South Sudan

Secondary

Physics 2

Teacher's Guide

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Do's

1. **Please cover with plastic or paper. (old newspaper or magazines)**
2. **Please make sure you have clean hands before you use your book.**
3. **Always use a book marker do not fold the pages.**
4. **If the book is damaged please repair it as quickly as possible.**
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South Sudan

SECONDARY
2

Physics

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Part 1 Introduction

1.1 Organisation of the book

This teacher's guide is organised into two main sections; part 1 and 2.

Part 1 is the general **introduction** section detailing information on competence based curriculum and pedagogical issues.

The main elements of Part 1 are:

- **1.2: Background information to the new curriculum** - It gives a brief overview of the general requirements of the new South Sudan competence-based including the guiding principles, the competences the students are expected to acquire, cross-cutting issues to be addressed during learning and special needs education.
- **1.3: Basic requirements for an effective Physics lesson-** It highlights the teacher's and learner's roles for effective teaching/learning of Physics, teaching/learning resources, grouping learners for learning and teaching methods.

Part 2 provides a **topic to topic guide** to the teacher on how to facilitate learners to acquire the knowledge, skills and attitudes envisaged in each unit. This part is therefore structured into units.

The main elements of each unit guide are:

- **Unit heading** – This gives the unit title as stated in the syllabus.
- **Topic heading** – The units have been subdivided (by the authors) into manageable topics.
- **Learning outcomes** – This section outlines ***Knowledge and understanding***, ***Skills, Attitudes and values*** the learner is expected to achieve through his/her interaction with the concepts and activities planned for the unit.
- **Contribution to student's competences*:*** The section explains how the unit/topic will facilitate the student to acquire to the specified competences. These competences will be discussed in detail later in the next section.
- **Links to other subjects*:*** The section explains how the concepts in unit/topic link to other subject areas. This helps the teacher to understand how the unit will help the learner as he/she interacts with facts or concepts in those subject areas, or how the students can transfer knowledge from those areas to help them understand concepts in this unit.

- **Cross-cutting issues to be addressed in the unit*:*** The section outlines the specific cross-cutting issues that will be addressed through infusion as the learners do the activities and interact with concepts planed for the unit This is meant to make the teacher conscious on and be on the look out for suitable opportunities through out the teaching/learning process in the entire unit to address the cited cross-cutting issues. These issues will be discussed in detail later in this section. Note that a unit/topic may not necessarily address all the cros-scutting issues outlined in the curriculum
- **Teaching methodologies*:*** The section lists down the main teaching/learning methods that the teacher can employ in the unit/topic.
- **Attention to special needs*:*** The section guides the teacher on how to handle learners with special needs as they do the learning activities organised in the unit.
- **Background information*:*** This section outlines key knowledge, skills attitudes and values that learners need to have acquired earlier that will facilitate easier acquisition of the new knowledge, skills attitudes and values envisaged in this unit. It also guides the teacher on how to find out that the learners posses them before they start learning the concepts in this unit, and how to help learners in case they do not posses them.
- **Subtopics:** This is a list in tabular form of the structuring of the topic into subtopics
- **Suggested teaching/learning activities*:*** This section provides guidance to the teacher on how to facilitate students to learn by doing the activities outlined in the student's book. It also guides the teacher on how to assess the learning.

The guidance for each subtopic is structured as follows:

Subtopic title

Specific learning outcome

Teaching guidelines for the activity

Assessment

1.2 Background information on the new curriculum

The aim of the South Sudan Competence-based Curriculum is to develop in the learners competences that will enable them interact with the environment in more practical ways.

It clearly defines the **knowledge, skills** and **attitudes** that the learner should acquire by doing the specified learning activities.

Student's competences

Competencies are statements of the characteristics that students should demonstrate, which indicate they have the ability to do something to the required level of performance.

The following are the four competencies envisaged in this curriculum:.

(i) Critical and creative thinking

Physics lessons and activities facilitate learners to acquire these competences by giving then opportunities to:

- Plan and carry out investigations, using a range of sources to find information.
- Sort and analyse information and come to conclusions.
- Suggest and develop solutions to problems, using their imaginations to create new approaches.
- Evaluate different suggested solutions.

(ii) Communication skills

Physics lessons and activities facilitate learners to acquire these competences by giving them opportunities to:

- Read and comprehend critically a variety of types and forms of texts during research activities.
- Write reports on scientific investigations and activities.
- Speak clearly and communicate ideas and science related information coherently.
- Listen and comprehend scientific facts presented by fellow classmates, group members, teachers and resource persons.
- Use a range of media, technologies and languages to communicate messages, ideas and opinions.

(iii) Cooperation and interpersonal skills

Physics lessons and activities facilitate learners to acquire these competences by giving them opportunities to:

- Work collaboratively towards common objectives when doing activities.
- Be tolerant of others and respectful when differing views and working together.
- Adapt behaviour to suit different situations
- Negotiate, respect others' rights and responsibilities, and use strategies to resolve disputes and conflicts.
- Contribute to environmental sustainability.

(iv) Culture and identity

Physics lessons and activities facilitate learners to acquire these competences by allowing them to

- Take pride in South Sudanese identity and the diverse nature of South Sudanese society.

- Build understanding of South Sudanese heritage in relation to the wider world.
- Appreciate and contribute to the development of South Sudanese culture.
- Value diversity and respect people of different races, faiths, communities, cultures, and those with disabilities.

(b) Cross-cutting issues to be addressed during learning

These are issues that are of high national priority and hence have been incorporated in the learning process. The three cross-cutting issues for that should be addressed through the teaching/learning process are:

(i) Environment and sustainability

A well-conserved environment is obviously key to our health and survival. It is therefore important for the Physics teacher to make use of the opportunities that arise in the process of teaching and learning Physics through activities to sensitise learners on the importance of conserving the environment. One way is by ensuring that the learners always dispose off the waste materials at the end of an activity in ways that do not pollute the environment.

(ii) Peace education

Peace is critical for a society to flourish and for every individual to focus on personal and national development.

The teacher of Physics teacher needs to be in the fore front in educating his/her students on the need for peace, for example by encouraging group work activities and showing them ways of solving interpersonal problems peacefully that occasionally arise during interactions and discussions.

(iii) Life Skills

Learners need to progressively acquire some skills abilities and behaviours that will help them effectively deal with the events and challenges of everyday life. Such skills include first aid, communication skills, conflict resolution, basic ICT skills etc. The physics teacher should as much as possible facilitate the learners to acquire these skills whenever an opportunity arises in the lesson execution.

(c) Special needs education and inclusivity

All South Sudanese children have the right to access education regardless of their physical and physiological challenges. The physics teacher therefore is required to consider each learner's needs during the teaching and learning process. Assessment strategies and conditions should also be tailored to accommodate the needs of all learners.

The following are the most common categories of special needs in learners:

- Physical challenges
- Visual challenges
- Hearing challenges
- Mental challenges

The teacher should identify such cases and help facilitate the affected learners in learning. For example, learners 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.

(i) Learners with Physical challenges

These are learners, who have some of their body parts not able to function normally due to Physical problems. For example, some learners have partial or total incapacitation in the use of limbs or hands. In such cases, the learners will need assistance during activities that involve movement. This could be during field excursions and other activities that learners have to stand for some reason. The teacher should organize for the learner's ease of movement. 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.

(ii) Learners with visual challenges

These learners have problems with their eyesight. The may be long sighted, short sighted or have some eye sicknesses. They should sit at a position where they are able to see the chalkboard without straining.

The material to be observed should be brought to appropriate location where these learners can be able to see. The magnifying glasses can be 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.

The teacher should read aloud most of the things he/she writes on the chalkboard. Other learners can also assist by reading aloud. The lighting system in the classroom should also be improved.

(iii) Learners with hearing challenges

The affected part in this case is the ear. The learner can 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. The teacher should also use gestures and signs while talking to such learners and figure out what he/she is saying.

(iv) Learners with speech challenges

One of the most common speech challenges is stammering. Such learners speak with many difficulties. The teacher should be patient with them and encourage them to express themselves in their own way. Such learners should be given more written exercises.

(v) Learners with mental challenges

The teacher should identify the nature and level of the mental difficulty with such learners. Such learners should then be given special assistance and attention at individual levels. They can be given special tests or assessments.

In general, all the learners with difficulties should be well facilitated. 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, the 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'.***

Treat them fairly but not with undue favours.

1.3: Basic requirements for an effective Physics lesson

1.3.1 Teacher's role and basic skills for effective Physics lesson

The teacher is the most important resource for an effective Physics lesson.

(a) Some of the key roles of the Physics teacher include:

- Organising the classroom to create a suitable learning environment.
- Preparing appropriate materials for learning activities.
- Engaging students in variety of learning activities.
- Encouraging and accepting student autonomy and initiative.
- Allowing student responses to drive lessons, shift instructional strategies,.
- 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.
- Using a variety of teaching and assessment methods.
- Adjusting instructions to the level of the learner.

- Nurturing students' natural curiosity.
- Motivating learners to make them ready for learning.
- Co-ordinate 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.

(b) Some of the key skills that the S2 Physics teacher should have include:

- Creativity and innovation.
- Makes connections/relations with other subjects.
- A high level of knowledge of the content.
- Effective disciplining skills to adequately manage the classroom
- Good communication skills.
- Guidance and counselling skills.

1.3.2 Learner's role in learning Physics

Learning takes place only when the learner acquires the intended knowledge, skills and attitudes. As such, learning is a highly personal and individual process. Thus, a learner must be actively engaged in the learning exercise.

For active participation in learning, the learner should:

- Raise questions about what is observed.
- Suggest solutions to the problems observed.
- Take part in planning investigations with appropriate controls to answer specific questions.
- Carry out investigations to search for answers with the help of materials in search of patterns and relationships while looking for solutions to problems.
- Working collaboratively with others, communicating their own ideas and considering others' ideas.
- Expressing themselves using appropriate Physics terms and representations in writing and talk.
- Engaging in lively public discussions in defence of their work and explanations.
- Applying their learning in real-life contexts.
- Reflecting critically about the processes and outcomes of their inquiries.

1.3.3: Teaching/learning 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
- Physics models
- Resource persons
- Firms such as hydroelectric power stations, engineering firms among others

(a) Classroom as a learning environment

A 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.

Classroom organisation

It is important for the teacher to make the classroom an attractive and stimulating environment. This can be done by:

- Carefully arranging the furniture in the classroom in an organised way. To allow free movement of learners and the teacher.
- Putting up learning and teaching aids on the walls. Examples are wall charts, pictures and photographs.
- Displaying teaching models.
- Providing objects for play for example toys.
- Having a display corner in the classroom where learners display their work.
- Setting a corner for storing materials so as not to obstruct learners or distract them.
- Spreading out the learners evenly so that they do not interfere with one another's activities.
- Setting up the materials for the series of lessons or activities going on for a number of days or weeks in a location where they do not interfere with other daily activities
- Organizing the sitting arrangement such that learners face the lighted areas of the room.
- Choosing the most appropriate location for the teacher and the chalkboard such that they are visible to all learners and the teacher has a good view of all learners in the class.

(b) Apparatus and materials

For learners to study Physics 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:

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

Since Physics is highly practical subject, materials help the teacher to convey his/ her points, information or develop skills simply and clearly, and to achieve desired results much faster.

Some of the materials that a teacher requires for Physics activities and calculations can be collected from the local environment.

Many others can be improvised while some have to be purchased. Whether collected, improvised or purchased, there are certain materials that are valuable to have around almost all the time.

These include:

(i) 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 requirement

(ii) 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 of Physics models include models of electric motors, hydraulic systems among others. Schools for use can purchase these models during Physics activities.

(iii) 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 organize 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.

(iv) Improvisation

If each learner is to have a chance of experimenting, cheap resources must be made available. 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.

(vi) Scheduling learning activities and venues

Some of the activities are suggested in the student's good planning and scheduling in order to get accurate results. An example is observing some effects of environmental factors on plant growth illustrated in unit 14. The teacher should therefore think ahead while making the scheme of work so that the prevailing weather pattern and the most appropriate timing are considered.

1.3.4 Grouping learners for learning activities

Most of the Physics activities suggested in the student's book are carried out in groups 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.

Learning grouping can be formed based on one or a number of the following considerations:

- Similar ability grouping
- Mixed ability grouping
- Similar interests grouping
- Common needs grouping.
- Friendship grouping.
- Sex-based grouping.

Grouping learners in a Physics class has several advantages that include:

- The individual learner's progress and needs can easily be observed.
- The teacher-learner relationship is enhanced.
- A teacher can easily attend to the needs and problems of a small group.
- Materials that were inadequate for individual work can now be easily shared.
- Learners can learn from one another.
- Co-operation among learners can easily be developed.
- 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.
- Learners' creativity, responsibility and leadership skills can easily be developed.
- Learners can work at their own pace.

The type of "grouping" that a teacher may choose may be dictated by:

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

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.

1.3.5: Teaching methods

There are a variety of possible methods 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/Research

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.
- Skills, attitudes and knowledge to be learned.
- Learning and teaching aids available.
- Local environment.
- Teacher's personal preference
- Prevailing weather condition.
- Requirements of Physics 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, in a 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.

This is the most preferred method of teaching in the implementation of competency-based curriculum.

(c) Group/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/her questions so that learners are prompted to think and express their ideas freely, but along a desired line of thought. The method leads learners from the known to unknown in a logical sequence; and works well with small groups. The method boosts confidence in learners and improve interpersonal and communication skills.

The main 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. It may give them more confident learners a chance to dominate the others.

(d) Project method

In this approach, the teacher organizes 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 main disadvantage of this method is that 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 activity.
- 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.

1.4 Assessment

What is assessment?

"Assessment is the process of gathering and discussing information from multiple and diverse sources in order to develop a deep understanding of what students know, understand, and can do with their knowledge as a result of their educational experiences; the process culminates when assessment results are used to improve subsequent learning.

Categories of assessment

There are two categories of assessment:

- Formative assessment
- Summative assessment

Formative assessment

Formative assessment refers to the range of formal and informal assessment procedures undertaken by teachers in the classroom as an integral part of the normal teaching and learning process in order to conduct in-process evaluations of student comprehension, learning needs, and academic progress during a lesson, unit, or course. Therefore, formative assessment is diagnostic as opposed to evaluative.

The feedback obtained through formative assessment helps the teacher to:

- Gauge learners' progress, achievement and learning needs; and make immediate intervention to intervene to improve student attainment.

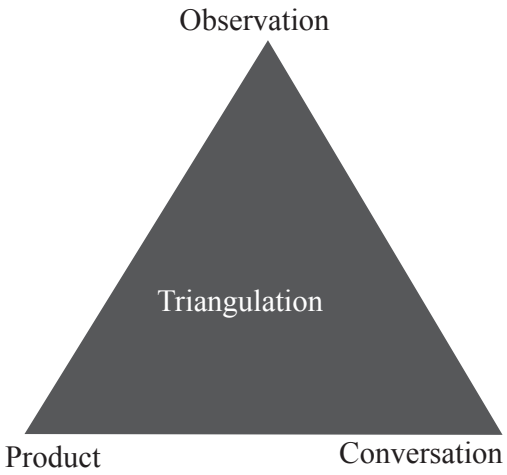
- Modify the teaching activities and instruction in order to enhance learners' achievement of learning objectives.

Opportunities for formative assessment occur in three forms.

Dr Anne Davies (Making Classroom Assessment Work 2011) called these three forms:

- **Observation** – watching students working (good for assessing skills).
- **Conversation** – asking questions and talking to students (good for assessing knowledge and understanding).
- **Product** – appraising the student's work (writing, science report, math calculation, presentation, map, diagram, model, drawing, painting etc). In this context, a "product" is seen as something physical and permanent that the teacher can keep and look at, not something that the student says.

When all three are used, the information can be checked against the other two forms of assessment opportunity. This is often referred to as "triangulation".



Triangulation of assesment opportunities

These opportunities can be found in the "Learn About' sections of each syllabus unit. The section describes the learning that is expected and in doing so, it set out a range of opportunities for the three forms of opportunity.

Summative assessment

This type of assessment is carried out at the end a defined instructional period like a project, unit, course, semester, program, or school year to evaluate the student's acquisition of knowledge and skills, academic achievement; and evaluate the effectiveness of

educational programs, measure progress toward improvement goals, or make course-placement decisions, among other possible applications.

The students achievement is compared to some standard or benchmark.

- Examples of formative assessment include:
- End-of-unit or chapter tests.
- End-of-term or semester tests.
- Standardized tests
- Final projects

Summative-assessment results are usually recorded as scores or grades into a student's permanent academic record e.g. a report card or test scores used in the college-admissions process.

Part 2 Topic to topic guide

UNIT 1

Behaviour of light at curved surfaces

Topics in the unit

Topic 1: Reflection of light at curved surfaces

Topic 2: Refraction of light in thin lenses

Learn about	Key inquiry questions
Learners should revisit their prior learning about light and through practical investigation in pairs and groups they should develop their understanding about the behaviour of light at curved surfaces, the application of laws of reflection on curved surfaces, identify concave and convex mirrors, define and calculate the focal length, principal axis, principal focus, centre of curvature and radius of curvature of curved mirrors. They should investigate how images are formed by curved mirrors; distinguish between different types of images and their locations. Learners should construct images formed by curved mirrors using ray diagrams, carry out investigations to determine the focal point of the curved mirrors and construct a simple telescope from curved mirror. They will learn to design and carry out investigation to demonstrate how images of objects are formed for different positions from the mirror and carry out calculations using mirror formula to determine focal length, image distance, object distance and magnification.	• How images are formed by curved surfaces and why are they different from those formed by plane surfaces? • Why are curved mirrors important? • Why are curved surfaces used in reflecting Telescope and Parabolic mirrors?

Learning outcomes		
Knowledge and understanding	Skills	Attitudes
• Understand the behaviour of light at curved surfaces	• Determine the focal point of curved mirrors and design a simple telescope from curved mirror: • Observe carefully • Predict what might happen • Use appropriate measures • Collect and present results appropriate in writing or drawing • Interpret results accurately • Report findings appropriately • Construct images formed curved mirrors using ray diagrams.	• Show curiosity in carrying experiments.

Contribution to student competencies

1. Creative and critical thinking

To achieve this in learners, involve them practical activities provided in this unit. They develop experimental set ups by themselves and then critically investigate and identify focal point, object distance, image distance and also solve problems involving mirrors and thin lenses. Ask them critical questions during learning process. And by doing so, they will acquire creative and critical thinking skills to solve problems in real life situations.

2. Communication and cooperation

To develop communication skills and cooperation in learners, ask them questions, allow them to answer questions from you and also from other students. During group work activities, let learners ask themselves questions, answer questions and consult with the teacher. By doing so, they develop communication skills and co-operation to work as a team.

Links to other subjects

1. **Mathematics**- learners are involved in solving problems involving calculations of quantities such as focal point, object distance, image distance, magnification and others hence linking the topic to Mathematics.
2. **Biology**- some of the applications of mirrors are in hospitals. For instance, dentists use curved mirrors to examine the patient's teeth before treatment, lab technicians use microscopes to examine specimens etc.
3. **Chemistry**- the processes applied in manufacturing the mirrors and thin lenses used in this topic are borrowed from Chemistry.

Cross-cutting issues to addressed

- **Gender:**
  i. Form groups comprising both genders.
  ii. Make sure you distribute your question to both sexes.
  iii. Avoid negative comments that either sex will be misinterpreted for example glasses are common to women for beauty reasons.
- **Peace and values education** – lenses should not be used to burn others by focusing rays from the sun on bodies of other students.
- **Financial education**- The unit deals with instruments such as microscopes that are costly to replace once it has been broken done. Caution learners to handle them with a lot of care.
- **Comprehensive safety measures** in everyday's life activities. First aid measures are broadly discussed and well elaborated.

