Student's book pages 428 - 430)

4. 60°
5. (a) 11 (b) 1 (c) 4 (d) 7
9. 160°
14. 20 cm