10

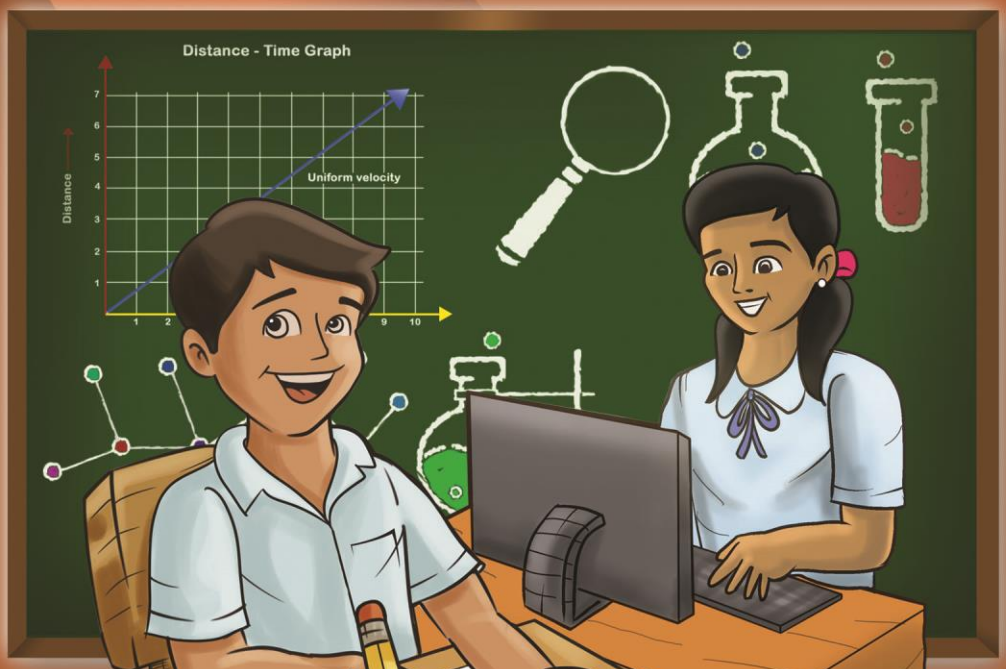
NATIONAL LEARNING CAMP

DepED DEPARTMENT OF EDUCATION

Science

Consolidation Learning Camp

Lesson Plans



Consolidation Learning Camp

Lesson Plans

Science Grade 10

Weeks 1 to 3

Contents

Dear Reader

Every care has been taken to ensure the accuracy of the information provided in this Booklet. Nevertheless, if you identify a mistake, error or issue, or wish to provide a comment we would appreciate you informing the **Office of the Director of the Bureau of Learning Delivery** via telephone numbers (02) 8637-4346 and 8637-4347 or by email at bld.od@deped.gov.ph

Thank you for your support.

National Learning Camp Overview

Overview

The National Learning Camp (NLC) aims to enhance student and teacher learning through interactive lessons based on prior educational content. The program focuses on consolidating student knowledge, updating and expanding teacher expertise, and applying research-based strategies to improve learning teaching outcomes.

The NLC offers grade-level review lessons that are directed by the teacher and designed to be highly interactive among:

(i) students with their teacher; and
(ii) students with their peers.

The Camp lessons are grounded in the 'Science of Learning' framework, focusing on cognitive research and practical applications to enhance learning outcomes. Lessons are structured to reinforce foundational knowledge and skills, involve real-world problem-solving activities, and encourage higher-order thinking. The Camps also offer teachers opportunities for reflection and professional growth, encouraging the adoption of new teaching approaches and the extension of student learning through systematic review and application of knowledge.

Design Basis

A strength of the design is the focus on both student and teacher learning. The intentions and expectations of the NLC are for:

- students to consolidate and enhance their thinking in topics already covered;
- teachers to update, strengthen and expand their subject knowledge in ways that encourage students to be involved in learning activities at different levels including those considered as higher order.
- teachers to enhance their pedagogical practices by focusing on selected skills, which include 21st century skills; and

Under the framework of 'Science of Learning', research-evidence is used to ground teaching and learning decisions around cognition research and features of a learning brain such as working memory demands, cognitive load, valuing errors, and domain specific skills. This framework highlights a *learning-focused approach* where teachers go beyond what might be considered current practice in the Philippines and incorporate brain-based ideas and approaches, including 21st Century skills, to make teaching more effective in enhancing learning for all.

To further support this direction, teachers are provided with resources, time and the opportunity to further extend their skills, knowledge and understanding of teaching and how students learn. The review lessons are designed to apply subject content already encountered by students. Because of this, lessons do not contain repetitive, routine questions of a particular subject aspect.

Review lessons

The review lessons are based on content already encountered by students in their current grade. All lessons *involve an exploration of ideas, concepts and content*. The purpose of the review lessons is two-fold:

(i) to establish in students a stronger basis for future learning development (prior to enrolling in a new Grade after the summer break); and

(ii) to enable teachers to strengthen and enrich their teaching practice in a research-based, learning-focused professional program (prior to a new academic year).

The primary focus of the review lessons concerns revising, clarifying and then applying previously-taught subject content with real-world problem-solving and/or comprehension activities. Each lesson begins by a focused content review and clarification of material needed in the lesson to come. For students, this initial review enables them to practice retrieving and practicing important basics relevant to the lesson to come.

For Teachers this information is designed to help determine learners' subject background knowledge and skills relevant to the lesson as well as help teachers identify where to build on previous learning. This approach is different to 'teaching' students anew as if they have not been taught previously.

Lesson Overview

All lessons in each of the three subjects, English, Mathematics and Science, contain five components. These are 1. Short Review, 2. Purpose/Intention, 3. Language Practice, 4. Activity, and 5. Conclusion.

Timing

Approximate component timings are indicated as advice to guide the teacher in the pacing of the lessons. Time management involves:

- moving through components at a pace that is appropriate for learners;
- ensuring that all components are completed in a timely, efficient and constructive manner.

Research on student-learning quality and 'time' is related through student 'time-on-task'. Time-on-task refers to when students are actively involved (engaged) in some aspect of the learning process. The suggested times for each component are intended to maximize the time available for student involvement. This will encourage the student and teacher to work efficiently, timewise, through the lesson without jeopardizing the importance of student activities such as to:

- answer routine and non-routine questions,
- respond to verbal questions and explanations,
- interpret and use appropriate terminology,
- discuss aspects with their peers,
- explain or justify his/her approaches and thinking,
- work productively on their own, and
- listen carefully to the teacher or peers.

Establishing what is time-on-task is more problematic when the teacher talks and students passively listen, such as in didactic teaching. With such an approach it is difficult to determine whether students are listening or even paying attention. Often in lessons identifying time-on task can also be problematic in case of problem-solving or intense reading and comprehension. Here, student activity is often subtler and more cerebral as students need to think quietly by themselves.

Ultimately, however, the time allocated to components will be determined by learners' needs and strengths, but not completely. There needs to be practical limits on the duration of the components to prevent major disruption to lessons which can have a detrimental impact on students' learning. Often, teachers should not expect too much learning to occur on an initial meeting of unfamiliar content. It is repeated exposure associated with elaboration, addressing errors, and deliberately practicing key aspects where most learning occurs.

When times are allocated appropriately, and students become familiar with the approach and teacher expectations, concept development and student skill levels are improved as well as student engagement.

Note: Care needs to be exercised in determining what engagement means. Engagement is clearer when **students are doing the learning** through answering questions, writing, discussing and reading.