Attention to special educational needs

- This unit involves the use of the eyes to study refraction of light. Take care of the students with sight problem. Give them more attention during and after the various activities suggested in the student book. Act innovatively depending on the sight problem concerned.
- Some of the questions in the exercises can be given to gifted learners. Prepare additional more challenging questions for them learners. (See remedial questions for gifted learners at the end of this Teacher's guide unit).
- For more guidance about attention to special needs students, refer to the introduction part of this teacher's guide.

Topic 1 Reflection of light at curved surfaces

(Student's book page 2-32)

Background information and/or prior knowledge

In our daily life we use curved mirrors in many ways. For instance side mirrors of a car are curved mirrors that enable a driver to see clearly overtaking vehicles and whatever that is behind of a car while driving.

In Secondary 1, the learners learnt about reflection at plane surfaces. In this unit they will learn about reflection of light at curved surfaces. Most curved mirrors are curved surfaces. The most common non-spherical type are parabolic reflectors, found in optical devices such as reflecting telescopes .This unit therefore will help the learners to understand how images are formed on these surfaces. Engage learners in practical activities with a view of making them appreciate and understand the effects and applications of reflections at curved mirrors.

Introduce the topic by reviewing what they learnt about reflection in the previous class by asking them some of the following questions about the meaning of reflection, reflection at plane surfaces and so on.

Subtopics

Subtopic no.	Name of Subtopic
1	Reflection of light at curved surfaces
2	Application of laws of reflection at curved surfaces
3	Terms used in concave and convex mirrors
4	Image formation by spherical mirrors
5	Locating images by construction
6	Equations of curved mirrors and magnification
7	Applications of curved reflecting surfaces

Suggested teaching/learning activities

1.1 Reflection of light at shiny curved surfaces

Specific learning outcome

By the end of this section, the learner should be able to:

i. *Demonstrate reflection of light at curved surfaces; concave mirrors, convex mirrors, and parabolic mirrors.*

ii. Explain reflection of light at curved surfaces.

Teaching guidelines for Activity 1.1

- Before the lesson, assemble all the required materials for this activity. Make sure that all the learners are able to access all of the materials in their respective groups.
- In case curved mirrors are not enough; improvise some from the locally available materials such shiny surfaces, for example, shiny spoons, side mirrors of a bicycle and others.
- In groups, ensure learners observe the spoons and note down their observations. They then polish both sides. Ask them to classify the two sides of the spoons. Are they able to differentiate the two images?
- After this classroom activity, most learners will do this activity at home. Some spoons they will use may not produce clear images. Therefore it is good to advise them to use new spoons in doing this activity. New spoons will give them clear images and make the activity interesting and more engaging!
- Ask them to observe Fig. 1.1 and 1.2 provided in the learner's book demonstrating the three shapes of curved mirrors. These curved surfaces are made from highly polished metals or glass.
- Give them an opportunity to answer the following questions:
  1. What is a concave mirror?
  2. What is a convex mirror?
- Allow them to explain their findings by giving each group an opportunity to present their work in a class discussion.
- **Caution:** while they are using the mirrors, spoons and other materials, remind them to be careful not to break them. They will need them in the next lesson.
- The real behaviour of rays at curved mirrors falls short of the ideal of passing through images exactly. Students will see this and learn a little about correcting for that 'aberration'. The ray optics equipment suggested in these activities looks simple, but some practical skill is needed to get the best out of it. Teaching guidelines provided in each activity will help you ask the right questions of students struggling to get results.
- You will be better prepared for student questions if you try out the experiments carefully beforehand. It is also advisable to read other textbooks that go beyond what students need to know for understanding purposes. For example, knowing that the minimum distance of the object and its real image from a concave mirror is zero and this occurs when the distance between the object and the mirror is equal to twice the focal length.

As well as for a converging lens, the minimum distance between the object and image is four times, the focal length. This will enable you to choose a lens that suits the length of a demonstration bench.

Assessment

Observation

- During the activity, supervise their work and ensure that every learner is able to access a spoon and a curved mirror. While they are doing the activity in groups, some may not be participating nor following. Ensure every learner is actively participating.
- Some of the expected observations the learner is expected to observe are: a spoon has two shiny surfaces of which both of them are curved and they reflect light.

  One side forms a big image whereas the other one forms a smaller image. Check whether learners are able to observe the above observations and note them down in their note books.
- Are they able to see their images of their faces in the spoons?
- Are they are able to identify and classify the curved surfaces of a spoon or curved mirrors? Help those with difficulties.

Conversation

- During group or class discussion ask learners to answer questions about the activity in the student's book. Some of the questions you can use to check their understanding are:
  1. Are they able to explain the meaning of a concave and convex mirror?
  2. How does light behave when it strikes the two curved surfaces?
  3. Why are the images different in size after reflection in both sides of the spoon?
- Give them an opportunity to answer the above questions.
- Evaluate each presentation and guide them appropriately. Again during classroom discussion ensure everyone is actively participating.

Product

- After the activity and discussion, evaluate their observations, drawings, presentations and reports to check their understanding. Guide and correct them appropriately.
- Give them further exercises on reflection at curved mirrors from other supplementary books and reference materials as home work. Mark their work and guide them where necessary.

1.2 Application of Laws of reflection at curved surfaces

Specific learning outcome

By the end of this section, the learner should be able to verify the two laws of reflection and explain how they are applied in reflection at curved mirrors.

Teaching guidelines for Activity 1.2

- Improvise some of the readily available materials for this activity. For example you can use a shinny surface of a serving spoon instead of a curved of mirror.
- Before starting the activity, ask the learners to be keener in performing the activity, as a lot of accuracy is needed for accurate constructions and results. To avoid parallax errors, the eye should be placed such that the line of view is perpendicular to the scale ruler.
- **Caution** them to be careful with the pins not to injure themselves.
- Experimental physics motivates teachers and students to create new techniques and apparatus and to use them to demonstrate both old and new ideas. It is impossible, therefore, to anticipate all of the specific hazards that might arise in the study of physics. While it is not desirable to eliminate creativity in the interest of safety, as a teacher temper their creativity with a constant alertness to potential dangers. Common sense can go a long way towards providing a safe environment. This applies in this activity and others in the process of learning.
- Ask the learners to always keep their eyes along the plane of the paper and in a convenient position look into to the mirror before sticking the pins. Ask them to follow all the steps stated to the latter, and then later measure focal length, radius of curvature and the focal length. Ensure they draw the ray diagram of the reflection.
- Ensure learners discuss the findings and observations amongst themselves, and then present the findings of their groups to the whole class. Allow other members to contribute in pointing out errors and adding any omission to the presented facts.
- Many ray boxes of traditional design become very hot after a lesson of use. Warn students provide with them the heat-resistant gloves or cloths if they need to handle the ray box when still hot.
- After the discussion, let each group to present the findings to the whole class. Guide them appropriately pointing out the key facts.

- Ask them the following questions:
    1. State the two laws of reflections.
    2. How are the laws of reflection applied in reflection at curved surfaces?

Assessment

Observation

- During the activity, one of the objective is learners are able to observe and note down the observations. To achieve this some of the questions and objectives you should ask yourself are:
- Are learners able to observe the converging or diverging rays at a point after reflection at curved surfaces? Some will or may and others may not! So as teacher it is good to go round the class supervise the each group work activity to ensure they observe the expected observations.
- Supervise their work and guide those who are not able to observe the expected observations.

Conversation

- Guide learners to discuss the findings and observations amongst themselves. During the discussion, ask them question about laws of reflection. This will improve their communication skills and critical thinking.
- Are they able to state the laws of reflection?
- Are they able to explain the application of laws of reflection at curved surfaces?
- Evaluate their answers and presentations and guide them appropriately. Ensure everyone is participating.

Product

- Check their drawings, evaluate their answers and guide them appropriately.
- Prompt them to attempt further exercises on reflection at curved mirrors from other supplementary books and reference materials. Check their work and mark it accordingly.

1.3 Reflection terms used in concave and convex mirrors

Specific learning outcome

By the end of this section, the learner should be able to state and explain all the terms used in reflection at curved mirrors.

Teaching guidelines for Activity 1.3

- Before the activity, take the learners through the terms used in concave and convex mirrors. Use Fig. 1.5 to help them identify the location of these terms as used in curved mirrors.
- If learners wear spectacles for reading it is best to keep them on for this experiment.
- Take the learners outside the classroom, where there is sunlight. Let them point the concave mirror towards the sun and bring the matchstick in front the mirror. Then allow them to move the concave mirror away from the stick up to a point where a white spot is formed on the head of the stick. Ask the learners to make observation and present to the class. Then let them observe Fig. 1.6 in the learners' book that shows the real principal focus.
- **Caution**: this activity involves burning of papers. Ensure learners do not burn themselves.
- Guide the learners further through Fig. 1.7 showing the virtual principal focus formed by a convex mirror. They then study Fig. 1.8 stating the relationship between the radius of curvature, r, and the focal length, f, of a curved mirror. $r = 2f$
- Ask the learners to study Fig. 1.9 and Fig. 1.10 showing paraxial & marginal rays and caustic curve respectively.
- Ask the learners to study Fig. 1.11 showing how caustic curve can be reduced through the cutting off the marginal rays. Also, let them study Fig. 1.12 on the focal plane of a concave mirror.
- Remind them to write down their observations during group discussions.
- Give each group an opportunity to present their findings and results in a class presentation. Are they able to explain terms used in curved mirrors?

Assessment

Observation

- Are learners able to observe the focal point of the concave mirror? Help those who have difficulties to note the observations.

Conversation

- Ask them to present their findings in a class discussion. During the discussion, let them answer questions in the student's book about the activity.
- Are they able to explain and identify points of curved mirrors?
- Are able to explain the meaning of focal point, radius of curvature, principal focus and centre of curvature? Guide them where necessary.

Product

- Mark their results, observations and their answers from the activity above.
- Give them further exercises on reflection at curved mirrors.

1.3.2 Experiments for measuring the focal length of a concave mirror

Specific learning outcome

By the end of this section, the learner should be able to describe and explain the principal focus of a curved mirror.

Teaching guidelines for activity 1.3-1.5

- With the same groups from the previous activity, ask learners to do Activity 1.4. Here, guide the learners through the determination of the focal length of a concave mirror using an illuminated object placed at the centre of curvature of the mirror.
- Guide the learners in setting up the apparatus appropriately and through all the steps stated within the activity as they follow the setup in Fig. 1.6. Here, they have to move the mirror back and forth up to a point when a clear image is formed on the screen adjacent to the object.
- In this experiment and others, darkness is necessary for clear observations. In case, there is no a dark room in the school, tell the learners to close the windows, doors, and then cover them with curtains to create darkness during the experiment.
- To achieve the accurate and best results advise the learners to be extra careful, use 30 cm rulers to draw the ray and avoid parallax when reading the points!
- Ensure learners to measure the distance between the pole of the mirror and the screen. Prompt them to discover that this distance is the ***radius of curvature*** of the mirror while half of this distance is the ***focal length*** of the mirror.
- Lead them to do Activity 1.4 on the determination of the focal length of a concave mirror using an optical pin. After setting up the experiment, ask the learners to measure the distance between the pin and the pole of the mirror.

- Ask them to do the investigation in Activity 1.5. This is an investigation. Your role as a teacher is to guide and facilitate for the investigation. Let learners design and conduct the investigation on their own. While facilitating ensure guide them where necessary.

Assessment

Observation

- Are they able to realize and note that half the distances is equal to the focal length of the mirror?
- Ensure learners discover that, half the ***radius of curvature*** of a mirror is equal to it is the ***focal length.***
- Lead them to discover other observations.

Conversation

- Ask them to explain the results of activity 1.4-1.6 in the student's book.
- Lead them through a class discussion to discuss their findings and results.
- Are they able to determine focal length of a concave mirror?
- Guide them appropriately.

Product

- Mark the values of focal length obtained during the activity.
- Are the values correct? Guide them accordingly.
- Give them further exercises on principal focus and focal length of a curved mirror.

1.4 Image formation by spherical mirrors

1.4.1 Properties of images formed by a concave mirror

Specific learning outcome

By the end of this section, the learner should be able to determine the characteristics and properties of images formed by concave mirrors.

Teaching guidelines for activity 1.6

- Supervise learners to set up the activity appropriately by varying the positions of the objects, at infinity, beyond C and between F and C. Ask them to make observations and note them down.

- You might choose to have all learners, in groups, doing just each of the activities one by one. Alternatively, assign each group to investigate images formed at specific point then they present their findings in a class discussion to reduce the amount of time spent in performing the activities (if materials are enough).
- It is good to remind the learners that to achieve the accurate and best results they need to be extra careful, use 30 cm rulers to draw the rays and avoid parallax when reading the points!
- Ensure they conduct a discussion within their groups of their observation and ask the group leader to note down the points discussed.
- Ask the group leaders or any other member from the groups to present their findings to the whole class and allow other members to contribute in pointing out errors and adding any omission to the presented facts. Correct them where they go wrong.
- Learners will find the idea of a ***virtual image*** more difficult than that of a real image. Some are helped by being shown a plane mirror forming a virtual image. This is not always as helpful as teachers hope since, to a learner, the plane mirror acts in quite a different way from a transparent mirror. So offer a plane mirror demonstration only as a tentative help to those who are having great difficulty. You might use the following instruction. "Hold the curved mirror close to your eye, with your thumb at the right place for looking at it. Whip the lens away and see whether you can see your thumb. Without the mirror, your thumb is too close for you to look at and see comfortably at that distance. Now put the mirror back. You can see your thumb comfortably and it looks big. Ask them:

  Where must the image be? What is the range of places for objects that you can see comfortably? It is from about 25 cm in front of you to right out away at 'infinity'. Where must that image of your thumb be when you can see it comfortably with this magnifying glass? The image you are looking at must be out in front of you, like anything else your eyes can see comfortably. It must be on the same side of the mirror as your thumb, but further away. We call that ***a virtual image***, one that the rays of light seem to come from, but do not actually pass through. You cannot catch that image on a piece of paper or screen."

Assessment

Observation

- Watch learners to observe and discover characteristics of images formed at different positions by the mirrors in activity 1.7 in the student's book.
- Are they able to observe the characteristics of images formed at different positions by a concave mirror? Help them where necessary.

Conversation

- In groups let them discuss and explain the various properties of images formed by a concave mirror in the above activity. Supervise their discussion and guide them appropriately.
- Ensure every learner is actively participating.
- Are they able to state and explain the characteristics of images formed at different positions?
- Ask them to present their findings in a class discussion.

Product

- Mark their drawings, characteristics and properties of images formed by concave mirrors.
- Give them homework to attempt further exercises on the characteristics and properties of images formed by concave mirrors. Mark their work and correct it accordingly.

1.5 Locating images by construction

Specific learning outcome

By the end of this section, the learner should be able to be able to locate images formed by curved mirrors by construction.

Teaching guidelines for Activity 1.7

- Using the properties of images formed by curved mirrors let them use them in making various constructions as a guided in the student book. They have to put into consideration that the angle of reflection is equal to the incidence angle. In addition, an incident ray that is parallel to the principal axis is reflected through F in a concave mirror while in a convex mirror, the reflected ray appear to come from F, Fig. 1.19.
- Take the learners through the four rules of construction in Figures 1.20 to 1.21 in the learners' book. Then guide them through the construction of the image using a concave mirrors at different positions as shown if Figures 1.22 to 1.30 in the learners' book.

- This section involves constructions. Remind and emphasize to the learners they have to be careful, sharpen their pencils and use 30 cm rulers to draw and construct the ray diagrams.
- Prompt them to do activities on locating images by construction. *At infinity, beyond C, at C, between C and F, at F, between F and P* for both concave and convex mirrors
- Are their constructions correct and accurate?
- Again learners will find the idea of a ***virtual image*** more difficult than that of a real image. Use the practical example discussed to explain to them to understand.

Assessment

Observation

- Are learners able to locate the images by construction?
- Guide learners to locate images by construction when an object at different positions as explained in the student's book. Assist them where necessary.
- Ensure every learner is actively participating.

Conversation

- Are learners able to locate images formed by curved mirrors by construction?
- Ask them to discuss and compare their constructions in locating images formed by curved mirrors.
- Ensure they construct accurate diagrams.
- Ask them to discuss example 1.1 in the learner's book.
- Check their work and assist those with difficulties.

Product

- Check their work and assist those with difficulties.
- Are their constructions correct and accurate?
- Help them to construct accurate diagrams.
- Prompt them to attempt further exercises on the locating the images formed by curved mirrors.

1.6 Equations and magnification of curved mirrors

Specific learning outcome

By the end of this section, the learner should be able to:

i. Derive all the curved mirror equation and magnification equation.

*ii. To solve all the mathematical problems invo*lving curved mirror equations.

Teaching guidelines

- Guide them through the various ways of relating the main equation with the others. Curved mirrors equation and magnification equation.
- Ask learners to derive all the curved mirrors equations and use them to solve the mathematical problems involving curved mirrors.
- Learners will find difficulties in deriving the equations, use mathematical concepts to assist those with difficulties.
- Guide the learners through Examples 1.2 to 1.5 in the learners' book. These examples will help the learners to be able to handle all the mathematical problems involving curved mirrors and magnification.
- Later, guide the learners through group discussions to solve problems involving mirror equations.

Assessment

Observation

- While taking them through Examples 1.2 and others in the learners' book, learners to observe and ask questions as the workings progress.
- Ensure every learner is actively participating.

Conversation

- Ask learners to derive all the curved mirrors equations and use them to solve the mathematical problems involving curved mirrors.
- Learners to discuss and discover applications of curved mirrors.
- Learners to discuss example 1.3 and the rest in the student's book.
- Ask them to present their findings in a class discussion.
- Ask them oral questions about the curved mirror equations and correct them where they answer wrongly.

Product

- Check their constructions.
- Are they correct and accurate?
- Help those who may have difficulties to construct them accurately.
- Give them homework to attempt questions involving mirrors equation and magnification in the Unit test 1. Mark their work and give them further exercises of the same.

1.7 Applications of curved reflecting surfaces

Specific learning outcome

By the end of this section, the learner should be able to explain applications of curved mirrors.

Teaching guidelines

- Learners have come across some of the applications of curved mirrors in real life. Use familiar applications to explain some of them. For example side mirrors of a car or motorbike.
- They then present their findings in a class presentation. Involve each of them to contribute their findings in a class discussion. That is to explain applications of curved reflecting surfaces. Here the learners should be able to tell some of the areas where the curved mirrors are used in making work easier. For instance, solar concentrators, side mirrors of a car, telescope and parabolic dish aerial, which are some of the areas where curved surfaces have been applied.
- For those applications that they are not able to find out, take this chance to explain and guide them through the various applications of curved reflecting surfaces. Concave, parabolic and convex mirrors.
- Guide the learners through the Unit project in the learner's book.

Assessment

Observation

- Provide them with some of the applications of curved mirrors to observe. For example side mirrors of a car and others.
- Ensure they observe and explain the applications of curved mirrors and curved surfaces and ensure everyone is actively participating.

Conversation

- Learners to research on applications of curved mirrors.
- Ask them present their findings in a class discussion.
- Evaluate their answers and presentations and guide them appropriately. Ensure everyone is participating.

Product

- Check their reports and correct them appropriately.
- Ask them oral questions about application of curved mirrors and curved surfaces.
- Are they able to state and explain the applications of curved mirrors?
- Guide the learners through the Unit project in the learner's book.