Key Ideas and Questioning

Critical aspects of the NLC for the teacher include questions related to learning areas, based around a *key idea*. The questions are offered at different levels of difficulty involving lower- to higher-order thinking, starting with questions of modest complexity up to those that require more developed reasoning.

In the lessons, students are provided with opportunities to practice solving non-routine questions to help improve their conceptual understanding by applying known content to subject-related problems.

Teacher Reflection

Teacher reflection on the lessons offer important insights to stimulate teachers and their peers to enhance their own practice and the learning of their students. This includes:

- new teaching approaches encouraged by lesson components that can contribute in different ways to student learning and lesson success;
- the use of review lessons that help review learnt material and extend student abilities in problem solving by utilizing known information;
- a focus on student concept and skill acquisition, pedagogical approaches, student errors, time-on-task, deliberate practice and working memory demands.

Enhancement and Consolidation Camps

The Enhancement Camp and the Consolidation Camp offer students the chance to review their subject background knowledge by consolidating previously taught material. The intention is:

- for students to have opportunities to review past work and to practice applying this knowledge of concepts and ideas through grade-related sets of questions of developing difficulty; and
- for teachers to follow the given format of components with some flexibility to adjust parts of a lesson to meet the learning needs of students in their class, particularly, if students are having difficulties.

Camp Differences

In the case of lessons for students in either the Enhancement Camp or Consolidation Camp, the materials, including the lesson plans and the sets of questions are on the surface, the same. These questions range from those of modest difficulty to those which require more insight and more knowledge and understanding.

There are important reasons for both Camps sharing the same content. Exploring and answering these question sets has value to students from both Camps, albeit in different ways. It enables students to work through a range of ideas on their own before hearing from their peers and teacher concerning the same questions – a very rich learning environment. Also, similar questions mean that expectations for students in both Camps is not limited and students have the same potential for growth.

The difference between Camps concerns the teaching focus, which is related to the breadth and depth of conceptual knowledge of students. It is anticipated that based on student performance within a lesson, the teacher will decide whether the class needs more practice and discussion of straightforward questions or whether extension material is more appropriate for the class.

In particular, questions marked as **Optional** (typically high-order questions) are more likely to be addressed in the Enhancement Camp than the Consolidation Camp, but not exclusively. It is the teacher who decides whether to include 'optional' questions and this will depend on student-learning success and understanding at that time.

If Optional questions are not used, teachers would spend that time productively. This includes reinforcing the concepts by increasing the focus on student errors and/or increasing student-student, and student-class directed conversations.

Lower- and Higher-order Thinking Skills and Knowledge Development

In all learning, lower-order thinking is a pre-requisite for higher-order skills and knowledge development. Many students are disadvantaged in their attempts to move forward in their learning through a lack of practice and conceptual development of needed lower-order skills, knowledge and understandings. Hence, *all* students benefit from a stock-take on relevant lower-order skills from previously addressed content. This helps establish a basis upon which student learning should build.

In both the Enhancement and Consolidation Camps important lower-order content skills, knowledge and understandings are re-visited at the beginning of each lesson. This helps ensure that potential learning obstacles are made visible to the student and the teacher. It also means that some errors in understanding or misconceptions are identified. This information is important to teachers in helping all students move forward regardless of their achievement levels.

As many questions posed are about applying content already encountered to a new problem, students have the opportunity to use their current knowledge, skill and understanding in a practical way at their level, further developing their conceptualization and understanding of the subject matter.

Both Camps offer students the opportunity to improve their learning and conceptual development by a stepped approach that involves:

(i) reminding students of relevant lower-order skills through practice,
(ii) having students use and discuss their knowledge in sets of graded questions with an emphasis on straightforward questions,
(iii) expecting students to apply their knowledge leading to more breadth in learning,
(iv) beginning an initial focused practice on higher-order skill development.

The approach advocated to solve problems or comprehend passages extends student learning beyond simple repetitive exercises sets. For these students, the teaching part of the lesson requires teachers reviewing closely student solution attempts through student explanation, discussion, and questioning of fundamental aspects of topics that are typically found in the earlier questions. Teachers should be sensitive to students' self-perceptions here as they may meet the ideas presented in the lessons maybe, after many failures with these concepts in the past.

Nevertheless, these students should become aware of the more difficult questions as teachers allow them to consider links or connections between concepts previously taught. There is great value in problem solving for students to have time to read the problem and then be able to indicate in their own words, what the problem is about.

Finally, it is important that students in the Enhancement and Consolidation Camps become aware of what their students know, where it is progressing and how to build on student skills and knowledge. Teachers need to be nurturing and supportive of this development and continually look for evidence of success and growth. Teachers also need to encourage students to persist, continue to practice individual aspects, and use any mistakes/errors they make as an opportunity to learn more. These are important features of a successful learning journey.

Lesson Components: Short Overview

Lesson Component 1 (Lesson Short Review)
Component 1 offers teachers the chance to:

- settle the class quickly;
- review previously encountered information;
- address previous content in the form of a few targeted questions that are *relevant to the current lesson;*
- note what students already know;
- elicit answers from the class to reinforce the important content needed for the lesson; and
- address briefly issues that may arise.

The questions set for the Short Review section of a lesson are designed to *remind* students of knowledge and skills developed when first studying the topic area, which are relevant to the lesson.

Lesson Component 2 (Lesson Purpose/Intention)
This component offers teachers a chance to acquaint students with the purpose/intention of the lesson. It is valuable if students see a link here with their prior knowledge or experience, especially if the teacher can connect it to the responses and levels of student understanding evident in Component 1.

In addition, this component is an appropriate time to address what students might expect/aim to achieve, i.e., their lesson goal(s). Teachers should clarify, in clear language, the learning intention for the students as well as what success will look like. (Note**:** The degree of success or partial success of student learning in the lesson should occur as part of Component 5.)

Lesson Component 3 (Lesson Language Practice)
Component 3 concerns language use – speaking, hearing, listening and comprehending. The focus is on words or phrases that are to be used in the lesson.

The language practice suggested has been identified by considering the whole lesson and identifying those words/phrases that have the potential to cause difficulties for students through speech, or listening, or understanding. Typically, the language identified is restricted to less than 6 words/phrases so that there is enough time to use a variety of approaches of practice within the time available.

Lesson Component 4 (Lesson Activity)
Component 4 has three aspects, 4A, 4B, and 4C.

In the case of the Learning Camp activity, Component 4 addresses the key idea for the lesson. It is about students applying known content to solve real-world problems. This requires students to interpret/understand the correct meaning of the ‘stem’, a stimulus, (such as a passage/text or diagram or the first part of the problem or story) before answering questions of differing degrees of complexity related to the stem.

Students are first presented with the stem in 4A and are given the time/chance to interpret its meaning. Then in 4B and 4C, two separate sets of questions related to the same stem are asked.

4A Reading and Understanding the Stem

4A involves understanding the language of the stem. The purposes here are for the teacher:

- to model fluent reading of the stem (first)
- to identify any unfamiliar language for the student (possibly addressed in Component 3)
- to read the passage or describe the figure, etc.
- to hear and experience fluency in reading the stem.

4B Solving the First Set of Questions

4B involves a set of questions associated with the stem. Students will need to refer to the stem as they prepare to answer the set of questions. Students write down responses or attempts at each question. It is important that every student in the class is expected to have a response for each question. It is expected and acceptable that students would make errors, which provide teachers with important information concerning students' learning needs. A critical procedural action here for teachers is the importance of **all** students are starting on the same set of questions, *at the same time*.

When the students are finished, or sufficient time has been allocated, the teacher marks the questions. This can be achieved by student answers or approaches to the questions and by explaining or justifying their reasons. Time should be allocated to student discussion, explanation, and reasoning about answers.

4C Solving the Second Set of Questions

4C offers a new start for students regardless of how they performed in Component 4B. The structure is very similar to Component 4B, i.e., undertaking a new set of questions related to the same stem. In addition, the lesson structure allows a refresh as 4C presents a new starting point for the student. This structure also allows all students in the class to start a new activity at the same time.

This approach serves two purposes for teachers. *First,* it enables teachers to bring all students back together to proceed as a group with issues able to be directed to and considered by every student at the same time. *Second,* it offers teachers a way to extend their students problem solving practice where *a different set of questions* can be used with a single Stem. This is an efficient way to incorporate more problem-solving or comprehension practices on specific content into a lesson.

Lesson Component 5 (Lesson Conclusion)

Component 5 has a high metacognitive aspect for students – students thinking about their own thinking – which can be further enhanced by teacher modelling. Component 5 is designed to offer a student-focused overview to the main intentions of the lesson. In particular, the focus is about helping students reflect on their progress and achievement (or partial achievements) of the lesson intention as well as their understanding development during the lesson.

It builds on comments from Component 2 about teacher expectations. There is the chance here to confirm student progress during the lesson. A teacher may use a diagram, picture or some aspect of the lesson as a catalyst to stimulate student discussion and reflection.

NOTE: A fuller description of the Components and features of the lessons is provided in the **Learning Camp – Notes to Teachers Booklet.** It is recommended that these notes are read and discussed by teachers as they provide a further basis to understanding the structure of lessons and the pedagogy.

Science Grade 10 Lesson No. 1

Volcanoes, Earthquakes and Mountain Chains – Evidence for Plate Tectonics

Key Idea

The Philippines Archipelago provides strong evidence for the Plate Tectonic Theory through the distribution of its active volcanoes, earthquake epicenters and major mountains.

Component 1: Short Review (Time: 7 minutes)

- Ask learners to answer the following questions on their worksheet.

  Q1a. What is a 'chain'? and Q1b. What is a 'belt?

  Q2. What are some features of a *Mountain* and a *Mountain chain*?

  Q3. What might cause the big mountain chains of the Philippines to be long and narrow?

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

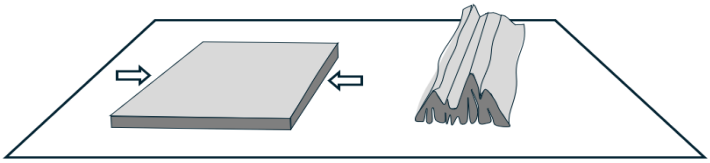
Sample answers:

Q1a.
- *A piece of jewelry for your neck or wrist.*
- *A line of metal links used for fastening or securing something, or for pulling loads.*
- *An old measurement of length.*
- ***A sequence of landforms of the same type forming a line.***

Q1b.
- *A leather waist strap that holds clothes up.*
- *A continuous band of material used in machines for transferring motion from one wheel to another*
- *A sequence of objects of the same type forming a line.*
- ***A strip or area of landform of the same type forming a line.***

Q2.
- *Mountains are big with steep sides; A Mountain chains are similar,*
- *A Mountain chain is made of lots of mountains joined together.*
- *Mountain chains are made of folded and fractured rock.*

Q3.
- *They are formed from lots of volcanoes erupting and building up over time*
- *They are formed from big forces in the Earth pushing sideways on older sediments and rocks.* " A good way to show or explain this may be done through demonstration by pushing a modelling clay on a table to see it squash and rise high, forming a long narrow shape.



Component 2: **Lesson Purpose** (Time: 3 minutes)

This lesson is about how the location of volcanoes, earthquakes and mountains of the Philippines suggest sound evidence for tectonic plates.

Component 3: Lesson Language Practice (Time: 5 minutes)

- Read aloud difficult or unfamiliar words or phrases e.g.:

Mountain chains; Earthquake belts; Tectonic plates

- The lesson has lots of terms that have both ***everyday meanings*** and ***scientific meanings*** because in the development of Earth Science, scientists over many years have used everyday objects to describe massive physical features of the Earth. Some examples include ***plates***, ***belts*** and ***chains.***
- Have a short class discussion about the use of common terms for massive structures.

Component 4*:* Lesson Activity (Time: 25 minutes)

Component 4A

Refer learners to the main lesson stimulus pointing out that the legend helps interpret what is being shown on the map. To reinforce this concept, learners can mark the location of their school today on the map. Suggest marking it on with a red X.

Philippine Volcanoes, Earthquakes and Mountains – Evidence for Tectonic Plates

The Philippine Archipelago has numerous of long mountain chains or belts, active volcanoes and earthquake zones which provide scientists with compelling evidence for the Theory of Plate Tectonics. The distribution or patterns observe in these features, especially the alignment with the islands of the Philippines provides the most critical form of evidence that can be observed from the ground. The following map highlights the location of some of the chain mountains and active volcanoes – these features also align with areas of high earthquake activity.

Main Volcanoes and Chain mountains of The Philippines

Component 4B

- Read aloud the following questions and ask learners to answer in the space on their worksheets.

  Q1. Which volcano is associated with the Zambales mountains?

  Q2. Write down the names of some volcanoes that form a line or a chain of volcanoes?

  Q3. The Sierra Madre chain mountains are located on the big island of Luzon. Describe how these mountains related to the coastline of Luzon Island.

- Observe learners' answers. Ask the learners to volunteer their answers, giving positive feedback. Select a good sample answer for all learners to write down. This may come from the learners or from the following sample answer.

Sample answers:

Q1. Pinatubo; or Mount Pinatubo

Q2.
- **A long line:** *Isarog, Iriga, Mayon, Bulusan* (in South Luzon), *and Biliran and Cabalian* (in Visayas).
- **A short line**: *Musuan, Ragang, and Makaturing* (In Mindanao).

Q3. The Sierra Madre chain mountains closely follow the Eastern coastline of Luzon Island.

Component 4C

- Read aloud the following questions and ask learners to answer in the space on their worksheet.

  Q1. On which side of Luzon Island is Mount Pinatubo located?

  Q2. Describe how the chain mountains and the volcanoes are located in the Philippines?

  Q3. **(Optional)** How do the patterns or distribution of the volcanoes and the chain mountains relate to the arrangement of islands of the Philippines and what does this suggest about how the islands have formed?

- Observe learners' answers. Ask the learners to share their answers. Give positive feedback. Select a good sample answer for all learners to write down. This may come from the learners or from the following sample answer.

Sample answers:

Q1. On the Eastern side (*'On the left side' is correct as well, but may indicate that the learner is not able to apply the compass)*

Q2.
- *The chain mountains generally run in a North-South direction.*
- *The lines of volcanoes generally run in a North-South direction.*
- *Most of the chain mountains are either on the Eastern side (right side) or Western side (left side) of the islands that they are on.*
- *Most volcanoes occur within or close to a mountain chain.*

Q3. The distribution of the volcanoes and the chain mountains closely aligned with the general North-South orientation of island of the Philippines, and this suggest that the forces that have pushed to produce the Philippines are from the East and West of the archipelago.

Component 5: Lesson Conclusion (Time: 5 minutes)

1. What did you learn from this lesson?
2. What are some things you enjoyed about the lesson?
3. What is something you would like to learn more about this lesson?

REMINDER: Collect learner worksheets to review and analyze learner's knowledge and understanding.

Science Grade 10 Lesson No. 2

Plate Boundaries – Where the Action is!