Answers to numerical questions

Topic test 1

4. D

12. V = 15 cm

    h = 3 cm

15. b 1.5 cm

16. 10 cm

21. a. (i) 20 cm (ii) 0.33 (b) (ii) 3

22. v = –24 cm

    m = 1.3

23. 58.6 cm

Topic 2 Refraction of light in thin lenses

(Student's book page 33-72)

Background information and/or prior knowledge

Learners have come across thin lenses in real life. For example, some learners use glasses. Use this example to introduce the topic. In that, the glasses have lenses that enable one to see things clearly. It could be short sightedness or long sightedness. Use this example and any other example such as microscope from Biology laboratory to make the topic interesting and easy to understand. Involve learners in more practical activities.

This topic is not new to the learners. In secondary one, learners learnt about refraction. Use the knowledge they learnt to introduce this topic and build on it.

Subtopics

Subtopic no.	Name of Subtopic
1	Behaviour of light through a thin lens
2	Image formation by converging lenses
3	The lens formula
4	The applications of thin lenses

Suggested teaching/learning activities

2.1-2.4 Behaviour of light through a thin lens

(Definition, types and terms used in thin lenses)

Specific learning outcomes

By the end of this unit the learner should be able to

a) Explain refraction through a thin lens.

b) Locate images formed by thin lens.

c) Use lens formula and power of lens in solving problem in lens.

*d) Describe lens defects and their corr*ection.

2.1-2.2 Definition and types of lenses

Teaching guideline for activities 2.1-2.4

- In this section, learners will be able to learn about the types of lenses and terms used in lenses.

- Use common examples of thin lenses such optical glasses and others to explain to learners the meaning of thin lenses.
- Assemble all the materials required for this activity such as lenses and others.
- Ask them to define the thin lens and go ahead to discover the various types of lenses.
- Plastic lenses have steeper curves for the same powers compared with glass lenses, and the aberrations are therefore much greater (glass has a higher refractive index than plastic). Warn learners that the lenses are rather fragile and are easily scratched. After this instruction it is best to provide only those lenses, etc., that are needed for each activity.
- If the sun is visible from the laboratory/classroom windows, it is essential you remind learners that looking at the sun through a lens will cause blindness.
- Use common examples of lenses such as glasses to bring the topic closer to the learners.
- Guide them to ensure they have understood the concepts because they will be required to apply any idea they may have learnt about lenses.

Assessment

Observation

- Ensure each learner accesses the thin lenses and are able to make and note down their observations and actively participating.
- Are they able to see how water in the beaker behaves like a thin lens?
- Are they able to identify the various types of thin lenses?

Conversation

- Lead learners into a discussion about the definition and types of lenses.
- Supervise their discussions and later ask them to present their findings in a class discussion. Ask them questions.
- Are they able to identify and name the various types of thin lenses?
- Are they able to explain how light travels in thin lenses?

Product

- Check their drawings, their answers and evaluate their discussions.
- Ask learners to do all questions of Exercise 2. 2 in the student's book page 48. Mark their work that is the definitions of lenses and guide them accordingly

2.3 Terms used in thin lenses

Specific learning outcome

By the end of this section, the learner should be able to state and explain all the terms used in thin lenses.

Teaching guidelines for Activity

- Improvise some of the materials for example use other curved thin mediums as thin lenses such glasses and others.
- Take the learners outside the classroom, outside where there is sunlight. Let them point the convex lens towards the sun and concentrate the sunlight on a paper. Learners to make observations and present to the class.
- Give them an opportunity to explain why the paper burns.
- Take the learners through the terms used in concave and convex mirrors. Use Fig. 2.6-2.7 to help them identify the location of these terms as used in thin lenses.
- Guide the learners further through Fig. 2.8-2.9 showing the virtual principal focus formed by a convex mirror.
- Ask the learners to study Fig. 2.10 showing focal length.
- Remind them to write down their observations during group discussions.
- Give each group an opportunity to present their findings and results in a class presentation.

Assessment

Observation

- Are they are able to observe that the paper burns? Help those who don't perform the activity to achieve the expected observations.

Conversation

- Give learner an opportunity to discuss their findings and results of the activity. During the discussion, task them to answer oral questions about terms used in thin lenses.
- Are they able to state and explain: *the radius of curvature, the centre of curvature, the focal plane, optical centre, focal length, the principal axis and the principal focus of thin lenses?*

Product

- Evaluate their answers, discussions and written reports.
- Are their answers correct?
- Give them Exercise 2.1 as homework. Mark their work and guide them accordingly.

2.4-2.9 Image formation by converging lenses,

Ray diagrams, the lens formula, power and defects of a lens

Specific learning outcome

By the end of this unit the learner should be able to

a) Explain images formed by converging lenses.

b) Locate images formed by thin lens.

*c) Use lens formula and power of lens in solving pr*oblem in lens.

Teaching guidelines for activities 2.4 to 2.11

- Learners having done the activity hold a constructive and discuss the facts given in the student's book after every activity from activity 2.4 to 2.11. This is important because it will help learners to see errors on their finding and correct them hence enabling them to understand the concepts required in each section.
- Activity 2.5 is an **investigation**. Your role as a teacher is to guide and facilitate for the investigation. Let learners design and conduct the investigation by themselves.
- In these activities, darkness is necessary for clear observations. In case, there is no a dark room in the school, improvise by telling the learners to close the windows, doors, and then cover them with curtains to create darkness during the activity.
- If the sun is visible from the laboratory windows, it is essential for the teacher to remind learners that looking at the sun through a lens will cause blindness.
- In some of these activities, the source of light is a candle. In some cases, an electric lamp may be better, as it can be used in a room that is at least half dark. A carbon filament lamp and mounted lamp holder are suitable if available.
- Emphasise the use of real, virtual magnified demolished, upright, inverted, at infinity, at 2F, at F between f and optical centre in stating the character or nature of image formed by both convex and concave lenses.
- The brighter the image, the more colourful it will look. This always surprises some learners, before they even notice that the image is upside down. Begin with a +7D lens

and then use lenses of different powers. Note the distance between the lens and the screen.

- Many learners will need help to do some of the steps, but the time spent helping them will be worth it. Remind them that they will not see an object clearly when it is very close to their face: they must be a considerable distance from it. If they cannot find the image, put the paper back and repeat the process. Give help by suggesting to them that the image is located in space, just where the screen was. To see it, their eye must be focused at that place.
- Again, learners will find the idea of a ***virtual image*** more difficult than that of a real image. Use the previous example discussed in the previous unit under **"Image formation by spherical mirrors"** to bring the concept closer and clear for them to understand. In place of the mirror this time round use a lens.
- Use the formula **1/f=1/u +1/v**
- Discuss with them Examples 2.14- 2.22 given in the student's book on the chalkboard.
  - Every time, ask learners to do the activity and discuss their finding within the group.
  - Take them through the section of power a lens and defects of lenses.
- Once they finish the activities, ask the groups to give a brief summary on their findings to the whole class.
- Guide them through the discussion on their findings and guide them appropriately.

Assessment

Observation

- Are learners able to construct, observe and explain the characteristics of images formed by converging lenses?
- Help those with difficulties to note down the observations.

Conversation

- Give learners an opportunity to discuss the results and observations of the above activity. Ask them to present their findings in a class discussion.
- At random, ask different learners to lead others in brief discussions of different concepts highlighted in the unit summary given the student's book.
- Are they able to describe characteristics of images formed by converging lenses?
- Are they able to state, explain, draw and locate the image formation by ray diagrams?

- Are able to locate images by simple ray diagrams and describe their characteristics of an image at different position by a convex lens?
- Are learners able to use the lens formula to solve mathematical problems involving lenses?
- Help them where necessary.

Product

- Ask the learners to attempt the exercises 2.7-2.8 given in the student's book.
- Practice the use of sign convention by discussion and come up with practice exercise that can help them to master them well.
- Select some numerical questions to practice use of **m=v/u** and **power = 1/f.**
- Ask learners to do questions in the Unit Test as a CAT. Supervise and mark their work. Guide them appropriately.
- Form study groups and give the groups specific but different problem to solve and report to the rest the class.
- Ask them to do Exercise 2.2 in the student's book.
- **Remedial activities -**after each lesson identify weak learners. Encourage them to form small study groups through which you can reach them more effectively. Allow them to try the activities individually. In this way you can help them to catch up with the rest of class.

2.10 Applications of thin lenses

Specific learning outcome

By the end of this section, the learner should be able to explain applications of thin lenses.

Teaching guidelines

- Learners have come across some of the applications of thin lenses in real life. Use familiar applications to explain some of them. For example the human eye, optical lenses such as glasses, a camera and others.
- Ask learners to discuss and explain applications of thin lenses. Here the learners should be able to tell some of the areas where the thin lenses are used in making work easier.
- For those applications that they are not able to find out, take this chance to explain and guide them through the various applications of thin lenses.
- Guide the learners through the Unit project in the learner's book.

Assessment

Observation

- Provide them with some of the applications of thin lenses to observe. For example a camera.
- They will notice that as the lens of the camera is moved towards the object being viewed, the image moves back and grows in size. You might summarize this for learners like this: You see a thing by receiving rays, which come straight to your eye from each point on that thing. A lens bends the rays that come from a bright point, and makes all of them pass through another bright point, which we call the image. You see that image by receiving rays coming from it to your eye.
- That is what a camera lens does. It makes an image of the thing you want to photograph, and the photographic film or CCD element is put just at the image position. The image sensor in a digital camera is a ‹charge-coupled device› but it is not appropriate to explain this term.
- Ensure they observe to see the location of a lens and explain how the camera works.

Conversation

- Guide learners to research and discuss the applications of thin lenses
- Ask them present their findings in a class discussion.
- Evaluate their answers and presentations and guide them appropriately. Ensure everyone is participating.

Product

- Check their reports and correct them appropriately.
- Are they able to state and explain the applications of thin lenses?
- Guide the learners through the Unit project in the learner's book.
- Give them work to do: Topic test 2 in the learner's book.

Answers to numerical questions

Exercise 2.2

4. v = -3 cm

   h = 3 cm

Exercise 2.3

11. 4.8 cm
12. v = -11.1 cm

    h = 1.67 cm
13. 25 cm
14. (a) y = 60 cm

    M = 2

    (b) 2

15 u = 0.8 m

    f = 0.16 cm

16. 33.3 cm
18. 1.6
19. 72 cm
20. (ii) 15 cm

Topic test 2

3. (a) –24 cm
5. 5 cm
6. (b) 7

UNIT 2

Forces and turning effects

Topics in the unit

Topic 3: Moment of a Force

Topic 4: Centre of gravity

Learn about	Key inquiry questions
Learners should revisit their prior learning about effects of force and discuss their experience in groups. Through practical investigation in pairs and groups they should develop their understanding about moment of force (turning effects), pivot point and state the principles of moments. Learners should describe couple forces and torque, their effects and applications and investigate simple experiments on moments, how couple forces work and solve of mathematical problems on moments. Learners should know about the centre of gravity and discuss their experience. Learners they should develop their understanding about equilibrium, center of gravity, stability and its application through practical investigations. They should investigate the center of gravity of objects and their stability and describe the different states of stability; stable, unstable and neutral equilibrium. Learners should design a test to locate the center of gravity of regular objects by method of balancing, locate the centre of gravity of irregular shaped objects by means of plumb line, identify that objects with low and high center of gravity are classified as stable and unstable equilibrium	• Why pivot is important in taking moment of force? • What do you understand by couple force? • Why cars are designed to have a wide base? • Why an object cannot be in equilibrium if it is in motion? • Why an overloaded vehicle is prone to overturn?

Learning outcomes		
Knowledge and understanding	**Skills**	**Attitudes**
• The effects of forces and centre of gravity	• Design tests to locate the centre of gravity of regular objects by method of balancing and locate the centre of gravity of irregular shaped objects by means of a plumb-line. • Observe carefully • Predict what might happen • Use appropriate measures • Draw a simple diagram to show moment of a force. • Interpret results accurately • Calculate problems related to moments of forces. • Report findings appropriately	• Appreciate the applications of moment of a forces

Contribution to competencies addressed in this unit

1. **Lifelong learning**

   As learners keep on learning more about stability and effect of force of gravity in their daily lives

2. **Creative and Critical thinking**

   When doing activities provided in this unit, learners creatively develop experimental set ups by themselves and they critically investigate and identify the different sources of energies, renewable and non-renewable and solving of problems.

3. **Communication and Co-operation**

   During group work when doing experiments and presenting their results learners ask themselves questions, answer questions and consult with teacher. By doing so, they develop communication skills and cooperation to work as a team.

Links to other subjects

1. **Mathematics**- learners are involved in solving problems involving calculations of work, energy and power

2. **Building and construction –** force concepts are applied in buildings and construction to determine stability and strength of buildings.
3. **Engineering-** engineers apply moment in manufacturing products such steel bridges, roads and others. Centre of gravity is applied mechanical engineering to design of racing cars and modern bus.
4. **Carpentry-** centre of gravity concepts are applied in carpentry to determine stability of furniture.

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
- **Standardization culture**-It is emphasized by cautioning learners that it is dangerous to stand on a moving vehicle thus in a moving vehicle.

Attention to special educational needs

- Plan remedial classes for slow learners. Gifted learners to be given heavy tasks that require more critical thinking while slow learners are given easy ones that they can manage though this should not be mistaken that only easy tasks should be given to them.
- For more guidance about attention to special needs learners, refer to the introduction part of this teacher's guide.

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.

Topic 3 Moment of a force

(Student's book page 73-94)

Background information and/or prior knowledge

In the previous class (Secondary 1 Physics) learners learnt about forces. One of the effects of a force is that it produces a turning effect on body. But how can we quantify the turning effect? What are some of the applications of this effect in our daily lives? In this unit, assist learners to seek answers to these questions.

Subtopics

Subtopic no.	Name of Subtopic
1	Moment of a force
2	The principle of moments
3	Couple
4	Centre of mass of a body
5	Centre of mass of a lamina
6	Applications of the moment of a force

Suggested teaching/learning activities

3.1 Moment of a Force

Specific learning outcome

By the end of this section the learners should be able to define the term moment of a force and investigate the turning effect of a force.

Teaching guidelines for activity 3.1

- Involve learner's daily activities involving moment of a force for example opening a bottle top of a bottle, pushing a body on a steep slope and others. Through these learners will be able to discover and understand moment of a force.
- It is good to use locally available materials for example, for masses, weigh exact mass of stones needed to use as masses.
- Ask them why the ruler balances on the finger and later it doesn't after being pushed at one end.

- While they are balancing the rulers ensure they don't break the rulers. Advise them to handle them with care.
- Take them through Example 3.1 in the learner's book and let them discuss Example 3.2 in their respective groups.
- Ask them to answer the following questions:
    1. What is the meaning of moment of a force? Give examples.
    2. What is the SI Unit of moment of a force?

Assessment

Observation

- Are learners able to observe that a ruler balances on a finger and after it is pushed at one end it doesn't?
- Ask them to write their observations down. Ensure every learner is actively participating.

Conversation

- Let them discuss to the class their findings. All learners, whether disabled or normal should be involved actively in performing the activity. For instance, those with sight problem can be helped to push the wall or to sit on a chair.
- Ask them to present their findings in a class discussion.
- Are they able to explain the meaning of moment of a force, anticlockwise and clockwise moments?
- Help them where necessary.

Product

- Check their written report, answers and evaluate their presentations.
- Ask them to do Exercise 3.1 given in the student's book. Evaluate their work and guide them accordingly.
- Are they able to solve the problems correctly? Help them where necessary.

3.2 The principle of moments

Specific learning outcome

By the end of this section the learners should be able to define the term principle of moments and investigate the principle of moments.

Teaching guidelines for Activities 3.2-3.4

- In this section, you will introduce the learners to the concept principle of moments. Use practical activities to assist them understand the concepts easily.
- It is good to use locally available materials for example, for masses, weigh exact mass of stones needed to use as masses.
- Ask them to observe and record the observations. After this activity, prompt them to do Activity 3.2, 3.3 and 3.4 as guided in the student book.
- Activity 3.5 is an **investigation**. Your role as a teacher is to guide and facilitate for the investigation. Let learners design and conduct the investigation by themselves.
- Different students will require different amounts of support in this. The most able will not only identify a pattern of balancing the metre rule but will see for themselves that they can use it to make predictions of load position in order to achieve balance. Others will not see a pattern at all unless it is directly pointed out to them. It is worth explaining that the pattern is important because of its predictive power, which can be applied in many practical situations.
- Alternatively, to illustrate the turning effect of a force, demonstrate with the classroom door. Let one pupil try pushing it at the edge, then close to the hinge, then at intermediate positions. Compare the effects. One pupil could try pushing near the hinge while a pupil pushes (from the other side) farther out.
- If you do this then take care that fingers of the pupils cannot be trapped if the door closes.
- Faster students will quickly learn how best to balance the beam. They shouldn't be allowed to discourage those who take a bit longer.
- Take them through examples 3.3. Task them to discuss example 3.4-3.5 in the student's book. Ask them various questions about principle of moments i.e. state and explain principle of moments.

Assessment

Observation

- Supervise their work and prompt them to be keener.
- Are they able to observe the balancing effect of the ruler?
- Ensure every learner is actively participating.

Conversation

- While they are presenting their findings supervise them and help where they are wrong.
- Are they able to explain the facts, results and observations correctly?
- Give them an opportunity to discuss the examples 3.3-3.5 in learner's book.
- Ensure they master the correct formula of finding moment of a force.

Product

- Check their answers, evaluate their presentations and guide them where necessary.
- Are their findings and observations correct?
- Ask them to do Exercise 3.2 given in the student's book. Mark their work and guide them accordingly. Assist the slow learners in tackling some question as they may find them difficult.

3.3 Couple

Specific learning outcome

By the end of this section the learners should be able to define the term couple forces and investigate the moment of a couple.

Teaching guidelines

- Ask the learners to work in groups.
- Help them to observe examples of couple forces such steering of a car, a stick rotating in clockwise or anticlockwise manner.
- Let them discuss about couple forces and present their findings to class.
- Use practical examples such as steering of a car and others to explain the couple forces.
- All learners, whether disabled or normal should be involved actively in performing the activity.
- With your help allow them discuss Example 3.6 in the student book ask them to do Exercise 3.3.
- Ask them to answer the following questions:
    1. What are couple forces?
    2. Where are they applied in our daily activities?

Assessment

Observation

- Are learners able to observe an example of couple forces such as a steering of a car, a stick rotating in clockwise or anticlockwise manner?
- Ensure every learner is actively participating.

Conversation

- Learners to discuss the torque, how to calculate torque and example 3.6. Ask them to present their findings in a class discussion.
- Are they able to explain the meaning of torque and derive its formula?
- Ask them to give examples where couple forces are applied.

Product

- Check their answers, their reports, and drawings.
- Ask them to do Exercise 3.3 given in the student's book. Mark their work and guide them appropriately.

3.4 Determining centre of mass of regular objects

Specific learning outcome

By the end of this section the learners should be able to determine the centre of regular objects.

Teaching guidelines

- Ensure learners balance the metre rules on knife edges as shown. They then put a mass at one end and observe what happens. They record their data in the table provide and later use the data to answer questions.
- Ask them why the ruler does not balance when a mass is put at one end.
- Take them through example 3.7 in the learner book. Let them discuss example 3.8 in the book in groups and guide them where necessary.

Assessment

Observation

- Are learners able to observe and record the data from the activity correctly? Help those with difficulties.

- Ensure active participation while they are conducting the activity.