Key Idea

The Philippine Archipelago provides strong evidence for the Plate Tectonic Theory because of the strong correlation between its distribution of volcanoes, earthquake epicenters and major mountain belts and the proximity and highly active plate boundaries.

Component 1: Short Review (Time: 7 minutes)

- Ask learners to answer the following questions on their worksheet.

  Q1. What is a cross sectional diagram?

  Q2. How might a tectonic plate interact with another tectonic plate at a convergent boundary (i.e. when two plates come together)?

- Q3. How can we explain the frequent occurrence of earthquakes in the Philippines?

  Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. A diagram that shows the vertical section through a body so we can interpret the structures in the body in a three-dimensional way.

Q2.
- O*ne might descend below the other.*
- *The two plates might press together with neither sinking below the other – this would cause the plates to squash up and form a mountain.*
- *The two plates might slide past one another.*
  (an unacceptable answer would indicate that the plates would move away from each other).

Q3. Earthquakes are caused when large blocks or slabs of rocks move suddenly past one another. In the Philippines, this could occur:
- just before or after a volcano suddenly erupts, or
- it could be caused when parts of mountains rise to equalize unbalanced forces, or
- it could be caused by tectonic plates moving near the Philippines.

Component 2: **Lesson Purpose (**Time: 3 minutes)

This lesson is about the nature of the highly active plate boundaries that are located near the Philippines.

The lesson may also help learners to better explain the distribution of volcanoes, earthquake epicenters and major mountain belts of the Philippines.

Component 3: Lesson Language Practice (Time: 5 minutes)

- Read aloud the difficult or unfamiliar words or phrases and ask the learners to read them to themselves and then out loud as a class, e.g.:

  Continental crust; Oceanic Crust; Lithosphere; Asthenosphere; Mantle
- Ask the learners to practice saying the words.

To help with the meanings of the words: *Litho* means *rock; Asthenos* comes from the Greek word, asthenós meaning 'without strength' – it refers to the partially molten zone where movement of tectonic plates occurs in the mantle.

Component 4*:* Lesson Activity (Time: 25 minutes)

Component 4A

Refer learners to the main lesson stimulus, which includes *text and diagrammatic information* about the tectonic forces that are shaping the Philippines. Point out that the cross-section helps to visualize what is happening in three dimensions.

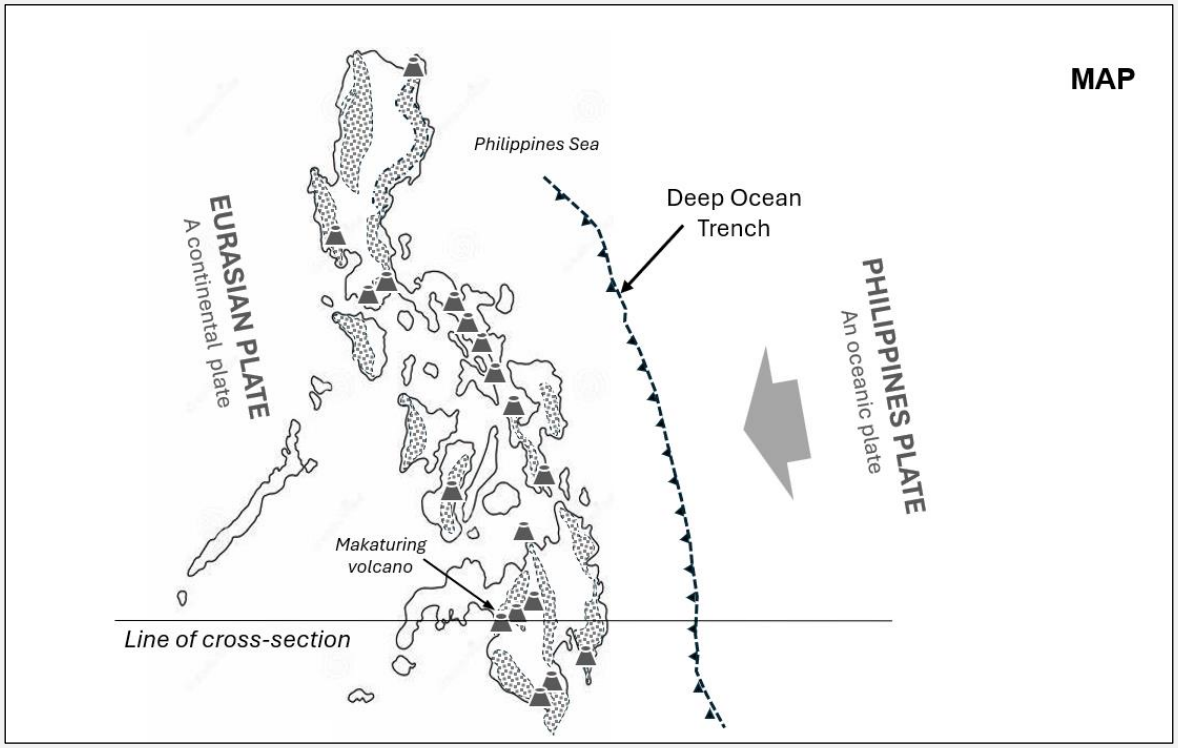
Is the Philippines Being Shaped by *Plate Tectonics*?

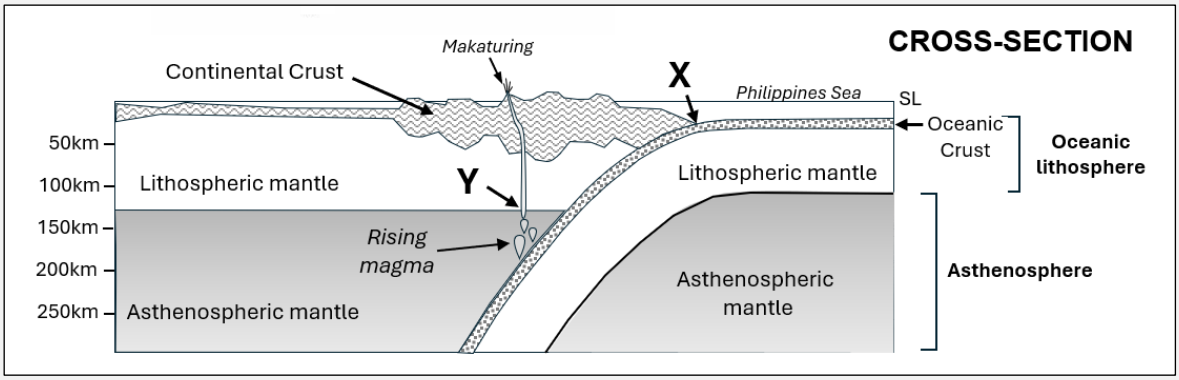
According to the ***Theory of Plate Tectonics***, the Earth's outermost layer, called the ***lithosphere,*** is made up of solid *crust* and solid *lithospheric mantle*.

The lithosphere forms large plates, called ***tectonic plates,*** which move relative to each on a partially molten layer of the mantle, called the ***asthenosphere***. Due to convection currents in the asthenosphere and push and pull forces acting on the lithospheric plates, they slowly move around the Earth at rates of between 2-15 centimeters per year. The interaction of the tectonic plates is responsible for many different geological features, such as the volcanoes, earthquake epicenters and mountain belts of the Philippines. The volcanoes and the long mountain chains that form the Philippine Archipelago all align in a North-South direction.

Scientists now detect features of the ocean floor and structures in the Earth's crust that add more evidence for Plate Tectonics, including *ocean rifts* and *mid ocean ridges* (MORs) at ***divergent plate boundaries*** and *deep ocean trenches* at ***convergent plate boundaries***.

Map and Cross-section views of The Philippines





Component 4B

- Read aloud the following questions and ask learners to answer in the space on their worksheets.

  Q1. What is the name of the feature shown at point **X** in the cross-section of the Philippines?

  Q2. What are the names of the layers that can be seen in the cross section of the Philippine Archipelago?

  Q3. The lithosphere in the Philippines is found in two forms – the *Continental lithosphere* and the *Oceanic lithosphere*. What makes up the *Oceanic lithosphere*?

- Observe learners' answers. Ask the learners to share their answers. Give positive feedback. Select a good sample answer for all learners to write down. This may come from the learners or from the following sample answer.

Sample answers:

Q1. An Oceanic Trench.

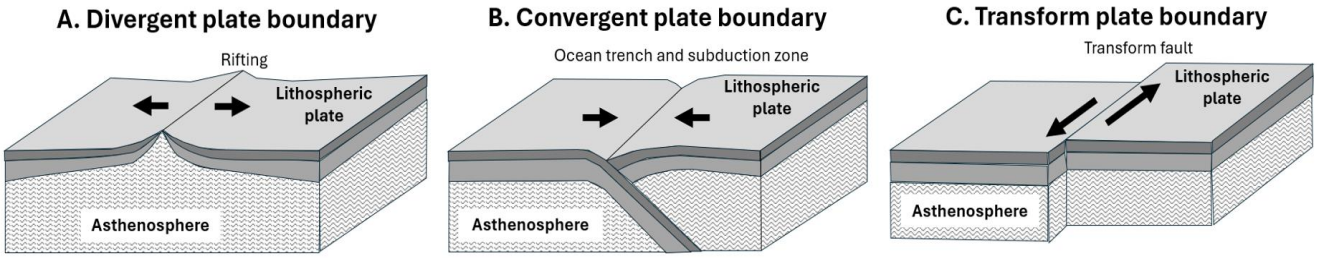
Q2.
- *Continental crust,* (the highest layer)
- *Oceanic Crust,*
- *Lithospheric Mantle, or*
- *Oceanic lithosphere (made up of Oceanic crust and Lithospheric mantle), and*
- *Asthenospheric Mantle.* (the lowest layer)

Q3. The *Oceanic Lithosphere* is made up of the *Oceanic crust* and the *Lithosphere mantle.*

Component 4C

- Read aloud the following questions and ask learners to answer in the space on their worksheets.

  Q1. Here are three ways that tectonic plates interact with each other at their plate boundaries:



  Which of these three plate boundaries match the type that are shown in the stimulus diagram?

  Q2. What does the structure marked as '**Y'** in the cross-section connect together?

  Q3. **(Optional)** How does the location of the ocean trench to the eastern side of the Philippines Archipelago provide evidence that the archipelago is being shaped by Plate Tectonics?

- Observe learners' answers. Select a good sample answer for all learners to write down. This may come from the learners or from the following sample answer.

Sample answers:

Q1. Plate Boundary B

Q2.
- It connects t*he Asthenospheric mantle and the Continental crust.*
- It connects t*he Rising magma* with a *Volcano – it is a volcanic conduit.*

Q3. The location and shape of the ocean trench to the eastern side of the Philippine Archipelago aligns very closely with the predominant North-South alignment of the islands as well as with the distributions of chain mountains, volcanoes and earthquake zones. This provides evidence that forces are pushing from the East towards the islands of the Philippines. The ocean trench suggests that the forces pushing on the archipelago are caused by a tectonic plate descending under the Philippines. This also provides a mechanism for the sources of magma for the active and historical volcanoes that are distributed along the archipelago from north to south.

Component 5: Lesson Conclusion (Time: 5 minutes)

- The focus of this lesson was on understanding how plate tectonics impacts on the Philippines.
- Ask learners to answer the following questions either by class discussion or writing the answers in their worksheets.

Q1. Has this lesson helped you to better understand Plate tectonics? If so, how?

Q2. Has this lesson helped you to remember the names of the crustal and mantle layers of the Earth? If so, how?

Q3. What was hard to do or understand in the lesson?

Let learners reflect on their learning.

REMINDER: Collect learner worksheets to review and analyze learner's knowledge and understanding.

Science Grade 10 Lesson No. 3

Evidence for the Movement of Tectonic Plates

Key Idea

Evidence for continents moving include a jigsaw puzzle matching of coastlines, rock types, and fossils that can be seen when the continents are reassembled to form a previous supercontinent such as Gondwanaland.

Component 1: Short Review (Time: 7 minutes)

- Ask learners to answer the following questions on their worksheet.

  Q1. What is a jigsaw puzzle?

  Q2. What are the names of some large present-day continents?

  Q3. What do you think a 'supercontinent' might mean?

- Ask learners to share their answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. It is a tile puzzle that needs to assemble irregularly shaped pieces, each of which usually has a portion of a picture on it that helps with matching the pieces.

Q2.
- *Africa,*
- *Asia,*
- *Europe,*
- *Australia, and*
- *South America.*

.

Q3.
- *A supercontinent might be a big continent made up of other smaller continents. Different land masses put together to create one large continent.*

(For Teacher Information: Today, the connected Africa-Europe-Asian landmass may be called a supercontinent. It also has the Indian subcontinent as part of it which came from Gondwanaland. The most recent definitions require 75% of all of Earth's continental crust to be part of one landmass.)

Component 2: **Lesson Purpose (**Time: 3 minutes)

This lesson is about further evidence for the theory of Plate Tectonics. This lesson is focused on the ways that the continents may have been in a supercontinent that split up and drifted apart.

Component 3: Lesson Language Practice (Time: 5 minutes)

- Read aloud difficult or unfamiliar words or phrases and ask the learners to read them to themselves and then aloud as a class, e.g.:

  Reconstruction; Triassic; Permian; Gondwana; Gondwanaland

- Ask the learners to practice saying the words.
- Discuss what r*econstruction* means in the context of scientist testing models and theories for plate tectonics.