Conversation

- Ask them to present their findings in a class discussion.
- Are their data and discussions meaningful?
- Are their answers correct?
- Ask them to discuss example 3.7.

Product

- Check their data and answers of activity 3.6. Are their answers and workings correct?
- Please guide them where necessary. Ask them to do Exercise 3.4 given in the student's book.
- Mark their work and guide them where necessary.

3.5 Applications of moment of a force

Specific learning outcome

By the end of this section the learners should be able to explain the applications of moment of a force.

Teaching guidelines

- Learners come across applications of moment of a force every day e.g. opening a soda, pushing a wheel barrow and others. Use such applications and to explain more of the applications of moment of a force.
- Some of the applications are: bottle openers, pair of scissors, see-saw, screwdriver, crowbar and others. In groups, give them an opportunity to cut papers into small pieces using a pair of scissors. They then explain how the pair of scissors works.
- In groups, ask learners to research on applications of moment of a force.
- Let them discuss their findings in a class discussion.
- Discuss with them the applications they miss out to mention or explain.
- We apply moment of a force in our daily activities. Create awareness in learners about this by explaining the applications of moment of a force.
- This activity promotes in learners: teamwork, values and enjoyment, communication and critical thinking through discussions.
- Help them to achieve them.

Assessment

Observation

- Are they able to observe some of the applications of moment of a force? Are they opening the bottle right, using the scissors to cut paper well? Ensure active participation among them while doing the activity.

Conversation

- Ask to learners to discuss the applications in group discussions. Ask them to present their findings in a class discussion.
- Are they able to explain how moment of a force is applicable in opening a bottle using a bottle opener, scissors, crow bar and others?
- Emphasize the above point and explain how moment of a force is applicable in the above applications.

Product

- Are their reports, presentations and results correct?
- Check their work and give guidance where necessary.
- Ask them to do 3.4 Unit Test 3 given in the student's book. Mark their work and guide them appropriately.

Answers to numerical questions

Exercise 3.1

2. 24 Nm
4. 0.6 m

Exercise 3.2

2. 6.67 m
4. a. i) 2.4 Nm
   ii) 2.5 Nm
5. 16 N
6. 7 m

Exercise 3.3

1. 0.2 F
2. 2.24 Nm
3. 200 N

Exercise 3.4

1. (a) 0.12 kg
   (b) 960 kg/m3
   (c) 2.7 N
2. (a) 1.6 N
   (b) 0.16 kg
3. (a) 500 N
   (b) 50 kg

Topic test 3

3. 12.5 kg
4. 450 N
5. 0.6 m on the side of 1kg mass
6. Not clear
7. 3.8 N
9. Not clear

Topic 4 Centre of Gravity

(Student's book page 95-109)

Background information and/or prior knowledge

In Secondary 1, learners were introduced to forces and their effect on a body. They learnt about balanced and unbalanced forces on a body. Actually, when unbalanced forces act 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 example, overturning of trucks on our roads, balancing a toy bird in the supermarket and 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 4.1 in student's book of balancing a book using the finger.

Subtopics

Subtopic no.	Name of Subtopic
1	Centre of Gravity and Centre of mass of a body
2	Centre of Gravity of a regular lamina
3	Centre of Gravity of an irregular lamina
4	Effect of position of centre of gravity on states of equilibrium
5	Relationship between position of the weight of the body and its stability
6	Factors affecting the stability of a body and applications of position of the centre of gravity

Suggested teaching/learning activities

4.1 Centre of Gravity and Centre of mass of a body

Specific learning outcome

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

Teaching guidelines for Activity 4.1 and 4.2

- Ask learners to investigate where the weight of a body acts. All learners whether disabled or normal should participate actively in the lesson and all activities. For instance, they can hold a ruler as other learners draw.
- Improvise some of the materials in this experiment for example use instead of manila papers learners can use foolscaps as regular lamina and others.
- Help them 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 4.2 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.
- Ask the learners to do activity 4.3 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.
- Guide them in class discussion on their result by pointing out the key points:

Assessment

Observation

- Are they able to locate the centre of gravity of various objects?
- Help them to observe and locate points of centre of gravity of various objects.
- Ensure every learner is actively participating.

Conversation

- Ask the learners to discuss and present their findings in a class discussion.
- Are they able to explain the meaning of centre of gravity and locate the c.g of various objects?

Product

- Check the learners' answers, results, and drawings and evaluate their presentations.
- Are their answers correct?

- Ask them to do Exercise 4.1 in student's book. Mark their books and assist them where necessary.

4.2 Centre of Gravity of a regular lamina

Specific learning outcome

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

Teaching guidelines for Activity 4.3

- Ask learners to conduct an investigation to determine the centre of gravity of a regular lamina (rectangular manila paper) using geometrical instruments.
- 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 centre of gravity is.
- Ask them why the point of centre of gravity is at the middle of the book.

Assessment

Observation

- Watch and ensure learners to observe centre of gravity of books, card books and others.
- Are they able to locate the c.g of the materials with regular lamina?
- Help those with difficulties and ensure maximum and active participation.

Conversation

- Supervise learners to discuss the points of centre of gravity of books and other regular objects.
- Are their answers and discussion meaningful?

Product

- Check their drawings, reports of the investigation, evaluate their presentations and guide them where necessary.
- Ask them to do Exercise 4.1 in student's book.

4.3 Centre of gravity of an irregular lamina

Specific learning outcome

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.

Teaching guidelines for Activity 4.4

- Help learners to locally improvise and assemble a plumb line using a stone and a string. They tie a stone tightly using a string and by doing so, they would have made a plumb line.
- Guide the learners (especially slow learners) through activity 4.4 and help them to determine the centre of an irregular lamina using a plumb line.
- Ask them to present their findings 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, plumb line, 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.

Teaching guidelines for Activity 4.5

- Let learners discuss how to determine centre of gravity of different lamina and locate the point M (centre of gravity) on them.
- Ask them to determine the points of their centre 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.

Assessment

Observation

- Learners to observe and note down the observations, centre of gravity of various irregular materials.
- Ensure they are actively participating.

- Find out whether they are able to locate centre of gravity of an irregular lamina using a plumb line (stone and a string) and using a straight line method. If not help them.

Conversation

- Learners to discuss the steps, procedures and results in the above activity. Ask the present their findings in a class discussion.
- Are the centres of gravity of the irregular materials they have indicated correct?
- Are their drawings and constructions correct?

Product

- Check their drawings indicating the centre of gravity of the irregular materials. Are they correct?
- Evaluate their presentations and discussions. Help them where necessary.

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

Specific learning outcome

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.

Teaching guidelines for activity 4.6 and 4.7

- 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.
- Help learners to improve a thistle funnel by folding a manila paper or any piece of paper into a funnel. They will like this.
- Let the groups to 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.
- Ask and give them an opportunity to answer the following questions:
  1. What is referred as the state of rest of a body?
  2. Some bodies are in a more stable condition than others are. Why is that so?
  3. The state of balance of a body is called….?

  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 4.7, 4.8 and 4.9 will raise the curiosity of learners to know more about them.

Three states of equilibrium

Stable equilibrium

Teaching guidelines for activity 4.7

- Ask them to do activity 4.6 given in the student book i.e. define and describe three states of equilibrium.
- Guide them in a class discussion and emphasize the key points.
- Ask them to explain why the funnel does not fall while sitting on its base but falls while sitting on its tip?
- Use this 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.

Unstable equilibrium

Teaching guidelines for activity 4.7

- Guide them through the activity.
- Ask 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.
- Ask them to explain why the funnel does not fall while sitting on its base but falls while sitting on its tip?
- Allow the groups to have a group discussion on their observation and let the group to note the main points from their discussion.
- Ask them the following question:

Why does the funnel fall?

- Summarise the lesson through class discussion. Point out the key points.

Neutral equilibrium

Teaching guidelines for activity 4.7

- Guide the learners through the activity 4.9 and help them to understand that the position of centre of gravity of plastic funnel does not change when given a slight push.

- Ask them to explain when a body is said to be in a neutral state.
- Ask learners to explain the three states of equilibrium; stable, unstable and neutral and how to describe each of them. Lead them (especially slow learners) systematically 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.

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

Teaching guidelines for activity 4.8

- Ensure learners to find out the explanations of the activity. Prompt them to connect the activity to the states of equilibrium; stable and unstable.
- Ask learners to explain why it is not advisable for buses and other vehicles to carry 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 the lower part hence raises the centre of gravity making the vehicle unstable.

Assessment

Observation

- Are learners able to observe that a thistle funnel when it is stable, it does fall? When it's unstable it falls and when it neutral states it neither does fall nor it is stable?
- Ensure active participation during the activity and throughout the lesson.

Conversation

- Guide learners in group discussions to discuss the three states of equilibrium.
- Ask the present their findings in a class discussion.
- Are learners correctly explaining the observations of the activity that is why the funnels at some positions it falls, does not fall and rolls?
- Help them where they are wrong.

Product

- Check the answers, drawings and explanations. Evaluate their presentations and guide them accordingly.
- Prompt them to role play the three states of equilibrium.
- Ask them to do Exercise 4.1 go around marking their work. Note that the quick learners will finish first; let them do the remaining questions.

4.6, 4.7 Factors affecting the stability of a body and applications of position of the centre of gravity

Specific learning outcome

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.

Teaching guidelines 4.6

- Learners have seen different situations where position of centre of gravity is applied e.g. balancing bird, in supermarket, boat tilting etc. Capitalize on these and other common situations to trigger the curiosity of learners so that they can understand the application of position of centre of gravity.
- Learners have already done activities 4.7 and 4.8. Ask them to repeat activity 4.6 and let them tell when the body is said to be in a stable equilibrium. Moreover, guide them to do activity 4.11 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 learners from different groups to contribute on each presentation.
- Ask them to explain the following :
  a) How does the c.g affect stability of a body?
  b) How does the base area affect stability of a body?

c) Where does vertical line drawn from the c.g always fall?

4.7 Applications of position of the centre of gravity

Specific learning outcome

By the end of this section, the learners should be able to explain applications of position of the centre of gravity in real life.

Teaching guidelines 4.7

- Ask learners to state some of the applications of position of the centre of gravity.
- Using factors affecting stability as a basis, lead the learners into some of applications of the position of the centre of gravity through activity 4.12.
- 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.

Assessment

Observation

- Ensure learners observe balancing of a toy bird or any other locally available toy bird and some of the tools where c.g is applied.

Conversation

- Help learners to discuss the steps, procedures and results in the above activity.
- Ask them to present their findings in a class discussion.

Product

- Ask learners to do unit Test 4 question one. Go round checking how learners answer and correct them. Note that the quick learners may finish fast, let them do question five 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 4.

Answers to numerical questions

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.

UNIT 3

Work, energy and power

Topics in the unit

Topic 5: Work, Energy and Power

Learn about	Key inquiry questions
Learners should revisit their prior learning about work, energy and power and through practical investigation in groups they should develop their understanding about energy, work and power and the principle of conservation of energy. They should know that an object may have energy due to its motion (kinetic energy) or its position (potential energy), and that energy may be transferred and stored. Learners should know that potential energy have many forms and that work done is a form of energy. Learners should investigate and describe different sources of energy (renewable and non-renewable) and give examples of renewable energy (hydroelectric, solar, wind, tidal, wave, geothermal and bio-fuels), and non-renewable energy (Fossil fuels and Nuclear fuels). They should also be able calculate kinetic and potential energy and power efficiency.	• How does the world get its energy? • Why is energy not destroyed? • Why work done is energy?

Learning outcomes		
Knowledge and understanding	**Skills**	**Attitudes and values**
• Understand the concepts of work, energy and power	• Design tests to relate work done to the magnitude of a force and • the distance moved, power to work done and time taken, using appropriate examples • Observe carefully • Predict what might happen • Use appropriate measures • Collect and present results appropriate in writing or drawing • Interpret results accurately and derive kinetic and potential energy formula • Report findings appropriately and relate work, energy and power	• Appreciate that food eaten is an energy

Contribution to student competencies

1. Creative and Critical thinking

When doing activities provided in this unit, learners creatively develop experimental set ups by themselves and they critically investigate and identify the different sources of energies, renewable and non-renewable and solving of problems.

2. Communication and Co-operation

During group work when doing experiments and presenting their results learners ask themselves questions, answer questions and consult with teacher. By doing so, they develop communication skills and co-operation to work as a team

Links to other subjects

1. **Mathematics**- learners are involved in solving problems involving calculations of work, energy and power.
2. **Biology**- some of the sources of energy for example biomass discussed in this unit, are borrowed from Biology.
3. **Chemistry**- reactions in producing chemical energy in this is applied in Chemistry.

Cross-cutting issues addressed in this unit

1. Conservation of energy

   Learners are advised to conserve energy in various ways. For example switching off lights during the day conserves energy. Avoid cutting down trees as they are source of energy.

2. Environment, climate change and sustainability

   Learners learn how to conserve energy in various ways. For example switching off light during the day conserves energy. Avoid cutting down trees as they are source of energy.

Attention to special educational needs

- Identify learners with hearing and visual impairment and have them seated in front of the class so that proper attention can be given to them. Large print text should be given to visually impaired learners and hearing aids to those with hearing impairment.
- For more guidance about attention to special needs learners, refer to the introduction part of this teacher's guide.

Topic 5 Work, energy and power

(Student's book page 112-166)

Background information and/or prior knowledge

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 learners confuse work and energy so engage them in a number of activities to help them to differentiate between them. Field trips to energy production sites may help the learners to discuss energy concept with ease.

Subtopics

Subtopic no.	Name of Subtopic
1	Work
2	Power
3	Energy
4	Forms of energy
5	Sources of energy
6	Renewable and Non-renewable Sources of Energy
7	Environmental effects of the use of Energy
8	Energy Transformations
9	The law of conservation of Energy
10	The law of conservation of Mechanical Energy
11	Ways of conservation of Energy

Suggested teaching/learning activities

5.1 Work

Specific learning outcome

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

Teaching guidelines for activity 5.1

- Ask one of them to walk from his/her desk to the chalkboard and write the word work on the chalkboard.

- Ensure they note down whether work has been done or not in carrying out the simple tasks such as pushing a wall, lifting up various objects such as books and others provided in the learner's book.
- Some of the materials may be not enough or not locally available, as a teacher lead learners to improvise some of them for example where there are no stairs, repeated step-ups onto any raised surface can be used.
- **Precautions** are needed to prevent a chair knocking student's face or a chair falling onto the toes.
- Let them discuss the findings. All learners whether disabled or not should be involved actively involved in performing the activities. For instance, those with sight problem can be helped to push the wall or to sit on a chair.
- Help 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.
- Ask them to explain why in activity 5.1 task (b) and (c) we say no work is done.
- Discuss with the learners the derivation of the formula for work and use it to guide them through example 5.1 in the learner's book.

Assessment

Observation

- Watch how groups work together to do the learning activities and note down their observations and findings.
- Ensure they note down whether work has been done or not in carrying out the simple tasks such as pushing a wall, lifting up various objects such as books and others provided in the learner's book.
- Ensure each learner is following and actively participating while doing the activity.

Conversation

- Guide learners to discuss their findings and present them in a class discussion.
- Do their conversations demonstrate a good understanding of work?

Product

- Ask them to do question 1, 2 and 3 in Exercise 5.1 given in the student's book. Mark their work and guide them appropriately.

5.1. 1 Work done in pulling an object along a horizontal surface

Teaching guidelines for activity 5.2

- Before the period, prepare a set of the materials mentioned above for each of the groups you will work with. In case some of the materials are not enough, as a teacher lead learners to improvise some of them for example instead of stop-watches, alternatives include counting seconds, clapping at a constant rate, use of timers on mobile phones watching the second hand on a shared clock.
- This is an investigation. Your work as a teacher is to guide the learners and ensure whether the following have be done or achieved:
- Ensure they place a block of wood on a horizontal surface and attach the spring balance on the block.
- Ensure they 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.
- Learners to 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 them to explain why the block does not move smoothly on the surface.
- Ask learners to calculate the work done using the formula (***work = Fxd***).
- Summarise the activity by asking each group to give a presentation to the class.
- Guide 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.

  Work = force x distance

  W= F x d

Assessment

Observation

- Watch how groups work together to do the investigation and note down their observations and findings. Ensure each learner is following and actively participating while doing the activity
- Ensure they note down their observation and each one of them is actively participating.
- Some of the observations expected in this investigation include: a block does not move easily when it being pulled on a flat surface. Help them to achieve this.

Conversation

- Guide learners to discuss their findings and present them in a class discussion.
- Do their conversations demonstrate a good understanding of work done in pulling an object along a horizontal surface?
- Give them an opportunity to discuss why a block does not move easily when it is being pulled on a flat surface.
- Give them an opportunity to discuss examples 5.2, 5.3, 5.4 and 5.5 in the learner's book.

Product

- Check their written report, observations and answers. Are they correct?
- Do their answers demonstrate a good understanding of work?
- Ask them to do Exercise 5.1 in student's book. Mark their work and guide them appropriately.

5.1.2 Work done against the force of gravity

Teaching guidelines for activity 5.3

- Ask them to hang a mass from a Newton meter and record its weight.
- Ask one of the members in the group to lift the mass at a constant speed upwards up to a certain point or if they are using a pulley, they should first tie the mass on the thread and then record the observations.
- Thread around a pulley fixed/clamped on a retort stand. Let one learner pull on the side without the mass
- Ask one student to measure the distance through which the mass has been raised using the meter ruler or tape measure.
- Let them calculate the work done from the formula $W=f\times d$ where the F is equal to the weight of the mass.
- Ask them to repeat the activity with different masses and calculate the work in each case
- Guide them to suggest reasons why work is not the same with different masses.
- The hazard presented by these activities is that of 'working at heights'. No one must stand on a stool or bench to set up the apparatus on a high shelf. If apparatus can be clamped onto the shelf at bench level, it can be lifted into place by two tall persons standing on the floor.

- Summarise the activity by helping them know that the work done against gravity with different masses is different because of the difference in the weights of the masses being carried thus were the mass is very big, there is more work to be done. Take them through example 5.6 in the student's book.

Assessment

Observation

- Watch how groups work together to do these activities and note down their observations and findings.
- Are they able to note down some of the expected observations?

Conversation

- Guide learners to discuss their findings and present them in a class discussion.
- Do their conversations demonstrate a good understanding of work done against the force of gravity?
- Take them through examples 5.5 and 5.6.

Product

- Mark their observations, answers and check their understanding. Assist those who may have mastered the concept.
- Ask them to do Exercise 5.2 in student's book. Mark their work and guide them appropriately.

5.1.3 Work done along inclined plane

Teaching guidelines 5.1 (c)

- Assist them to form an incline by putting a piece of wood on a wedge.
- Let the mass hanger/stone /trolley be attached on to the spring balance
- Ask them to measure the length of the incline l in...cm
- Ask one of them to pull the spring balance with its object on from the bottom of the incline and note down the force used in pulling …N
- Let them change the units of length to meters and then calculate the work done along an incline by using $W= F\times d$ where by the distance is the length of the incline.
- Summarise the activity by asking each group to give a presentation to the class.
- $W = F \times d$ where by the distance is the length of the incline.

- Guide them through example 5.7 in the student book

Assessment

Observation

- Watch how groups work together to do these activities and note down their observations and findings.

Conversation

- Guide learners to discuss their findings and present them in a class discussion.
- Do their conversations demonstrate a good understanding of work done along inclined plane?

Product

- Ask them to do Exercise 5.2 in student's book. Mark their work and guide them appropriately.

5.2 Power

Specific learning outcome

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.

Teacher's guidelines 5.2 (a)

- After the activity, let each member present their findings to the rest of the class.
- Guide 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 of example 5.8 in the student book.

Assessment

Observation

- Watch how groups work together to do the activities and note down their observations and findings.

Conversation

- Guide learners to discuss their findings and present them in a class discussion.
- Do their conversations demonstrate a good understanding of power?

Product

- Ask them to do Exercise 5.4. Mark their work and guide them appropriately.

5.2.1 Estimating one's own power

Teaching guidelines 5.2 (b)

- **Note;** this experiment will generate noise and discipline problems unless it is well organized. Student will wish to compete against one another to find the most powerful person; plan in advance where learners will stand and how other staff and/or learners 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 accidents.
- 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 drop them and be far from their bodies, like the head, and the foot**.**
- 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.
- 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 × 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

$$\text{Power} = \frac{\text{work}}{\text{Time taken}}$$

- 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 5.9 to the learners.

Assessment

Observation

- Learners should be able to observe that by running one takes a shorter time but by walking up the stairs one takes more time to do so as compared to running.
- Help learners to observe and realize the above observation.
- Ensure every learner is actively participating.

Conversation

- Learners to discuss the steps, procedures and results in the above activity. Ask the present their findings in a class discussion. Learners should be able to observe that by running one requires a lot of power but by walking up the stairs one requires little power to do so as compared to running.
- Students may also ask why they feel fatigue when they hold up a load but the load doesn't move.
- Explain to them that, in order to grip the load, muscles are kept tensed; they squeeze the blood vessels and restrict blood flow. As a result the chemical products of muscular activity accumulate and are not washed away so quickly by the blood. This accumulation of chemical products makes the nerves give a sense of fatigue. So the feeling of fatigue is chiefly an indirect result of the muscle tension.

Product

- Mark their observations, reports and findings.

5.3 Energy

Specific learning outcome

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.

Teaching guidelines 5.3

- 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 5.8 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.

Assessment

Observation

- Watch how groups work together to do the activities and note down their observations and findings.

Conversation

- Guide learners to discuss their findings and present them in a class discussion. Do their conversations demonstrate a good understanding of energy?

Product

- Ask learners to do question 3 and 4 of Exercise 5.5 in the student's book. Mark their work and guide them appropriately.

5.4 Forms of Energy

Specific learning outcome

By the end of this section the learner should be able to define and explain forms of energy which may include solar energy, heat energy, wind energy, sound energy, electrical energy, chemical energy etc.

5.4.1 Solar Energy

Teaching guidelines 5.4 (a)

- 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. Ask them to explain why the paper burns.

5.4.2 Sound Energy

Teaching guidelines 5.4 (b)

- Ask them to lift a stone a metre above the ground, then release it and ask them to explain 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. They vibrate and then produce sound.

5.4.3 Heat Energy

Teaching guidelines 5.4 (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 5.11 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.
- After some time the other end of the nail is observed to become hot. Ask them to explain this form of energy.

5.4.4 Electrical Energy

Teaching guidelines 5.4 (d)

- 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.
- Let the learners do activity 5.12 in the learners book.
- Ask them to explain the meaning of electrical energy?

5.4.5 Nuclear Energy

Teaching guidelines 5.4 (e)

- 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.
- Ask them to explain the meaning of nuclear energy.

5.4.6 Chemical Energy

Teaching guidelines 5.4 (f)

- 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.
- 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.

5.4.7 Mechanical Energy

Teaching guidelines 5.4 (g)

- Ask the learners to remind themselves of what happens to them whenever a driver applies brakes suddenly while stopping a car.
- Ask them to explain why their bodies move forward when the car is in motion stops suddenly.
- Let the learners do activity 5.15 in the student's book.

(a) Potential Energy

Teaching guidelines 5.4 (h)

- 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.
- It is helpful to talk about energy stores. A spring, or a rubber band, can rather obviously store energy. You do work to stretch them (or to squash the spring), and you can get back pretty much the same amount of energy when they relax. These then are two of the best iconic examples for grasping what 'potential energy' is all about. It is energy in a mechanical store or energy at state of rest.
- Many learners find the term 'potential' confusing. They think 'potential energy' is somehow different from actual energy. Talking about energy stores offers a way of deferring the term 'potential energy' until later, for students who choose to continue studying physics. You can similarly feel energy being stored when magnets are pushed together or pulled apart.
- The example nearly all textbooks/teachers give of potential energy is perhaps the most difficult of all. It is the gravitational energy of a lifted mass. Now the energy is said to be 'in' the lifted object – as for a spring it is said to be 'in' the spring. If you have the courage, you could say that the energy is stored between the Earth and the lifted object (in the gravitational field). The trouble is of course that an external examiner might score that truthful answer as wrong because specialist understanding is not required at this level.
- Another kind of energy store is a mixture of fuel and oxygen. In this case bonds between carbon and oxygen atoms can snap shut, releasing energy in a fire or explosion. It is common to talk about just the fuel – for example petrol – as the energy store, but do remember that for this chemical spring to snap shut, there must be oxygen too. Take them through example 5.10 in the student's book.

(i) Gravitational Potential Energy

Teaching guidelines 5.4 (i)

- 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 H_2 H_3 H_4. 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. Prompt them to explain their explanations.
- 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 lesson 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.
- When you discuss examples involving gravitational potential energy, students will often ask questions about where the energy resides. This demonstration can help students think of the uphill energy stored in the gravitational field that connects the Earth with the raised load, by telling them an artificial story. You might introduce the story with these words:

  'Imagine a spring connected between the load you are holding and the centre of the Earth. There is no real spring but the pull of that stretched spring is just an imaginary idea to help you think about the way the Earth pulls on the load.

  Ask the student holding the brick to shut their eyes and imagine the spring connecting the brick to the Earth.

  'Feel how heavy the brick is. Feel its weight. Feel how the Earth pulls it down. If you don't believe the Earth pulls it down, let go and see what the Earth does to the brick.'

  (Protect the floor and the student at this point!)

'Pretend to yourself that the pull of the Earth, which you can feel, is the pull of a long stretched spring that is attached to your brick and runs through a hole in the ground to the centre of the Earth. You will find it difficult to imagine that spring if you keep your eyes open and can see that there is no spring there. So now shut your eyes and think about that spring.'

'Raise the brick up, holding it with your two hands. As you haul the brick up, you can feel that spring

S-t-r-e-t-c-h-i-n-g. Keep your eyes shut, lower the brick, and let the spring contract a little. Now pull the brick up and stretch the spring. Were you able to imagine the spring?'

- If students can visualize this long spring being stretched, some may use their knowledge of springs to expect gravity to increase with height above the Earth, (because the force of the spring grows as it stretches). If so, you need to explain that this imaginary spring, all the way to the centre of the Earth, is so long that ordinary stretches would not make it change its strength. Then, to avoid the story being misleading, you should add a warning that the real gravitational 'spring pull' of the Earth gets weaker as you go farther out. This is not the time to go into any inverse-square story.
- Guide them through example 5.11 in student's book: Then ask the learners to do exercise 5.3 in the student's book.

(b) Kinetic Energy

Teaching guidelines 5.4 (j)

- 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. K.E = ½ mv^2.
- Take them through examples 5.12 and 5.13 in the student's book on calculating kinetic energy.

Assessment for forms of energy

Observation

- Watch how groups work together to do the above activities and note down their observations and findings.
- While doing the activities, ensure every learner is actively participating.
- In each activity ensure they observe and note down the expected activities.

Conversation

- Guide learners to discuss their findings and present them in a class discussion after each of the above activity.
- Do their conversations demonstrate a good understanding of the various forms of energy?
- Keep asking them questions about the various forms of energy to check their understanding.

Product

- From the above activities, learners noted down observations, check their work, findings and guide them while during the discussions.
- Give them further exercise on kinetic energy. Ask them to do exercise 5.5 in the student's book. Check their work and guide them where necessary.

5.5 Sources of Energy

Specific learning outcome

By the end of this section the learner should be able to state and explain the various sources of energy. That is primary and secondary sources of energy.

Teaching guidelines 5.5

- Draw the attention of the students to the student's book. Ask them to do activities 5.19 using internet and reference books to tell where the water from the tap or steam comes from and define the meaning of a source.
- 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

Primary sources

- Still in groups, guide a discussion about the different examples of primary sources of energy.
- Ask learners to activity 5.20 and 5.21 in the student's book.

- 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 5.20 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.

Secondary sources

- 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.

Assessment

Observation

- Watch how groups work together to do these activities and note down their observations and findings.

Conversation

- Guide learners to discuss their findings and present them in a class discussion. Do their conversations demonstrate a good understanding of sources of energy?

Product

- Ask learners oral question about kinetic energy. Give them further exercise on kinetic energy. Ask them to do Exercise 5.6 in the student's book. Check their work and guide them where necessary.

5.6 Renewable and Non-renewable Sources of Energy

Teaching guidelines 5.5

- Draw the attention of the students to the student's book. Ask them to do activity 5.23 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.

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.

Assessment

Observation

- Watch how groups work together to do these activities and note down their observations and findings.

Conversation

- Guide learners to discuss their findings and present them in a class discussion. Do their conversations demonstrate a good understanding of renewable and non-renewable sources of energy?

Product

- Ask learners oral question about kinetic energy. Give them further exercise on kinetic energy. Ask them to do exercise 5.6 in the student's book. Check their work and guide them where necessary.

5.7 Environmental effects of the use of Energy

Teaching guidelines 5.7

- Draw the attention of the students to the student's book.
- Ask them to do activity5.24. 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.

Assessment

Observation

- Watch how groups work together to do these activities and note down their observations and findings.

Conversation

- Guide learners to discuss their findings and present them in a class discussion. Do their conversations demonstrate a good understanding of environmental effects of the use of energy?

Product

- Give them further exercise on kinetic energy. Ask them to do exercise 5.6 in the student's book.

5.8 Energy Transformations

Teaching guidelines 5.8

- Organise the learners in groups of between three and five groups.
- Ask learners to do activity 5.25 in form of research about energy transformations.
- Organise the learners into convenient groups. Let each group appoint a secretary.
- Guide them to do activity 5.25 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.
- They should have observed that the water in the basin boils that is electrical energy which 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 5.10, Fig 5.11, Fig 5.12 and Fig 5.13 in the student's book to discover some other forms of energy transformation and guide them on some explanations.

Assessment

Observation

- Watch how groups work together to do these activities and note down their observations and findings.

Conversation

- Guide learners to discuss their findings and present them in a class discussion. Do their conversations demonstrate a good understanding of energy transformations?

Product

Ask them to do exercise 5.7 in the student's book.

5.9 The law of conservation of Energy

Specific learning outcome

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

Teaching guidelines 5.9

- 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.
- 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 5.26 in the learners book.
- Ask them to identify:
- The energy transformation starting from the sun as the main.
- 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's book.

Assessment

Observation

- Ensure learners observe and explain the results from the above activity.

Conversation

- Guide learners in discussion of the steps, procedures and results in the above activity. Ask the present their findings in a class discussion.

Product

- Ask them to do exercise 5.8 in the student's book.

5.10 The law of conservation of Mechanical Energy

Specific learning outcome

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

Teaching guidelines 5.10 (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 5.27 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.

Assessment

Observation

- Watch how groups work together to do these activities and note down their observations and findings.

Conversation

- Guide learners to discuss their findings and present them in a class discussion. Do their conversations demonstrate a good understanding of the law of conservation of mechanical energy?

Product

- Ask them to do exercise 5.8 in the student's book. Check their work and guide them where necessary.

5.10.1To demonstrate the law of conservation of mechanical energy

a) A swinging pendulum

Teaching guidelines 5.10 (b)

- Organise the learners into pairs.
- In pairs, let the learners do Activity 5.28in the learner's 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 600 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 5.94. And let them give reasons for their answers.
- 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.

Assessment

Observation

- Watch how groups work together to do these activities and note down their observations and findings.

Conversation

- Guide learners to discuss their findings and present them in a class discussion. Do their conversations demonstrate a good understanding of the law of conservation of mechanical energy?

Product

- Ask them to do exercise 5.8 in the student's book. Check their work and guide them.

(b) A body thrown upwards

Teaching guidelines 5.10(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).
- 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 5.16
- Guide the learners through a discussion about Fig 5.16 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 5.8 in the student's book.

Assessment

Observation

- When a body is thrown upwards, it comes back to the earth. Are learners able to observe that?
- Ensure active participation from the learners.

Conversation

- Guide learners to discuss their findings and present them in a class discussion.
- Do their conversations demonstrate a good understanding of energy of the body thrown upwards?
- Ask them to explain why the body comes back to the earth?

Product

- Evaluate their presentations, answers and observations. Guide where necessary.
- Ask them to do exercise 5.8 in the student's book

5.11 Ways of conservation of Energy

Specific learning outcome

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

Teaching guidelines 5.11

- 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 5.30 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.

Assessment

Observation

- Ensure earners research on ways of conserving energy.

Conversation

- Guide the discussion on ways of conserving energy.

Product

- Ask them to do exercise 5.8 in the student's book. Mark their work.

5.12 Energy efficiency

Teaching guidelines 5.12

- 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.
- 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 efficient incandescent light bulb with a more efficient compact fluorescent bulb, you are practicing energy efficiency.

Assessment

Conversation

- Guide the discussion on energy efficiency. Ask them questions to check their understanding.

Product

- Ask learners to do exercise 5.9 in the student's book.
- Ask them to do the project on energy saving: charcoal burner and solar heater
- Guide them to do Unit Test 5 in the student's book.
- Check their work, mark and carry out remedial lessons for those who may have not understood some of the concepts in this unit.

Answers to numerical questions

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 5.1

3. 200 J **4.** 1000 J

Exercise 5.2

2. 180 J **3.** 1 500 J

4. a) 3 000 N (b) 120 000 J (c) 120 000 J

5. 3 000 J **6.** 180 J

Exercise 5.3

1. (a) 4 000 J (b) 4 000 J

2. (a) 10 m (b) 1 500 J (c) 5100 J (d) 990 J (e) 480 J

3. 16 800 J

4. (a) 2 750 000 J (b) 2 610 000 J

Exercise 5.4

2. 200 W **3.** 450 000 J **4.** 14.3 S

5. 75 N **6.** 500 000 J **7.** 432 000 J

8. 5 W **9.** 210 W **10.** Student B, 20 W

11. Machine C, 400 W

Exercise 5.5

4. 500J **6.** 1.42 J **7.** 10 J

8. (a) 245 J (b) 11.83 m/s

Unit Test 5

2. a) 1800 J b) 64.3 W

3. a) 4000 J b) 800 W

4. 400 W

5. a) 4000 N b) 9200 J c) 1800 J

6. b) 600 W

UNIT 4

Machines

Topics in the unit

Topic 7: Introduction to Waves

Topic 8: Sound Waves

Learn about	Key inquiry questions
Learners should revisit their prior learning about machines. Through practical investigation they should develop their understanding about how machines can be made to lift loads with low force (efficiency), enlarge magnitude of forces and increase rate of doing work. Learners should know different types of simple machines such as levers, pulleys, wedges and screws and their usage. They should know three types of lever; first class, second class lever, and third class. Learners should develop their understanding about the use of mathematical formulae to relate mechanical advantage to effort and load, velocity ratio and efficiency of machines. They should derive and calculate mechanical advantage, velocity ratio and efficiency of a given machine. They should demonstrate how simple pulleys of different velocity ratios may be assembled, appreciate use of machine to ease work.	• Why do vehicles use low gears in steep places? • Why are pulleys important in load lifting? • Why does a cyclist get tired when cycling up-hill? • How can we design machines to enable humans to move masses greater than the human mass?

Learning outcomes		
Knowledge and understanding	**Skills**	**Attitudes and values**
• Define machines and explain the dynamics of objects	• Design and carry out tests on pulleys and simple pulleys of different velocity ratios may be assembled Predict what might happen • Observing carefully • Use appropriate measures • Collect and present results appropriate in writing or drawing • Derive and Calculate mechanical advantage, velocity ratio and efficiency of a given machine • Draw a labelled diagram to explain a lever	• Appreciate use of machine to ease work

Contribution to competence addressed in this unit

1. Communication skills, co-operation and interpersonal relation

To achieve this, the unit has provided many practical activities. Through group work and discussion based activities learner will be able to learn and improve communication and interpersonal skills. Ensure they carry out the activities to achieve this.

2. Research and problem solving skills

In this unit, learners will come across activities which involve researching on a particular area. Involve learners to do them to acquire the research and problem solving skills.

3. Critical and creative thinking.

Learners will be able to set up experiments and also improvise some of the materials required to do activities**.** Ensure they answer questions; explain the hypothesis of the experiments and come up with answers.

Links to other subjects

1. **Mathematics**- learners are involved in solving problems involving calculations of work, energy and power.
2. **Biology**- some of the sources of energy for example biomass discussed in this unit, are borrowed from Biology.

3. **Chemistry**- reactions in producing energy by machines in this is applied in Chemistry.

Cross cutting issues addressed in this unit

Environment- through provision of environment based activities, discussions and knowledge for instance wells i.e. we cover wells or boreholes in our homes and after use. This promotes environmental aspects and how we can conserve our environment.

Attention to special educational needs

- Arrange the classroom such that it will enable the easy movement for the physically challenged learners.
- For more guidance about attention to special needs students, refer to the introduction part of this teacher's guide.

Topic 6 Machines

(Student's Book pages 169-196)

Background information and/or prior knowledge

Simple machines help 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. It may be necessary for students constructing apparatus for physics experiments to use various power tools contained in a wood or metal shop. In these situations, the industrial arts instructor should be consulted for proper safety precautions necessary for each tool or machine.

Subtopics

Subtopic no.	Name of Subtopic
1	Definition of Simple Machines
2	Terms used in simple machines
3	Terms used in simple machines
4	Screws and bolts
5	The Wheel and Axle
6	Pulleys

Suggested teaching/learning activities

6.1 Definition of Simple Machines

Specific learning outcome

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

Teaching guidelines for Activity 6.1

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

- Improvise some of the materials. Help learners to locally assemble a bottle opener using a timber or a wire.
- 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 the students open the bottle using their hands and later use the opener. They then note down the observations and report their findings in a class discussion.
- Ask them to explain which other way they can apply to open the soda bottle. Some of them have opened the bottle using an edge of a bench or a table. Advise them that this is risky and may cause injuries and even break the bottle whose pieces are dangerous if swallowed.
- Ask them to explain the meaning of a machine.
- **Caution**: While using their hands to open the bottle it is advisable to remind them not to be careful not to injure themselves. Guide them in a whole class discussion on their findings.
- Summarise by emphasizing on the safety precaution when using a machine.

Assessment

Observation

- Are they able to observe and discover that it is easier to open the bottle using an opener than using the hands?
- Make sure every learner is actively participating and help them to carry out the activity.

Conversation

- Lead learners to discuss the above observation and be able to explain how the opener makes works. Let them explain. This way they will define a machine easily.
- Ask them to state examples of simple machines.
- Give them an opportunity to answer the above questions.

Product

- Check their work, findings, and observations. Guide those who may have difficulties.

6.2 Mechanical advantage, velocity ratio and efficiency of machines

Specific learning outcome

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.