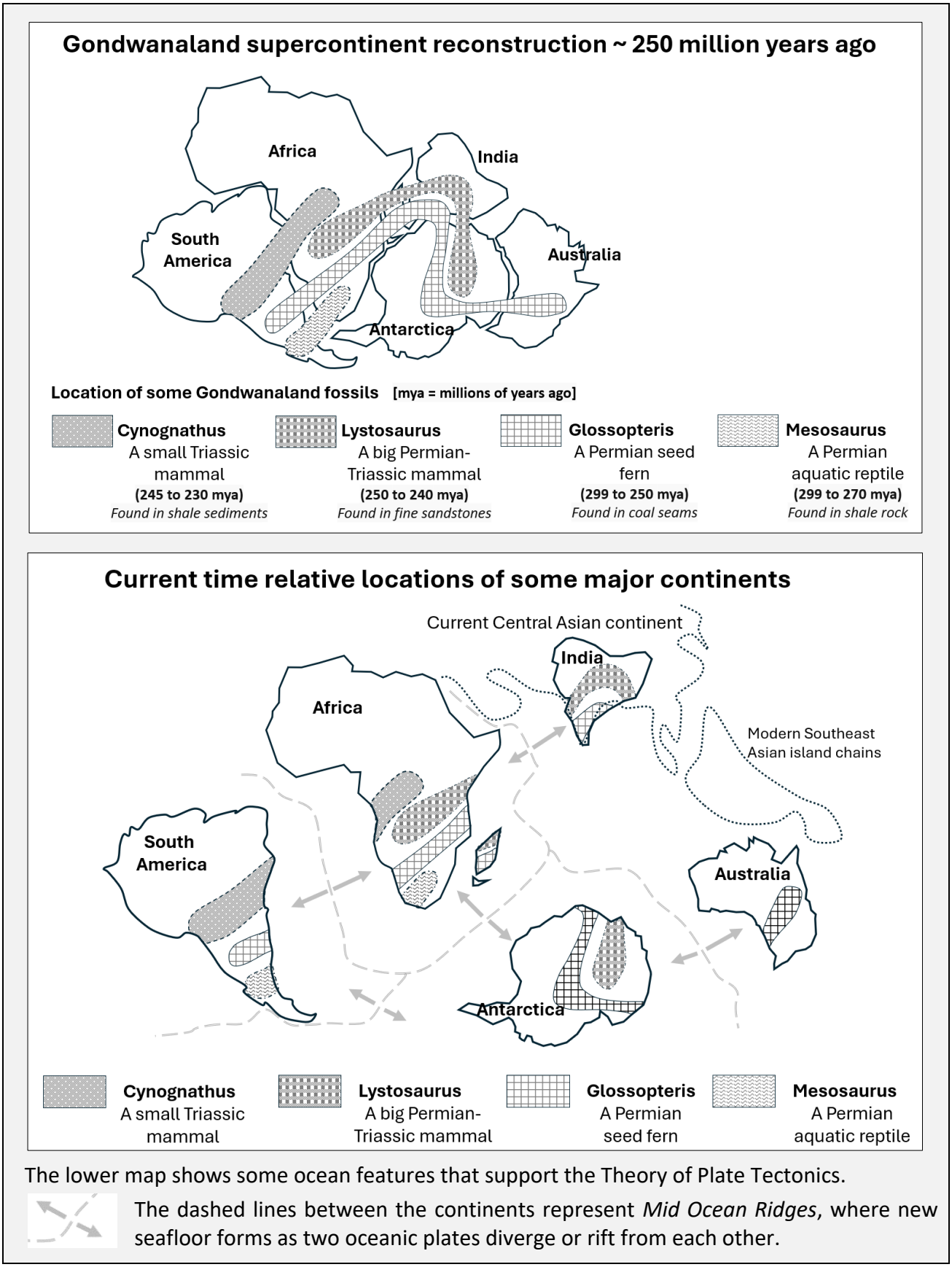
  Point out to learners that *Triassic* and *Permian* periods are geologic time periods. The Permian period was from about 300 million years ago (mya) to 250 mya. The Triassic period was from about 250 mya until about 200 mya. The Permian Period was longer ago than the Triassic Period.

  Note that *Gondwana* and *Gondwanaland* are basically naming for the same supercontinent.

Component 4*:* Lesson Activity (Time: 25 minutes)

Component 4A

- Refer learners to the main lesson stimulus and point out that it includes *two maps* that show the same fossils and rock types on both.



The lower map shows some ocean features that support the Theory of Plate Tectonics.

The dashed lines between the continents represent *Mid Ocean Ridges*, where new seafloor forms as two oceanic plates diverge or rift from each other.

Component 4B

- Read aloud the following questions and ask learners to answer in the space on their worksheets.

  Q1. What is the name of the supercontinent shown in the first illustration?

  Q2. What continents made up the supercontinent shown in the first illustration?

  Q3. If all the fossils were formed on the supercontinent, how long has it taken for the present-day continents to get to their current locations?

- Observe learners' answers. Ask the learners to share their answers. Give positive feedback. Select a good sample answer for all learners to write down. This may come from the learners or from the following sample answer.

Sample answers:

Q1. Gondwanaland.

Q2.
- *South America,*
- *Africa,*
- *India,*
- *Antarctica, and*
- *Australia.*

Q3. About 230 to 240 million years.

(The thinking would be that Gondwanaland was still together when the more recent fossils were there = Cynognathus at 230 mya to Lystosaurus at 240 mya.)
[ADDITIONAL INFORMATION FOR INTEREST: Given the member continents are now about 6,000 to 8,000 km apart – the speed of separation of the continents would thus be about 10-16 cm/year!! (about the 'speed' a person's fingernail grows!)]

Component 4C

- Read aloud the following questions and ask learners to answer in the space on their worksheets

  Q1. Which is the 'youngest' fossil shown. i.e. the one that had been on Earth the most recent of those presented.

  Q2. Complete table 1 on your worksheet to show the geographical distribution of the fossils shown on the maps.

Table 1: The distribution of fossils on the continents that formed Gondwanaland

Continent locations	**FOSSILS**			
	Cynognathus	***Lystosaurus***	***Glossopteris***	***Mesosaurus***
South America	✓			
Africa	✓			
India	×			
Antarctica	×			
Australia	×			

  Q3. **(Optional)** What evidence for the *Theory of Plate Tectonics* can be seen in the maps in the Stimulus, or shown in the table from Component 4C Question 2?

- Observe learners' answers. Ask the learners to share their answers. Give positive feedback. Select a good sample answer for all learners to write down. This may come from the learners or from the following sample answer.

Sample answers:

Q1. Cynognathus 9at 230mya

Q2. Sample completed table.

Table 1: The distribution of fossils on the continents that formed Gondwanaland

Continent locations	FOSSILS			
	Cynognathus	***Lystosaurus***	***Glossopteris***	***Mesosaurus***
South America	✓	×	✓	✓
Africa	✓	✓	✓	✓
India	×	✓	✓	×
Antarctica	×	✓	✓	×
Australia	×	×	✓	×

Q3.
- *The maps show a supercontinent separating from each other to form the present-day arrangement of continents.* (Simple answer)
- *The current continents can be reassembled with a jigsaw puzzle fit where the shapes of continents fit together to form the shapes of the continents and the picture pattern of fossil distributions matches as well..* (A very good answer)
- *The oldest fossil (Mesosaurus) and youngest fossil (Cynognathus) were only found in South America and Africa, which provides evidence that these continents were once connected. The map of Gondwanaland fossils shows the widest distribution for Glossopteris, so it is a good marker fossil to indicate that all five continents were once together as a supercontinent.* (A very good answer)
- *The table provides a quick way to show that Glossopteris has the widest distribution. It is a good marker fossil to indicate that all five continents were once together as a supercontinent.* (A very good answer)
- *The second map shows the structure that exists following the breakup and separation of the continents* (the structures shown are the mid-ocean ridges where new oceanic crust is formed.)

Component 5: Lesson Conclusion (Time: 5 minutes)

The focus of the lesson was on understanding more deeply about *Plate Tectonics*.

1. How has the lesson helped you better understand the evidence for current continents once being on a supercontinent that split up and drifted apart?
2. Which questions were easy to answer – the ones in Component 4B or Component 4C? Why?
3. What strategies did you use to answer the harder questions?

REMINDER: Collect learner worksheets to review and analyze learner's knowledge and understanding.

Science Grade 10 Lesson No. 4

Classification of Living Things

Key Idea

That there is a hierarchical classification system that places all living things into groups.

Component 1: Short Review (Time: 7 minutes)

- Ask learners to answer the following questions on their worksheet.

  Q1. What does the word *classification* mean?

  Q2. What are the characteristics of all living things?

  Q3. Why is it important to classify living things?

- Ask learners to share their answers. Give positive feedback. Read a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. Classification means placing things into systematic groups.

Q2. Living things are made of cells, they grow, they move, they reproduce, and they respond to stimuli.

Q3. It is important so that we can find out about the relationships between different groups of living things.