Teaching guidelines for Activity 6.2

- This is an **investigation**. Your role as a teacher is to facilitate the learners to do the activity.
- Let learners organise themselves into groups. Ensure that they are of different abilities and gender (if any).
- Improvise some of the materials. Help learners to assemble an inclined plane from locally available materials such a timber and stones.
- All learners whether disabled or normal should participate actively during the lesson and in all activities.
- Ask them to conduct the investigation on the mechanical advantage (M.A), velocity ratio (V.R) and efficiency of machines.
- Allow them to report their findings in a class discussion.
- Heavy masses may be used the experiments involving an inclined plane. Warning should be given to students to prevent hands and feet from being caught between a moving heavy mass and floor or table surfaces. Students may not anticipate how difficult it is move or support stones, timbers and others.
- Use the activity to guide them in a discussion of the terms. M.A, V.R and efficiency of machines.
- Guide the student in group's discussion of Examples 6.1, 6.2 and 6.3.
- Ask them questions about this section to gauge the objectives of the lesson.

Assessment

Observation

- Ensure learners carry out the investigation and are able to observe and explain the results of the above activity in the student's book.
- Ensure every learner participates actively.

Conversation

- Ask them to present their findings in a class discussion.
- Do they demonstrate a good understanding of mechanical advantage, velocity ratio and efficiency of machines?
- To check their understanding, ask them question such as
  1. What are mechanical advantage, velocity ratio and efficiency of machines?
  2. How do we solve mechanical advantage, velocity ratio and efficiency of machines?
- Take them through examples 6.1 to 6.3 to cement the learning.

Product

- Check their work/reports, observations and findings.
- Do they demonstrate a good understanding of mechanical advantage, velocity ratio and efficiency of machines? Help them where necessary.
- Ask them to do Exercise 6.1 given in the student's book.

6.3 Types of simple machines

Specific learning outcome

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

6.3.1. Levers

Teaching guidelines for Activities 6.3 and 6.4

- In groups, guide learners to remove a nail from a wood using their hands and later a hammer.
- Caution them to be careful not injure themselves when using a claw hammer.
- Are they able to realize that it is easier when using hammer?
- Ask any member of the group to present their finding to the whole class.
- Allow other learners to point out omissions and errors on each fact given.
- Summarise their discussion by guiding them to classify levers into three groups.
- 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.

Assessment

Observation

- Watch them as they carry out the experiment and ensure they note down the observations.
- Are they able to tell and realize which task is easier? That is between using their hands or a claw hammer? Using their hands or a pair of scissors?
- Ensure active participation during the activity.

Conversation

- During group discussions, ask them which task is easier between using their hands or a claw hammer? And explain why during their group discussions.
- In groups let them discuss example 6.4 and 6.5 in the student's book.
- Do their explanations demonstrate a good understanding of classes of levers?
- Help them where necessary.

Product

- Check their work, answers and evaluate their presentations.
- Ask them to do Exercise 6.2 given in the student's book. Mark their work.

6.3.2. Inclined plane

Teaching guidelines Activity 6.5

- Improvise a locally assembled inclined plane. For example, learners can use a piece of timber and lean it against a wall.
- It may be necessary for students to use a locally assembled inclined plane to use various power tools contained in a wood or metal shop. In these situations, the teacher should be consulted for proper safety precautions necessary for each tool or machine.
- Long runways or heavy shorter ones should be handled by two persons. Ensure that a string is tied across the bottom of the runway, to prevent the trolley falling onto anyone.
- 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 student's research on the M.A., V.A & efficiency of an inclined plane and report their findings.
- In groups, allow the learners to perform Activity 6.6 on how length of the inclined plane affects M.A.

Assessment

Observation

- Help them as they carry out the activity to realize how the inclined plane makes work easier?
- Ensure active participation of all learners during the activity.

Conversation

- In groups, lead learners to discuss the observations in the above activity. Ask them to present their findings in a class discussion.
- Students are likely to be disappointed when they find that the values for $1/2\,mv^2$ and mgh do not agree. You will need to discuss the results.
  1. How reliable is the experiment?
  2. Where do students think that the energy might have been transferred to?
- Some energy will be transferred thermally, e.g. warming the pulley, and the load in the trolley.
- Probe them using probing questions to check their understanding.

Product

- Mark their findings and ask them to do Exercise 6.2 given in the student's book.

6.3.3 Screws and bolts

Specific learning outcome

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

Teaching guidelines Activity 6.7

- Let the learner perform activity 6.7on screws and bolts as a class experiment. Ensure they note down the observations.
- Through question and answer method, ask them various question for example, define the term pitch.
- Some screws are very sharp. They can injuries if not well handled. Learners must be cautioned to be careful when using the screws and bolts.
- Some learners may find it challenging when counting the number of threads. Please help them where necessary.

- 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

Assessment

Observation

- Are learners able to observe and explain the results of the above activity in the student's book?

Conversation

- Ask learners to discuss the steps, procedures and results in the above activity. Ask them to present their findings in a class discussion.

Product

- Ask them to do Exercise 6.2 given in the student's book.

6.3.4 The Wheel and Axle

Specific learning outcome

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

Teaching guidelines Activity 6.8

- Ensure that the group formed comprises disabled students in case they exist in your class. This will enable learners to appreciate others and boost their self-esteem as they from each other.
- With the help of locally available materials, ask learners to assemble a wheel and axle. Improve the V-shaped part by using a v-shape wood and joining to woods instead of a metal. They can use a rope made of sisal to pull an object.
- Let them demonstrate the working of the wheel and axle as a simple machine. Ensure they draw and fill the table provided.
- **Caution** learners that in this activity and other activities involving use of pulleys, exposed belts and pulleys must be covered with a shield. This prevents the hazard of broken belts, and of fingers or clothing being caught between belts and pulleys. Any device attached to a rotator should be fastened securely and checked for tightness frequently.

Loose clothing and long hair should be kept away from moving parts, and observers should not be in the plane of rotation.

- 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.

Assessment

Observation

- Are learners able to observe and discover the working of a wheel and axle?
- Ensure they note down their observations.
- Involve every learner in making of a pulley and doing the activity.

Conversation

- Ask learners to discuss the steps, procedures and results in the above activity. Ask them to present their findings in a class discussion.
- Do their explanations demonstrate a good understanding of the working of wheel and axle?

Product

- Mark their answers, reports and observations.
- Ask them to do Exercise 6.2 given in the student's book.

6.3.5 Pulleys

Specific learning outcome

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

Teaching guideline 6.6

- Organise learners into groups. Ensure that the groups comprises 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 in a discussion of their individual research of Activity 6.9 given in student's book and let the group secretary note the key points and harmonize them.
- Ask the groups to give a report on their findings to the whole class.
- Guide the learners through activity 6.9 and 6.10 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 6.6, 6.6 and 6.8 given in student's book as you guide them through.
- Ask learners to do exercise 6.3 given in student's book.
- Encourage the learners to solve as many problems as possible in the unit Test 6.
- Set aside a period to help the learners to discussing the difficult problems.

Assessment

Observation

- Are learners able to observe how the block and tackle works?

Conversation

- Guide learners to discuss how the pulleys work, solve problems involving pulleys.
- To check their understanding, ask them questions such as :
  1. How do we get the velocity of a pulley?
  2. How does a pulley work?

Product

- Ask them to do Exercise 6.3 given in the student's book and Unit test 6 in the student's book.
- Mark their work and guide them appropriately.

Answers to numerical questions

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. The following are answers for numerical question:

Exercise 6.1

1.	73.3%	**2.**	3600 J
3.	83.3%, 1800 J	**5.**	5.67

Exercise 6.2

3. (a) 4.4 (b) 66 N

Exercise 6.3

2. (a) 2 (b) 106 (c) 112.5 N
   (d) 67.5 J (e) 13.5 J
3. 307.6 N
4. 80%

Topic test 6

2. (c) 15 m (d) 2 250 J f. 2 400 J
3. (a) 4 (b) 75%
4. 33.33%
5. (a) 260 J (b) 2.167 (c) 50 N
6. (a) 85.7 (b) 131.8
7. (a) 2 m (b) 226 J (c) 180 J (d) 79.6 J
8. 75%
9. (a) 3 (b) 1.6 (c) 53.3%
10. (a) 3 (b) 88.9%
11. (b) 5 (c) 400 N (d) 2 000 J (e) 50 J
12. 1000 W

UNIT 5

The properties waves

Topics in the unit

Topic 7: Introduction to Waves

Topic 8: Sound Waves

Learn about	Key inquiry questions
Learners should investigate wave motion, types of waves and properties of waves and construct transverse wave through practical work. They should define speed, frequency, and wavelength and derive mathematical formula related to the given parameter. They should know the characteristics of transverse and longitudinal waves, be able to demonstrate individually how waves travel, and interpret graphical representations of transverse and longitudinal wave. They should know different types of waves, state the effects of waves, understand and use the terms displacement, amplitude, phase difference, period, frequency, wavelength and speed, compare transverse and longitudinal waves. They should know what is meant by wave motion as illustrated by vibration in ropes, springs and ripple tanks, construct a wave, represent waves in displacement-position and displacement-time graphs, relate the equations governing the motion of waves. Learners should develop their understanding about nature of sound waves and that sound is a longitudinal wave and is produced by vibrating systems. They should know that sound waves travel with different velocities in different media and velocity increases with temperature. They should differentiate between the ranges of frequencies detectable by the normal human ear and those not detectable, relate pitch and loudness to frequency and amplitude, estimate the speed of sound in air using echoes and state the uses of ultrasound, and find the relationship between energy and intensity of sound wave.	• What constitute a wave? • What parameters characterize a wave? • What evidence is there that wave exists? • How can we apply our knowledge of waves?

Learning outcomes		
Knowledge and understanding	**Skills**	**Attitudes and values**
• Understand and explain the motion, types and properties of waves	• Design tests to investigate waves using strings and ripple tanks. • Observe carefully • Predict cause and effect • Use appropriate measures • Collect and present results including representing waves in displacement-position and displacement-time graphs • Interpret results accurately • Report findings appropriately	• Appreciate the wave motion and that there are certain features common to all waves. • Appreciate use of ultrasound in medical diagnosis and radar

Contribution to students' competences

1. Creative and critical thinking

To achieve this in learners take them through derivation of mathematical formula and solving problems involving waves. Let them calculate period, frequency, time and wavelength.

By doing so, they will acquire creative and critical thinking skills.

2. Communication skills and co-operation

Involve learners in group work activities. They then discuss in groups, ask one another questions. Ask them questions too. This promotes in them communication skill and co-operation.

Links to other subjects

1. **Geography** -waves are used in the study of seismic waves.
2. **Medicine** - doctors use x-rays and other machines to treat patients in hospitals
3. **Mathematics** –learners calculate and solve mathematical problems involving waves.

Attention to special educational needs

- Learners often have different capacities and varying needs thus engage the quick learners to help the slow learners in understanding of concepts.
- For more guidance about attention to special needs students, refer to the introduction part of this teacher's guide

Topic 7 Introduction to waves

(Student's book page 198-217)

Background information and/or prior knowledge

What are some of the applications of waves in our daily lives? In this unit, assist learners to seek answers to these questions. Learners will learn about waves. Use simple experiments to demonstrate waves and common application of waves such a pendulum to explain the concepts. Later they will learn more about waves. That is sound, U.V lights and others.

Subtopics

Subtopic no.	Name of Subtopic
1	Oscillations
2	Characteristics of an oscillation
3	Factors affecting oscillations
4	Formation of waves and pulses
5	Characteristics of a wave motion

Suggested teaching/learning activities

7.1 Oscillations

Specific learning outcome

By the end of this section the learners should be able to define the term oscillation, investigate the characteristics of oscillations, state and explain the factors affecting the rate of oscillations.

Teaching guidelines for activities 7.1-7.3

- Learners have come across oscillations in daily life. For example most of them have come across a pendulum. Use this example to introduce the lesson. And if there is a pendulum in the school take them there to demonstrate practically that a pendulum is an example of an oscillation.
- In class, ask them to swing a pen using their hands for 20 seconds. Then they record the number of oscillations in 20 seconds.
- After the activity put them in groups to compare the number of oscillations they recorded and the directions in which the pen was swinging. They then define the meaning of

oscillation. Thereafter state and explain the characteristics of oscillations.

- What are other examples of oscillations?
- The aim of this introductory discussion is to whet students' appetite for learning more about waves. Waves are all around us and behave in interesting ways. You could answer students' questions with further questions.
- In groups guide them to do activities 7.1 to 7.3 about factors affecting oscillations.
- Allow them to discuss their observations and findings then ask them the following questions:
  1. How does length affect the rate of oscillations?
  2. How does mass affect the rate of oscillations?
  3. How does frequency affect the rate of oscillations?
- The point of these questions is to stimulate curiosity and to demonstrate that waves have some interesting properties. At an introductory stage, you must leave many questions unanswered.

Assessment

Observation

- Ensure learners are able to observe how oscillations work. For example a pendulum swings to and fro. This is one of the expected observations.

Conversation

- Put learners in group discussions the ask them to discuss about characteristics of oscillations. While they are discussing supervise their work and ask them probing questions. How are oscillations connected to waves?

Product

- Mark their observations and findings and guide them appropriately.

7.2 The concept of waves

Specific learning outcome

By the end of this section the learners should be able to define waves and pulses and investigate formation of waves and pulses, state and explain types of waves.

Teaching guidelines for activity 7.4

- In pairs, let one learner knock one end of a desk while the other one listens and touches the other end. Ask them to state what they observe.
- Some of them have come across a mobile phone vibrating. Ask them to describe the disturbance when it is vibrating.
- From the knowledge learnt in the previous lesson link the lesson to waves. Ask learners the following questions:
  1. What is a wave?
  2. Are oscillations waves?
  3. What are examples of waves?
- A lot of space is needed for students to demonstrate waves along ropes. If the whole class is to do this at one time, arrange to use a long, wide corridor or the school field.
- Ask learners to roll a rope on a flow such that it moves in manner in which it behaves like a wave. Draw students' attention to the way that the pulse diminishes in size as it moves along the rope. You may also want them to observe the inversion of the pulse after each reflection.
- Challenge the student holding the far end of the rope not to let their hand move. That they cannot do so always surprises and intrigues them - and makes it clear that energy is being delivered.
- Students may produce both continuous waves and standing waves without further instruction.
- To produce standing waves: mark off the rope into equal segments, such as fifths. Holding the ends of the rope tightly, each person makes a loose ring with a finger and thumb round the rope at the nearest marked point. One person then moves the rope up and down, adjusting the frequency until the 5-loop motion builds up. Different resonances can be produced, of course, by changing the frequency of the tension. This impedance matching will produce an effective standing wave.
- The Slinky spring should be at least 10 cm long when closed up. It is useful to tie a bright ribbon marker on one loop of the spring, so that students can watch how a single loop moves when a pulse passes it.
- If your main object with the slinky is to see how pulses and continuous waves travel, avoid distractions such as producing standing waves or making the Slinky walk down stairs. Pulses of different shapes will be seen if you demonstrate both a rubber tube and a slinky spring.
- With a slinky it is also possible to show travelling longitudinal waves by oscillating the end of the Slinky backward and forward

- Ensure they note the observations.
- Are they able to explain how waves are formed?
- Are they able to differentiate between longitudinal and transverse waves?
- Guide the appropriately.

Assessment

Observation

- Ensure learners are able to observe the formation of a wave using a rope. Supervise them and ensure each of them is able to note down their observations during the lesson.

Conversation

- In groups let them hold a discussion about formation and types of waves. Ask them to present their findings in a class discussion. While discussing, ask them probing questions to check whether they have mastered the concepts well.
- Are they able to differentiate between longitudinal and transverse waves?
- Students generally enjoy devising their own investigations, using materials readily found at home. From time to time, this can be a good alternative to standard homework, especially when it leads to writing short reports or oral presentations. Home experiments give valuable practise with practical problem-solving and with conceptual thinking for example: standing waves in a rectangular tank, standing waves under a running tap, step waves under a running tap and others. Task them to do the above activities and later present their findings in a class discussion.

Product

- Check their observations and findings. Are they correct? Ask them to do Exercise 7.1 given in the student's book. Mark their work later and give them some more work from supplementary books.

7.3 Characteristics of wave motion

Specific learning outcome

By the end of this section the learner should be able to explain and solve problems involving the characteristics of wave motion.

Teaching guidelines

- This section involves calculations. In groups, ask learners to discuss about characteristics of a wave motion. Ensure they note down their observations and findings.
- Ensure all learners, whether disabled or normal should be involved actively in performing the activity.
- Summarise the lesson by deriving formulae of calculating: period, amplitude frequency, speed and others. Ask them discuss Examples 7.1-7.7. Are they able to calculate the quantities?

Assessment

Observation

- Ensure learners are able to follow and note down some notes (formulae) during the lesson.

Conversation

- During discussions, ask them questions to determine their understanding i.e. what are some of the applications of waves?

Product

- Ask them to do Exercise 7.2 and Topic test 7 given in the student's book. Mark their work and assist those with difficulties.

Answers to numerical questions

Exercise 7.2

3. (a) 2 Hz (b) 0.5 s

5. 340 m/s 6. 1.5×10^{-4} 7. 533.33 Hz

10. b 2.5×10^{-4} (c) 4000 Hz (d) 140 m/s

11. a) (i) 300 Hz (ii) 0.00333 m/s (iii) 13.5 m/s (b) 18.52 s

14. (a) 1.1299×10^{-5} (b) 29 9999955 m/s (c) 301 361 970 m/s

15. 9 m 16. 2.4×10^{6} Hz

Topic test 7

6. (b) 2.5×10^{-4} Hz (c) 4 000 Hz (d) 140 ms^{-1}

7. (i) 300 Hz (ii) 0.0033 s (iii) 13.5 m/s

(b) 18.52 s

Topic 8 Sound waves

(Student's book page 218-244)

Background information and/or prior knowledge

One of the examples of a wave is sound. Sound is caused by a vibration. So sound is a wave. In the previous topic, learners learnt about waves. In this topic they will learn about sound as waves, the different between sound and noise and effects noise in the surroundings. Not forgetting the applications of sound in our daily lives. Use the knowledge they learnt in the previous topic to introduce this topic.

Subtopics

Subtopic no.	Name of Subtopic
1	Production of sound
2	Nature of sound waves
3	Human audible frequency
4	Ultrasonic sound waves
5	Characteristics of sound waves
6	Musical sounds
7	Propagation of sound
8	Speed of sound in solids, liquids and gases
9	Sound pollution

Suggested teaching/learning activities

8.1-8.3 Production of sound, sources of sound and nature of sound

Specific learning outcome

By the end of this section the learners should be able to investigate production of sound sources of sound and nature of sound.

Teaching guidelines for activity 8.1 and 8.2

- Improvise some of the materials required in these sections. For example learners can improvise a tuning fork by bending a metal wire into a shape like a tuning fork.
- In groups, ask learners to do activity 8.1-8.2 in the learner's book as they observe.
- Let them discuss to the class their findings. All learners, whether disabled or

normal should be involved actively in performing the activity. For instance, those with sight problem can be helped to push the wall or to sit on a chair.

- In these activities and others in this topic, rotators are sometimes used to demonstrate production of sound phenomena. Caution learners that any device attached to a rotator should be fastened securely and checked for tightness frequently. Observers should avoid contact with moving accessories such as toothed wheels, siren discs, etc. Loose clothing and long hair should be kept away from moving parts, and observers should not be in the plane of rotation. The use of safety goggles should be considered in student laboratories investigating rotating objects for example an electric bell. Extremely high-speed rotation should be avoided when possible. High speeds may cause some objects to fly apart unexpectedly.
- A strobe light is sometimes used to illuminate a rotating object, making the object appear to be at rest. If the object is a fan blade, a toothed wheel, or anything else with sharp edges, there is danger of injury from touching or inserting an object into the apparently stationary object. Students should be alerted to this danger.
- Choose suitable type of ruler for the experiment. Preferably the ruler can be made to vibrate freely with a slight force. Use G-clamp if deemed necessary. Do not use metre rule. Long ruler may give rise to accident if the ceiling fans are low.
- Strike the tuning forks on a rubber bung, not on any hard object like the bench top.
- Summarise the activity by helping the learners to understand that sound is produced through vibrations. Explain the various sources of sound and the nature.

Assessment

Observations

- Are learners able to observe vibrations of sound and hear various sounds produced by metallic springs, whistles and others?
- Ensure every learner is actively participating.

Conversation

- Give learners an opportunity to discuss the above observations and results from the above activity. Ask them present their findings in a class discussion.
- Do their explanations and presentations demonstrate a good understanding of the meaning of sound and how it is produced?
- Are they able to give examples of sources of sound?
- Ask: How do sounds travel so fast? Can sound waves in air travel faster than the wind?

- Ask: How do you know that sound carries energy?
- Help them where necessary.

Product

- Check their observations, reports, answers and their presentations.
- Ask them to do Exercise 7.1 given in the student's book.

8.4-8.5 Human audible frequencies and ultrasonic sound waves

Specific learning outcome

By the end of this section the learners should be able to investigate and explain human audible frequencies and ultrasonic sound waves.

Teaching guidelines

- Let learners discuss human audible frequencies and ultrasonic sound waves and present their findings to class.
- All learners, whether disabled or normal should be involved actively in performing 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 to investigate and explain human audible frequencies and ultrasonic sound waves. That is the human ear can detect sound waves of frequencies about 20 to 20 000 Hz. Ultrasonic sound is a sound wave that have a frequency above the human ear.
- Examples are ship siren and some factory sirens. Take them through example 8.1 and 8.2 in the student's book

Assessment

Observation

- Are learners able to observe the ears of their desk mates and the parts of the ear in the student book fig.8.6?
- Ensure every learner is actively participating.

Conversation

- Lead learners to discuss the above. While they are discussing ask them question to check their understanding.

- Are they able to approximate the values of frequency of sound the human can detect?
- Are they to explain the meaning of ultrasonic sound and its uses?

Product

- Check their findings, observations and any other written report and guide them well.
- Ask them to do Exercise 8.2 given in the student's book. Mark their work.

8.6 Characteristics of sound waves and musical sounds

Specific learning outcome

By the end of this section the learners should be able to investigate and explain characteristics of sound waves, resonant vibrations and musical sounds.

Teaching guidelines

- Ask the learners to discuss characteristics of sound waves and musical sounds.
- Prompt them to discuss their findings in a class discussion.
- All learners, whether disabled or normal should be involved actively in performing 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 to investigate and explain characteristics of sound waves and musical sounds.

Conversation

- Are learners able to discuss and demonstrate a good understanding of how pitches, intensity of sound, quality of timber affect musical sounds?

Product

- Evaluate their presentations and mark their answers.

8.7 -8.8 Propagation of sound, speed of sound in solids, liquids and gases

Specific learning outcome

By the end of this section the learners should be able to investigate and explain speed of sound in solids, liquids and gases.

Teaching guidelines

- This activity involves production of sound by an electric bell. Please borrow one from another school who has if your school does own one.
- Draw a chart of an electric bell and its parts to use in illustrating the electric bell and how sound travels.
- Let them discuss to the class their findings. All learners, whether disabled or normal should be involved actively in performing the activity. For instance, those with sight problem can be helped to push the wall or to sit on a chair.
- You should note that pupils who are exempted from physical education lessons for medical reasons especially those with ear problems should not be allowed to hear the louder sounds in this experiment.
- Ask:
  1. How do sounds travel so fast?
  2. Can sound waves in air travel faster than the wind?
  3. How do you know that sound carries energy?
- Summarise the activity by helping the learners to ***investigate*** and explain speed of sound in solids, liquids and gases using a tuning fork i.e. factors affecting speed of sound and how to calculate the speed of sound the formula; $v=\lambda f$. Take them through example 8.3 in the learner's book.

Assessment

Observation

- Are learners able to observe an electric bell and demonstrate role play the propagation of sound?
- Ensure each one of them is participating.

Conversation

- Are learners able to explain the propagation of sound in their group discussion and class presentations?
- Are learners able to investigate, explain and calculate the speed of sound in solids and in fluids?
- Are learners able to explain lighting and thunder?
- Are learners able to explain the factors affecting the speed of sound in solids and in fluids?

- Use the above question to check their understanding during conversation in class.

Product

- Evaluate their presentations and mark their answers.
- Ask them to do Exercise 8.3 given in the student's book.

8.9-10 Reflection of sound waves, speed of echo sound and sound pollution

Specific learning outcome

By the end of this section the learners should be able to investigate and explain reflection of sound waves, speed of echo sound and sound pollution.

Teaching guidelines for activity 8.6-8.8

- Ask the learners to work in groups.
- Ask them to do activities in the learner's book as they observe and note their observations.
- Let them discuss to the class their findings. All learners, whether disabled or normal should be involved actively in performing the activity. For instance, those with sight problem can be helped to push the wall or to sit on a chair.
- When the sound is reflected it is heard by ears. You should note that pupils who are exempted from physical education lessons for medical reasons especially those with ear problems should not be allowed to hear the echoes in this experiment.
- Summarise the activity by helping the learners to investigate and explain reflection of sound waves, speed of sound by echo method and sound pollution. Factors affecting speed of sound and how to calculate the speed of sound the formula; $v=\lambda f$.
- Take them through example 8.3 in the learner's book and prompt them to do Exercise 8.4.

Assessment

Observation

- Are learners able to observe and hear the echo sound?
- Ensure active participation.

Conversation

- Are learners able to explain the meaning of echo sound and it uses?
- Are learners able to calculate the speed of echo sound?

- Are learners able to explain the sound pollution?
- Use the above questions to ensure productive learning conversations.

Product

- Ask them to do Exercise 8.4 and 8.5 given in the student's book.

Answers to numerical questions

Exercise 8.1

5. i. 0.017

11. 247.5 m 13. 935 m 14. 342.85 m/s

15. 495 m

16. (a) 330 m/s (b) 1 120 m

Exercise 8.3

3. 258.3 m 4. 177.78 m/s

5. (a) 333.3 m/s (b) 833.3 m

6. 83 m

Exercise 8.4

3. 258.075 m

5. (a) 333.3 m/s (b) 833.3 ml

4. 177.78 m/s 6. 83 m

12. (a) 680 m (b) 5s

13. (a) 1 176 m

15. (a) 10 m/s

14. (b) 1 360 m (d) 5.0×10^{14} Hz

Unit test 8

10. 117.78 m

11. (a) 200 m/s (b) 833.3 ml

12. (a) 340 m (b) (ii) 170 m (ii) 3 s

13. (a) 1 176 m (b) 75

14. 1 360 m

UNIT 6

Heat transfer

Topics in the unit

Topic 9: Heat Transfer

Learn about	Key Inquiry Questions
Learners should revisit their prior learning and through practical investigation develop their understanding about heat and describe its effects on matter. They should know the coefficient of linear expansion and describe how to measure the value of this quantity for a metal rod or tube. They should investigate in groups the expansion of solids when heated to determine how different metals possess different coefficients of expansion. Learners should learn about the different types of transmission of heat and distinguish between good and bad conductors of heat. They should compare thermal conductivities by investigating how water, copper and iron conduct heat and design investigations to determine the coefficient of expansion of metals and determine if surface colour and sheen make a difference to heat conduction. Learners should know about conduction, convection and radiation design an experiment to show factors affecting heat transfer and explain applications of heat transfer.	• Why is heat important? • How can heat be produced? • Why is that the expansion of material a nuisance? • Why that a rough surface is a better emitter of radiation than a polished surface? • Why that a dull black surface is a better absorber of heat than a polish one. ?

Learning outcomes		
Knowledge and understanding	**Skills**	**Attitudes and values**
• Understand the nature of heat • and describe its effects on matter	• Design tests to show the factors affecting heat transfer, distinguish between conduction and radiation of heat, and between good and bad conductors of heat. • Observing carefully. • Predict expectations. • Use appropriate measures. • Collect and present results appropriate in writing. • Interpret results accurately. • Report findings appropriately. • Explain applications of heat transfer.	• Appreciate the application of modes of heat transfer

Contribution to student competencies

1. **Critical thinking** can be developed through investigating and identifying the different sources of energies, renewable and non-renewable and solving of problems.
2. **Communication and Co-operation** can be developed through group work in conducting experiments and presentation of the results. Asking and answering questions in class and consultation with teacher.

Links to other subjects

Biology and Chemistry

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.

Attention to special needs

- The unit comprises of numerous activities, you should involve the special need learners in these activities. For example, those activities that require use of hands they can be

assisted by others to observe and give their suggestion. Encourage the other student to appreciate suggestions of every student whether right or wrong.

- Some of the questions in the exercises can be given to gifted learners. Prepare additional more challenging questions for them learners. (See remedial questions for gifted learners at the end of this Teacher's guide unit)
- For slow learners, organise remedial lessons for them. Guide them through the activities and exercise once again and more slowly to help them understand.

Topic 9 Heat transfer

(Student's book page 246-278)

Background information and/or prior knowledge

In previous classes learners learnt about heat and temperature and its SI units, using the question answer method, ensure that they recall what they learnt before introducing this part of the unit. This is important because it will give learners a foundation to the concepts to be learnt in this section. Use simple experiments to introduce the language of energy and go on to include more terms that are advanced.

Subtopics

Subtopic no.	Name of Subtopic
1	Heat and temperature
2	Modes of heat transfer
3	Thermal expansion
4	Applications of thermal expansion

Suggested teaching/learning activities

9.1 Heat and temperature

Specific learning outcome

By the end of this section, the learners should be able to recall differences between heat and temperature.

Teaching guideline for activity 9.1

- In Secondary1 learners learnt about heat and temperature and its SI units, using the question answer method, review what they learnt before introducing this unit. This is important because it will give learners a foundation to the concepts to be learnt in this section.
- Organize the learner into suitable groups to perform activity 9.1. This is important because it will enhance teamwork and co-operation among the learners.

Caution!

Heat activities are sources of danger to the learners. Be alert all the time. Make sure you have first aid kit, firefighting equipment (that are working) to address the dangers posed by heating of thing. For example in this activity, instruct students that steam has a very high

heat capacity and is invisible (the visible "vapour" is already condensed droplets). Caution them not to aim steam outlets at their own skin or at other students.

- Develop a work sheet where the student should record their observations. Care must be taken by learners not to burn their fingers. It is advisable to try this activity in advance.
- Allow learners to discuss their findings among themselves. This will promote communication and critical thinking skills.
- Use the opportunity to point out errors in their findings as well as any omission.
- Through class discussion ask the learners the following questions:
    1. Differentiate between heat and temperature.
    2. What are the units and instruments for measuring heat and temperature?

Assessment

Observation

- Ensure learners are able to observe that when the same amount of heat energy is supplied to equal masses of two different substances that are initially at the same temperature, they both gain equal amounts of heat energy but their temperature rise to different values.

Conversation

- Involve learners in a class discussion and thereafter let them present their findings in a class discussion.
- Are they able to differentiate heat and temperature?

Product

- Mark their work, observations they noted down and findings about heat and temperature.

9.2 Methods of heat transfer

Specific learning outcome

By the end of this section the learners should be able to explain the different modes of heat transfer

Teaching guidelines for Activity 9.3

- This is an investigation. Your role as a teacher is to guide and facilitate for the investigation. Let learners design and conduct the investigation by themselves. While facilitating ensure the following:

- Guide them through the activity and let them discuss how heat is transferred by conduction.
- While they are conducting the investigation, ensure that, gas burners should be kept away from the body at all times. The pressure of the gas should be adjusted to allow proper ignition. Too high a pressure tends to blow the flame out. Do not allow gas to accumulate if ignition is delayed for any reason.
- Hold a discussion with learners to summarize their discussion.
- Having done the activity and discussed their findings, emphasis the following facts:
- There are three modes of heat transfer; conduction, convection and radiation.
- Ask them the following questions:
  1. Which modes of heat transfer that require medium of transmission and which one does not?
  2. What is Conduction?
  3. Is temperature difference or gradient needed for heat to flow in a solid?

Teaching guidelines for Activity 9.4

- Working in groups will promote personal and interpersonal management and cooperation among learners.
- A common cause of student injury is a burn from recently heated glassware. To avoid such burns, tell the learners to check the glassware, pins or wax by bringing the back of the hand close before attempting to pick it up. In case of an accidental burn, administer first aid and visit the appropriate health care person in the school or nearest health centre.
- Lead the learners through the steps of the activity and allow them to discuss their findings.
- Summarise the discussion that a temperature difference or gradient is needed for heat to flow in solids.
- Guide the discussion given in the student's book to clarify the findings from their discussion.

Teaching guidelines for Activity 9.5

- By now, learners should be aware of forming suitable groups that is, taking consideration of gender balance and different abilities of learners. Now organise them into suitable groups and provide them with the suggested materials for the activity.
- Many substances, especially glass, remain hot for a long time after they are removed from the heat source. Advise learners to always check objects by bringing the back of the hand near them before attempting to pick them up without tongs, hot pads, or gloves.

- Ask learners to do activity 9.5 in the student's book i.e. to show that heat transfer in solids depends on the material. This activity involves use of fire; great care must be taken by learners to avoid any incident that may be caused by fire if handled carelessly.
- Guide the learners through the activity and allow them to discuss their findings.
- Ask them the following questions:

1. Compare the rate of conduction of copper, aluminum and iron.

Teaching guidelines for Activity 9.6

- Working with the same groups used in activity 9.5, ask learners to do activity 9.6 in the student's book, that is, to observe convection current in water. Working in groups is important since it will promote teamwork and cooperation in learners.
- Guide them through the steps of the activity and allow them to do and discussion their findings on their own.
- While doing the activity it is good to note that, production of steam under pressures higher than atmospheric pressure should be limited to your demonstrations. You should therefore take necessary precautions associated with the higher temperatures of this steam and the explosion hazards.
- Remind pupils to handle hot water carefully to avoid heat burns.
- Hold a discussion with the learners on their finds.
- Having done the activity, hold a discussion with the learners to emphasise that convection is the heat energy transferred by the convection current in the liquid.

Teaching guidelines for activities 9.7 and 9.8

- Organise learners into appropriate groups depending on the availability of suggested materials. Prompt them to see the need of having a group leader and the secretary.
- Ask the groups to do activities 9.7 and 9.8 given in the student's book, that is, to illustrate convection in air and to illustrate that convection current possesses energy respectively. This will promote leadership skills, co-operation and teamwork among the learners.
- Allow the learners to discuss their findings among themselves. Listen how they discuss and guide them where necessary. This is important since it will give you opportunity to monitor and promote the communication skills of your learners.
- Go around ensuring that the main outcome s of these activities, that is, to observe and illustrate that convection current possesses energy.

- Hold a whole class discussion and ask the groups to give the summarized report to the class. Use the opportunity to point out omissions and correct any error in each report presented.
- The learner having done the two activities (9.7 and 9.8), let them understand the fact that heat is transferred in air through convection current. This convection current possesses energy.

Teaching guidelines for activities 9.9 and 9.10

- Organise learners into appropriate groups, that is, if the class is mixed, ensure you have the gender balance (i.e., equally number of boys and girls, if possible) and also they are of different abilities (slow and gifted learners). This will help learners to appreciate the factor that all students (whether boys or girls) should be given equal opportunity to learn and also to promote the sharing of ideas and co-operation among them.
- Ask the learners to do activities 9.9 and 9.10 given in the student's book, that is, to demonstrate heat transfer by radiation, to illustrate good and bad absorbers and to illustrate good and bad emitter respectively.
- With your guidance, lead them through the steps doing the activities.
- In this activity and other activities involving use of thermometers, it is good to note that thermometers present several possible hazards in the laboratory related to breakage and spillage of mercury. Following and cautioning the learners the following guidelines below will minimize the hazards.

  a) Use alcohol thermometers in place of mercury thermometers to eliminate the hazards associated with mercury spills.

  b) Consider the range of temperatures to be measured when choosing a thermometer. If heated beyond its capacity, a thermometer may break.

  c) Mount a thermometer in a safety rubber stopper whenever possible. When using other types of stoppers, use a lubricant on the glass or a split stopper. If necessary to free the thermometer from the stopper, split the stopper with a single-edge razor blade. Teachers should ensure that students use the thermometer in such a way that the equipment does not become unstable.

  d) If a mercury thermometer is used, be alert to the potentially serious hazard of a mercury spill. Instruct students that they must report any such breakage immediately and remove any source of heat which is present. Each laboratory where mercury is used should be equipped with a mercury-spill kit. Follow the directions that come with the kits.

- Give them few minutes to discuss their findings and let them write down the main points from the discussion. This will promote communication and leadership skills.
- Hold a whole class discussion and ask the groups to give the summarise report to the class. Use the opportunity to point out omissions and correct any error in each report presented.
- Ask the learners the following questions:
  1. What is radiation?
  2. Distinguish between:
     a) a good absorber and bad absorber
     b) a good emitter of heat and bad emitter of heat

Assessment

Observation

- Are learners able to feel how the metals get hot at the other end?
- Are they able to see the convection currents in water?
- Are they able to see the convection air current?
- Are they able to differentiate good conductors from bad conductors?

Conversation

- Prompt learners to discuss the observations and results in the above activity.
- Ask them present their findings in a class discussion.
- Are they able to explain conduction in solids?
- Are they able to explain convection in fluids?
- Are they able to explain radiation in gases?
- Are they able to identify, explain and distinguish between good and bad conductors of solids?
- Do their explanations demonstrate a good understanding of heat transfer?

Product

- Check their observations, reports, evaluate their presentations and guide them appropriately.
- Ask learners to do questions 2-6 of exercise 9.1 given in the student's book.

9.3 Applications of heat transfer

Specific learning outcome

By the end of this section the learners should be able to state the application of heat transfer

Teaching guidelines for 9.11

- Learners have interacted with vacuum flask, they have seen ventilations in their houses, and they may have seen solar heater and domestic water system. Through question and answer method inquire whether the learners have any idea on each of them. Use their suggestions whether wrong or right to introduce this part of the unit. This is important because it will raise the curiosity of learners to understand each of them well.
- Ask the learners to do activity 9.12 given in the student's book, that is, to carry out a research on the applications of heat transfer.
- In case a vacuum flask is used to demonstrate learning, advice learners to handle the vacuum flask with care to avoid accidental breakage of the flask. It is always safe to prepare a wooden stand to hold the vacuum flask.
- With your guidance, lead them through the steps of doing a comprehensive research on application of heat transfer. Note that some student may open different sites such as Facebook, twitter and instagram thus deviating from the main purpose of research. It is therefore important to go around the class and check whether they are doing the right thing. It is very important for Learners to know how to do a constructive research by their own since it will be promoting their research and problem solving skills that will be useful in their life time (lifelong learning).
- Give them few minutes to discuss their findings and let the group members write down the main points from the discussion. This will promote communication and leadership skills.
- Hold a whole class discussion and ask the groups give the summarise report to the class. Use the opportunity to point out omissions and correct any error in each report presented.
- Use field trips to show the learners more devices that apply heat transfer and are not available near your school.
- The devices used to show the application of heat transfer, allow the learners to explore how the 3 modes of heat transfer are employed.
- Emphasize on which mode is predominantly used and why. Refer to the discussion given in the student's book for explanation.

- Guide the learners through the discussion given in the student's book on applications of heat transfer.
- Choose one device e.g. solar heating and develop a project. Engage all the learners in this project.

Assessment

Observation

- Are learners able to observe some of the applications of heat transfer?
- Ensure active participation while conducting the activity.