Component 2: **Lesson Purpose** (Time: 3 minutes)

This lesson deals on how biologists classify living things including human. In addition, this may also help learners better understand their role in the living world.

Component 3: Lesson Language Practice (Time: 5 minutes)

- Read out difficult or unfamiliar words or phrases and ask the learners to read them to themselves and then aloud as a class,

  Kingdom; domain; phylum

- Ask the learners to practice saying the words.

The meaning for possibly unfamiliar words is described in the stimulus.

Component 4*:* Lesson Activity (Time: 25 minutes)

Component 4A

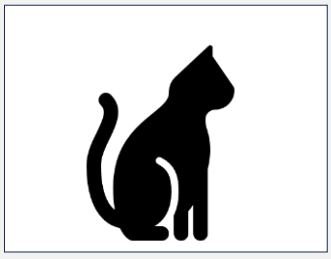
- Refer learners to the main lesson stimulus pointing out that it includes a *classification table* that describes a way to classify living things.
- Read out the written text. Ask the learners if there are any words that they are not familiar with and give descriptions of any words that may be unfamiliar or confusing.

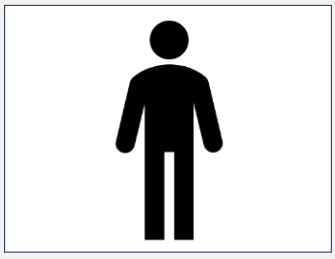
Hierarchical classification of living things

Carl Linnaeus in the 18th century carefully observed living things naming and organizing them into categories based on the observable structures. He proposed that there were three main categories of living things which he called ***kingdoms***. Linnaeus further suggested classifying living things into 5 hierarchical levels and used these levels to provide each living thing with a unique two-word name**.**

Now biologists believe that there are more classification groups needed. Biologists now use eight hierarchical levels to classify living things, and they are shown below in the Hierarchy column, along with three examples. The *human* example is missing its *Kingdom*, *Phylum* and *Class*.

	EXAMPLES		
HIERARCHY	***eggplant/talong***	***cat***	***human***
Domain	*Eukaryotes*	*Eukaryotes*	*Eukaryotes*
Kingdom	*Plantae*	*Animalia*	*?*
Phylum	*Tracheophyta*	*Chordata*	*?*
Class	*Magnoliopsida*	*Mammalia*	*?*
Order	*Solanales*	*Carnivora*	*Primata*
Family	*Solanaceae*	*Felidae*	*Hominidae*
Genus	*Solanum*	*Felis*	*Homo*
Species	*Melongena*	*Catus*	*Sapien*





Using this classification system, the unique name for the eggplant would be ***Solanum melongena.***

Component 4B

- Read out the following questions and ask learners to answer in the space on their worksheet.

  Q1. What *genus* do cats belong to?

  Q2. What would be the *kingdom* and *order* for the eggplant?

  Q3. What two-word classification would be the unique name for humans?

- Observe learners' answers. Ask the learners to share their answers. Give positive feedback. Select a good sample answer for all learners to write down. This may come from the learners or from the following sample answer.

Sample answers:

Q1. Felis

Component 5: Lesson Conclusion (Time: 5 minutes)

- The focus of this lesson was on the concepts behind the classification system for plants and animals by biologists.
- Ask learners to answer the following questions either by class discussion or by writing the answers in their worksheet.

Q1. Has this lesson helped you better understand biological classification? If so, how?

Q2. Has this lesson helped you remember the technical terms used to classify living things? If so, how?

Let learners reflect on their learning.

REMINDER: Collect learner worksheets to review and analyze learner's knowledge and understanding.

Science Grade 10 Lesson No. 5

Evolution

Key Idea

Several theories provide evidence about how living organisms have evolved.

Component 1: Short Review (Time: 7 minutes)

- Ask learners to answer the following questions on their worksheet.

  Q1. Where does the term "species" fit into the classification system for living things used today?

  Q2. Up until the early 19th century how old did scientists believe the Earth to be?

  Q3. What was the main issue that some scientists had with the theory of evolution?

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. Species is the final group of eight in the classification system.

Q2. Scientists believed that Earth was only a few thousand years old.

Q3. Many scientists believed that religion provides an explanation of how living things evolved.

Component 2: **Lesson Purpose** (Time: 3 minutes)

This lesson deals about the concept of evolution of living things. This will help learners better understand that humans belong to a species whose other members are now extinct.

Component 3: Lesson Language Practice (Time: 5 minutes)

Keywords/terms:

evolution; natural selection

- Ask the learners to practice saying the words.

The meaning for unfamiliar words is described in the stimulus.

Component 4*:* Lesson Activity (Time: 25 minutes)

Component 4A

- Refer learners to the main lesson stimulus.
- Read the written text. Ask the learners if there are any words that they are not familiar with and give descriptions of any words that may be unfamiliar or confussing

EVOLUTION THROUGH NATURAL SELECTION

What is evolution?

It is a theory that Charles Darwin (1809-1882) proposed, which suggests that every organism on Earth is a descendent of those that lived many millions of years ago.

What concept is it based on?

It is based on the concept that the characteristics of living things change and evolve over time and that this would mean that over many millions of years some species of today would have a common ancestor.

Where is the evidence?

Charles Darwin spent most of his life looking for evidence to support his idea that nature selects the variations within a species that are most useful for survival in their habitat. He finally published his theory of evolution through natural selection in 1859 acknowledging that Alfred Wallace had come up with the same ideas**.**

Today we have evidence of how living things are connected through the study of their DNA**.**

Variation and Natural Selection

Variations often occur due to isolation of species such as the examples of the Echidna and the Platypus in Australia. The mammals and marsupials of Australia are unique. However, despite this the Australian Marsupials have common features with those found in South America.

So why do giraffes have such a long neck?

The example of the giraffe is often used to fully explain the ideas of variation and natural selection.

It is postulated that the ancestors of the giraffes lived in a habitat where the leaves i.e. their food was in the of very tall trees and that some members of the group of the ancestors did, by chance have longer necks than others (the variation) and so they were able to obtain food. This meant that they had a better survival rate (the natural selection). This also meant that these individuals passed down through their DNA, the genes for a long neck.

Component 4B

- Read out the following questions and ask learners to answer in the space on their worksheet.

  Q1. What does survival of the fittest mean?

  Q2. Who was the other scientist who proposed the theory of evolution through natural selection?

  Q3. What important comment did Darwin make that would apply to humans who are alive today?

- Observe learners' answers. Ask the learners to volunteer their answers, giving positive feedback. Select a good sample answer for all learners to write down. This may come from the learners or from the following sample answer.

Sample answers:

Q1. The survival of the most adaptable organisms in a given situation is a predictor of the fittest.

Q2. Alfred Wallace.

Q3. He suggested that we have common ancestors.

Component 4C

- Read out the following questions and ask learners to answer in the space on their worksheet.

  Q1. On which other continent beside Australia might you find marsupials?

  Q2. Are there other living things that belong to the genus Homo besides humans?

  Q3. **(Optional)** Can acquired characteristics be inherited? Why? Or why not?

- Observe learners' answers. Ask the learners to share their answers. Give positive feedback. Select a good sample answer for all learners to write down. This may come from the learners or from the following sample answer.

Sample answers:

Q1. On the continent of South America

Q2. None, Homo sapiens are the only survivors of a once diverse group of living things.

Q3. No, they are not inherited as an example. If you are vaccinated against polio your children will not be immuned and they will need to be vaccinated also.