Conversation

- Are learners able to show how heat transfer is applied in some of the application such as a thermos flask?
- Are learners able to state and explain application of heat transfer?

Product

- Evaluate their explanations during presentation to check their understanding.
- Mark their projects as a sign of understanding of the application of heat transfer
- The marking scheme should show the acquisition of knowledge, skills and attitude envisaged in the syllabus.
- In addition, ask the learners to do question 7 of exercise 9.1 given in the student's book.

9.3 Thermal expansion

Specific learning outcomes

By the end of this section the learners should be able to;

i. Explain thermal expansion of solids

ii. Solve problem related to expansion

Teaching guidelines for activities 9.12, 9.13, 9.14 and 9.15

- Organising learners into suitable groups to perform activities 9.12- 9.15 in a rotation basis.
- You may consider making a trip to a railway tracks near or far from your school with your students. Identify the rail, gap rigid support and fishplate. Let the students suggest why they are there.
- Allow the learners to report their finding to class.

- Hold a class discussion on their finding from each activity.
- In Secondary 1, learners learnt that the molecules in solid are closely packed and are in continuous vibration about a fixed position. Use this to help the learners explain why solids expand on heating.
- Use model of marbles in a tray to also explain the behaviour of molecules in solids.
- Allow the learners to discuss the application thermal expansion.
- Emphasize that when you are talking about expansion, contraction is implied i.e. heating and cooling usually goes together.

Assessment

Observation

- Are learners to observe and draw the shape of a bimetallic strip after heating and expanding?
- Ensure every learner is actively participating.

Conversation

- Are learners able to explain thermal expansion?
- Are learners able to explain the bimetallic bends inward when heated or after cooling?
- Do their discussions or explanations demonstrate a good understanding of thermal expansion?

Product

- Check their drawings and sketches of a bimetallic strip. Are they correct?
- Discuss with learners Example 9.1, 9.2, 9.3 and 9.4 in the student's book on the chalkboard to explain the coefficient of expansion.
- Give exercise 9.2 given in the student's book as take away assignment. Mark and use it to judge the learners competence use.

Teaching guidelines for activities 9.17, 9.18 and 9.19

- The teacher may do these activities as additional activity. Therefore the he/ she may decide to maintain the groups formed earlier.
- Ask them to do activities 9.17-9.19 in the student's book.
- Lead the learners through the activities.

- Having done the activity, hold a discussion with learners on the concepts discussed in the student's book after each activity.

Teaching guidelines for activities 9.20

- Organise the learners into appropriate groups depending on the suggested materials in the student's book. The teacher should always remember that it is good for learners to work in groups but those groups formed should reflect gender balance (in case of a class comprises of boys and girls) and different abilities (slow and faster learners).
- Ask learners to do activity 9.20 in the student's book i.e., to conduct a research on expansion and contraction.
- Guide the learners on how conduct a research from Internet. Note that some learners may open different sites from the expected one; therefore it is important for the teacher to go around and guide them properly. This will promote research skill in learners.
- Allow them to discuss their observation from the activity. This will enable learners to realise the importance of teamwork and it will enhance communication skills in them.
- Go around ensuring that the main outcome of this section (i.e. Able to highlight and explain dangers associated with power generation and transmission) is realized by learners.
- Again, in this activity as other activities involving use of thermometers, it is good to note that thermometers present several possible hazards in the laboratory related to breakage and spillage of mercury.
- Ask the learners to report their findings through their secretaries. Time may be insufficient, so let each group give a brief summary.

Assessment

Observation

- Are learners able to observe and identify the materials that expand more than others?

Conversation

- Are learners able to state and explain the factors that affect linear expansitivity?
- Are learners able to explain why some materials expand more than others?
- Are learners able to solve problems involving thermal expansion?
- Are learners able to state and explain the applications of thermal expansion?
- Do their answers demonstrate a good understanding of thermal expansion?

Product

- Check their work, drawings and evaluate their presentations. Give exercise 9.2 and 9.3 as take away assignment. Mark and use it to judge the learners competence use.

Answers to numerical questions

Exercise 9.2

2. 26 m **3.** 0.013889/k **4.** 1.075 cm^3, 241.075 cm^3

5. 0.4454 cm^3, 96.4454 cm^2

Topic test 9

9. 200.166 cm^3

UNIT 7

Magnetism

Topics in the unit

Topic 10: Magnetism

Learn about	Key inquiry questions
Learners should revisit their prior learning about magnetism and through practical investigation in pairs and groups they should develop understanding about magnetism and explain the properties of magnets. They should describe and identify the polarities and strengths of a magnet, distinguish between magnetic and non-magnetic substances and describe the action of one magnet on another to observe that like poles repel each other and unlike poles attract one another. They should relate this to learning about electricity and heat transfer. Learners should magnetize a steel bar by electrical induction and the method of single and divided touch. Individually and in groups they should investigate magnetic fields. They should be able to use a compass and understand declination and inclination.	• Why a compass needle does always points to the north? • Why that some magnets are classified as strong? • Why that a point is identified as neutral in magnetic field lines? • Why would you shield a small compass needle from earth's magnetic field? • Why do we use soft iron keeper?

Learning outcomes		
Knowledge and understanding	**Skills**	**Attitudes and values**
• Understand the theory of magnetism and explain the properties of magnets	• Design investigations to determine the polarities of magnets, methods of magnetization and demagnetization, and how to distinguish between magnets and non-magnets. • Carry out accurate observation. • Recording results accurately in appropriate way. • Analysis of results in groups. • Explain analysis and consider applications.	• Appreciate the properties of magnets in construction of simple compass.

Generic competencies addressed in this unit

- Co-operation 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 learner's 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.

Attention to special educational needs

- This is 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.
- For more guidance about attention to special needs students, refer to the introduction part of this teacher's guide.

Topic 10 Magnetism

(Student's Book page 280-311)

Background information and/or prior knowledge

Most of the students have interacted with magnets in their daily lives. They also have an 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.

Build the familiar concepts to the learners to introduce the concept of magnetization and demagnetization of a magnet. Engage your learners in all activities given in this unit to bring the concept closer and evasion for them to understand.

Subtopics

Subtopic no.	Name of Subtopic
1	Definition of a magnet
2	Magnetic and non-magnetic materials
3	Properties of magnets
4	Test for magnetism
5	Types of magnets
6	Magnetic field pattern around a magnet
7	Magnetization and Demagnetization

Suggested teaching/learning activities

10.1 Definition of a magnet

Specific learning outcome

By the end of this section, the learner should be able to identify a magnet from other materials and define the term magnet.

Teaching guidelines for activity 10.1

- Group learners into groups of three. All learners whether disabled or normal should participate actively in the group.
- 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.

- Always check the number of magnets given out to the learners otherwise; you are likely to lose a number of them.
- 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 members 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.

Assessment

Observation

- Are learners able to indentify magnets?
- Ensure every learner is actively participating.

Conversation

- Are they able to define the meaning of a magnet?
- Ensure active participation during class discussion.

Product

- Evaluate their answers and discussions and help them where necessary.

10.2 Magnetic and non-magnetic materials

Specific learning outcome

By the end of this section, the learner should be able to identify magnetic and non-magnetic materials.

Teaching guidelines for activity 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 members or any other member of the group. Allow other members of the class to point out omissions or errors in the table.
- 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.
- **Caution:** Large permanent magnets and electromagnets may attract opposite poles or steel objects with unanticipated force. Students should be warned of the potential risk of pinching their hands between object and the magnet. In addition, exposed terminals on electromagnets should be insulated to prevent electric shock hazards.

Assessment

Observation

- Are learners able to identify magnetic and non-magnetic materials?
- Ensure active participation during the activity.

Conversation

- Are learners able to identify magnetic and non-magnetic materials?
- Ask them the following questions:
  1. Which materials are strongly attracted to a magnet and how they are referred to us?
  2. Which magnetic materials are used to make magnets?
- Give them an opportunity answer the above questions?

Product

- Evaluate their presentations, answers and explanations. Guide them where necessary.
- Ask them to do Exercise 10.1 given in the student's book.

10.3 Properties of magnets

Specific learning outcome

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 colour paint.

Teaching guidelines for activity 10.3-10.5

- 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 fillings 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 members and allow other members to point out the omissions and errors in the facts presented.
- 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.
- Iron filings must be kept out of eyes (and sinks). It is worth warning the class to keep fingers away from faces when iron filings are around.
- 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 the following questions:
  1. The bar magnet rests in which direction?
  2. The pole of a magnet that points to the direction of North Pole of the earth is called?
  3. In addition, the other, which points to the direction of South Pole of the earth, is?
  4. Which colour that represents the North Pole and the South Pole?
- Use this opportunity to point out the errors made in their discussion and assess whether the objectives have been made as you conclude.
- Sometimes students get into a tangle about North-seeking and South-seeking poles when they learn that the Earth is a big magnet, and that the pole that is geographically to the North must be a South-seeking pole. So at this stage it is unhelpful to shorten 'North-seeking pole' and 'South-seeking pole' into plain North and South poles

- **Caution:** Ensure learners do not get filings on magnets as they are very difficult to remove (many teachers have found out to their cost) so keep a sheet of paper over the magnet.

Assessment

Observation

- Are learners able to observe the ends of a bar magnet where iron fillings are seen to be more concentrated and the line that divides a magnet into two equal parts?
- Ensure every learner is actively participating.

Conversation

- Are learners able to identify the poles of a magnet and tell which is a north pole and the south pole?
- Are learners able to identify the directional property of a magnet?
- Are learners able to identify the poles of a magnet by color?

Product

- Evaluate their explanations, answers, presentations and their observations.
- Do their explanations demonstrate a good understanding of properties of a magnet?

10.4 Test for magnetism

Specific learning outcome

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.

Teaching guidelines for activity 10.6-10.7

- Let the groups 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 members 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.

- Permanent bar magnets' are bar-shaped magnets with opposite poles at either end. 'Magnadur magnets' are ceramic magnets with their poles on their flat faces. (It is interesting to see if the students can discover this for themselves.) See the illustrations. These magnets can come to no harm magnetically, but being ceramic can chip and fracture like china. If two are placed near to each other, oriented to attract, they may move together with sufficient violence to do damage.
- One of the pairs of magnets should be strong enough so that, when separated by a few centimetres, students can feel attraction and repulsion.
- A large permanent magnet should be used with teacher supervision.
- Guide them in a class discussion of their results of the activity. Through the discussion give them a chance to answer the following question:
  1. What is the basic law of magnetism?
  2. What is the surest way of testing magnetism?

Assessment

Observation

- Are learners able to observe?
  a) A south pole repels a south pole?
  b) A south pole attracts North Pole?
  c) A north pole attracts a south pole?
  d) A north pole repels North Pole?

Use this chance to correct errors made during the activity.

Conversation

- Are learners able to state the basic law of magnetism?
- Are learners able to identify that repulsion is the surest way of testing magnetism?
- 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.

Product

- Evaluate their presentations and answers. Help them where necessary.

10.5 Types of magnets

Specific learning outcome

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.

Teaching guidelines for activity 10.8

- 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
- Hard magnetic materials e.g. steel nails 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. Guide the learners through the uses of each as discussed on the student's book.
- **Caution:** Large permanent magnets and electromagnets may attract opposite poles or steel objects with unanticipated force. Students should be warned of the potential risk of pinching their hands between object and the magnet. In addition, exposed terminals on electromagnets should be insulated to prevent electric shock hazards.

Assessment

Observation

- Are learners able to observe that the nail becomes a magnet?

Conversation

- Are learners able to explain that when a current carrying conductor is coiled around a magnet material it gets magnetized?
- Are they able to explain the above observations?
- Are they to explain the uses of magnets?
- Are they able to distinguish between permanent and temporary magnets and their uses?

Product

- Evaluate their observations, explanations and presentations.
- Do their explanations demonstrate a good understanding of types of magnets?

- Ask them to do Exercise 10.1 given in the student's book.

10.6 Magnetic flied pattern around a magnet

Specific learning outcome

By the end of this section, the learner should be able to discuss magnetic field pattern on a round magnet.

Existence of magnetic field around a magnet

Teaching guidelines for activity 10.9 -10.10

- 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**
- Let them discuss in their groups their observations and drawings as the secretary prepare the final findings to present to the whole class.
- Small plotting compasses are very cheap. Badly balanced ones or those with sticky pivots should be discarded. Polarity is easily reversed; students should check which is the north-seeking pole of the compass needle. If their magnetisation is weak, they will oscillate slowly in the Earth's field. To strengthen their magnetisation, place them in a strong field, for example between poles of a pair of strong bar magnets.
- Ask the groups to present their findings to the whole class and all other members to point out errors and omissions in the facts presented.
- **Caution:** Ensure learners do not get filings on magnets as they are very difficult to remove (many teachers have found out to their cost) so keep a sheet of paper over the magnet. If iron filings get on the poles of a magnet, they can be removed by rolling plasticine over the poles.
- Warn the class to keep fingers away from eyes. Iron filings inadvertently carried to the eyes can damage the cornea.
- Summarize 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.
- Large charts of magnetic fields can be plotted out with a compass to make a classroom display.

Assessment

Observation

- Are learners able to observer how iron filings aligns themselves around a magnet and draw the magnetic patterns.

Conversation

- Learners to discuss the steps, procedures and results in the above activity. Ask the present their findings in a class discussion.
- Give them an opportunity the following questions:
  1. The space around a magnet where attraction or repulsion is felt is called?
  2. The pattern displayed by the iron filings represents?
  3. The magnetic line of force always originates from?
  4. Do the magnetic field lines cross each other?
- Do their explanations demonstrate a good understanding of magnetic field patterns of around a magnet?

Product

- Ask them to do Exercise 10.1 given in the student's book.
- Use this opportunity to ascertain whether the objectives have been achieved and identify challenges or areas to be discussed with learners during remedial hours.

10.7 Structure of an atom and domain theory of magnetisation

Specific learning outcome

By the end of this section, the learner should be able to name the composition of an atom and explain the origin of magnetism, state and explain the domain theory of magnetism.

Teaching guidelines for activities 10.11-10.12

- This part tries to explain the origin of magnetism. It is a brilliant idea to do sufficient research from internet or references books available. This will place you in better position to explain to your learners satisfactory.
- Organize learners into appropriates groups depending on the numbers of stations of the assemble materials.
- Let them discover that the spinning of electron about.

- For learners to understand magnetization and demagnetization, this part is fundamental. Emphasize on the dipoles, domains and how the domain theory is started to your learners. It is a good idea to read widely from different physics reference books and internet to be able to guide your learners adequately.
- Care should be taken not to destroy (bar magnets one is enough to demonstrate the concept on this section.
- Give them an opportunity to answer the following questions:
  1. The smallest molecule of a magnet (has both north and south) is called?
  2. The tiny region occupied by dipole is called?
  3. Domain theory states that?

Assessment

Observation

- Are learners able to draw the structure of an atom?
- Are learners able to observe the small pieces (dipoles) of magnets and how they arrange themselves when un-magnetized and when magnetized?

Conversation

- Are learners able to explain the domain theory?
- Do their explanations demonstrate a good understanding of domain theory and structure of man atom?

Product

- Check their drawings, evaluate their presentations and answers.
- Conclude this part by assessing whether the objectives have been attained through question answer methods

10.7.3 Magnetisation

Specific learning outcome

By the end of this section, the learner should be able to define magnetisation and explain different methods of magnetisation.

Teaching guidelines for activities 10.13-10.19

- This section is one of the main parts of this unit. You are, therefore, advised to take your time to guide your learners well. Let the learners note that magnetisation by stroking

only occur when a magnet is facing north-south direction. Similarly, let them note that magnetisation by electrical method only occurs when a direct current is passed through a magnetic material.

- Ask learners to group themselves into appropriate groups. Ensure that the groups formed comprise the right number of students (let them avoid surrounding at one group).
- Ask them to do activity 10.13, 10.14, 10.15, 10.16, 10.17, 10.18 and 10.19 on various methods of magnetisation given in the student book. Let the group leader lead others to do the activities on methods of magnetisation.
- Eye protection should be worn.
- While they are doing the activities and discovering the methods of magnetizations, it is important to emphasize that in hammering method, when hammering the magnetic materials they should be hammered while facing north- south direction. Unlike magnetisation, the method of demagnetisation by hammering and electrical method emphasizes on east-west direction and using of alternative current respectively.
- Guide the learners through the activity and allow them to discuss their findings.
- Summarize their discussions by pointing out that magnetisation is the process of making a magnet from a magnetic direction materials.
- While discussing ask them to answer the following questions:
  1. State and explain methods of magnetization.
  2. Do the ends of magnetic material being magnetised attain the pole opposite to that in the end of magnet touching it?
  3. During double stroking method, if similar ends are used, the magnetic material attains which poles at both of its ends?
  4. How is magnet magnetised?
  5. Which materials are easily magnetised and demagnetized?
  6. What is magnet shielding?
  7. How do we store magnets?

Assessment

Observation

- Are learners able to discover the easiest method to magnetize a magnetic material?
- Are learners able to observe how the magnetic materials are magnetised?

- Are they able to observe and identify magnetic materials that are easily magnetised and easily demagnetized and those that are hard to magnetise and demagnetize?
- Ensure maximum participation from learners during learning and doing the activities.

Conversation

- During class discussions, are learners able to explain their observation and how magnetisation takes place?
- Do their explanations demonstrate a good understanding of magnetisation?

Product

- Check their drawings, observations and evaluate their presentations. Guide them where necessary.
- Ask them to do topic test 10 and mark their work.

10.7.4-10.9 Demagnetisation, soft and hard magnetic materials and methods of storing magnets

Specific learning outcome

By the end of this section, the learner should be able to define demagnetisation and explain different methods of demagnetisation.

Teaching guidelines for activities 10.20-10.25

- Ask learners to group themselves into appropriate groups. Ensure that the groups formed comprise the right number of students (let them avoid surrounding at one group).
- Ask them to do activity 10.20, 10.21, 10.22, 10.23, 10.24 and 10.25 given in the student book. Let the group leader lead others to do the activities on methods of demagnetisation.
- Emphasize that, unlike magnetisation, the method of demagnetisation by hammering involves hammering the magnetised material in east-west direction and electrical method involves using of alternative current respectively.
- In activity 10.16 on electrical method of demagnetisation, some magnetising and demagnetising coils are powered by mains a.c. Only use them if they have been inspected and tested for electrical safety.
- Guide the learners through the activities and allow them to discuss their findings.
- While discussing ask them the following questions:
    1. What is demagnetisation?
    2. State and explain methods of demagnetisation.

3. Do the ends of magnetic material being demagnetised attain the pole opposite to that in the end of magnet touching it?
4. How is a magnet demagnetized?
5. What are the methods of demagnetisation?
6. Which materials are easily magnetised and demagnetized?
7. What is magnet shielding?
8. How do we store magnets?

Assessment

Observation

- Are learners able to observe how the magnetic materials are demagnetized?
- Are learners able to discover the easiest method to demagnetize a magnetized material?
- Are they able to observe and identify magnetic materials that are easily magnetised and easily demagnetized and those that are hard to magnetise and demagnetize?
- Ensure maximum participation from learners during learning.

Conversation

- During class discussions, are learners able to explain their observation and how magnetisation takes place?
- Do their explanations demonstrate a good understanding of magnetisation and demagnetisation?

Product

- Check their drawings, observations and evaluate their presentations. Guide them where necessary.
- Ask them to do Exercise 10.2 in the student's book and mark their work.
- Ask them to do topic test 10 and mark their work.

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.

NOTE:

Mark correct answers given by students.

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