Component 5: Lesson Conclusion (Time: 5 minutes)

- The focus of this lesson was on the theory of evolution as proposed by Charles Darwin.
- Ask learners to answer the following questions either by class discussion or writing the answers in their worksheet.

Q1. Has this lesson helped you better understand evolution? If so, how?

Q2. What concept was difficult to understand in the lesson?

Let learners reflect on their learning.

REMINDER: Collect learner worksheets to review and analyze learner's knowledge and understanding.

Science Grade 10 Lesson No. 6

Where is the Evidence?

CONSOLIDATION LESSON

Lines of evidence such as fossils, genetics, and comparative anatomy support the theory of evolution.

Component 1: Short Review (Time: 7 minutes)

- Ask learners to answer the following questions on their worksheet.

  Q1. How old is Earth today, according to modern scientist?

  Q2. Give a couple of examples of a living thing that once was alive but is now extinct?

  Q3. How do we know that some living things were once alive?

- Ask learners to share their answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. Scientists believe Earth to be 4.5 billion years old.

Q2. Dinosaurs and mammoths and diprotodons used to roam the Earth but are now extinct. Many other examples the dodo, the Tasmanian tiger, saber-toothed tiger/cat

Q3. Living things were once alive because of the fossils that have been found in specific area.

Component 2: **Lesson Purpose** (Time: 3 minutes)

This lesson deals on the evidence of the theory of evolution. It may help learners understand the processes of variation and natural selection.

Component 3: Lesson Language Practice (Time: 5 minutes)

Keywords/terms:

Fossils; comparative anatomy

- Ask the learners to practice saying the words.

The meaning for possibly unfamiliar words is described in the stimulus.

Component 4*:* Lesson Activity (Time: 25 minutes)

Component 4A

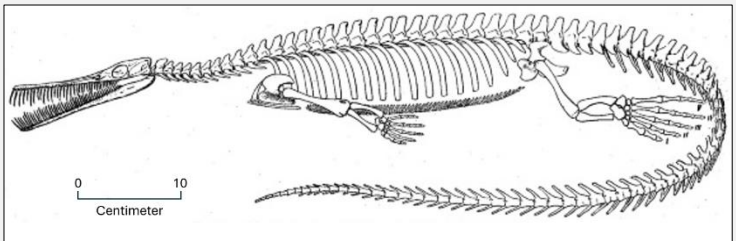
Read aloud/Read silently the written text. Ask the learners if there are any words that they are not familiar with. List the words and try to give the descriptions of the words identified for better understanding.

Evidence for the Theory of Evolution

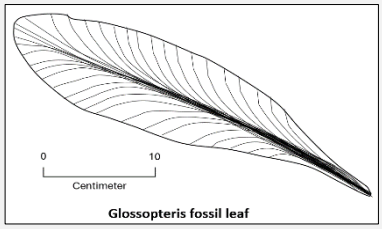
Earth is considered to be 4.5 billion years old and fossil records suggest that *prokaryote life* existed 3.5 billion years ago, but *eukaryote life* existed only around 2.7-1.8 billion years ago. The *dinosaurs* lived between 245 and 66 million years ago. They are now extinct. There is significant evidence for the theory of evolution through variation and natural selection in the fossil record as well as through the study of comparative anatomy and the study of molecular biology. Occasionally scientists come across a species they believe to be extinct but living organisms are found such as the *Wollemi pine* in Australia and the *coelacanth* in South Africa. These, when found, looked like the fossils found of them suggesting perhaps they have not changed in millions of years.

What are fossil records?

If an organism is covered by mud, silt or lava straight after death, such as in a mudslide or volcano, the microorganisms that usually bring decay can't operate because of lack of oxygen. This material will be pressed down over millions of years and become fossils, part of the rock.



Ref: *Fig 61 - Reconstruction of Mesosaurus (after McGregor)*

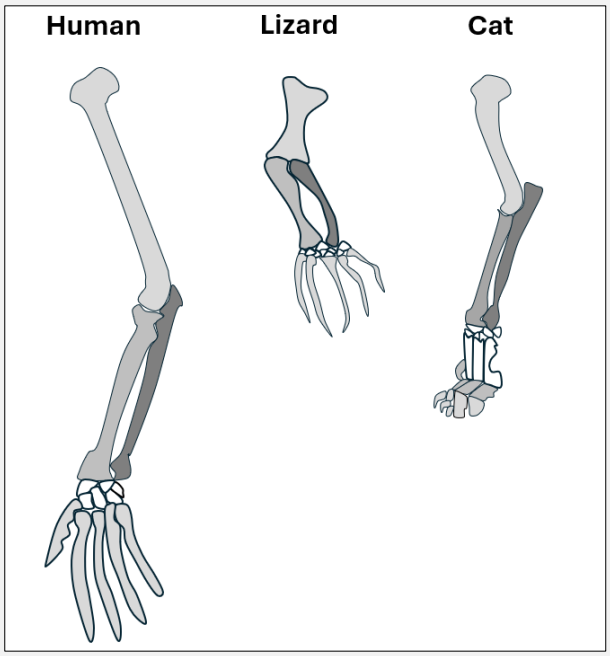


Glossopteris fossil leaf

Fossils may also be molds, casts or imprints. Many fossils have been found of dinosaurs and their footprints that show that they existed. Fossils are found in sedimentary rock and carbon dating can be used to date fossils up to 50 000 years old but other forms of radiometric dating can be used to date older rocks.

What is comparative anatomy?

It is when we compare the structural features of different species or even other classes of living things. For example: the forearms of mammals, amphibians, reptiles, and birds are remarkably similar even though these animals would not appear similar in other ways. These structures are used for different functions such as walking, swimming, or flying but have a common ancestor in the fins of fossilized fish from which early amphibians evolved.



Ref: Fig 61-Reconstruction of Mesosaurus (after McGregor)
Dinosaur Skeletal Reconstruction Prehistoric Animal Bones - Mesosaurus Skeleton Large (copyrightexpired.com)

Component 4B

- Read the following questions and ask learners to answer in the space on their worksheet.
  Q1. How long ago did dinosaurs roam the Earth?

  Q2. Which came first, the prokaryotes or the eukaryotes?

  Q3. Describe one way how fossils can be formed?
- Observe learners' answers. Ask the learners to share their answers. Give positive feedback. Select a good sample answer for all learners to write down. This may come from the learners or from the following sample answer.

Sample answers:

Q1. Dinosaurs lived between 245 and 66 million years ago.

Q2. The Prokaryotes came before the eukaryotes by billions of years.

Q3. Fossils could be formed when a volcano erupts and buries living things suddenly so that decomposition can't occur.

Component 4C

- Read the following questions and ask learners to answer in the space on their worksheet.

  Q1. Are there living organisms alive today that appear to have not evolved much?

  Q2. How has carbon dating helped support and confirm the theory of evolution?

  Q3. **(Optional)** Why are the forearms of mammals, amphibians, reptiles, and birds so similar in structure?
- Observe learners' answers. Ask the learners to share their answers. Give positive feedback. Select a good sample answer for all learners to write down. This may come from the learners or from the following sample answer.

Sample answers:

Q1. Yes, the coelacanth fish from South Africa was believed to be extinct but has been found living deep in the ocean. Yes, a living Wollemi pine tree was found growing in the Blue Mountains in Australia

Q2. Carbon dating of fossil remains has provided evidence to show how variations in species have changed over time.

Q3. The forearms of mammals, amphibians, reptiles, and birds are similar in structure because they have all evolved from a species of fish.

Component 5: Lesson Conclusion (Time: 5 minutes)

This lesson focused on understanding more deeply about the evidence for the process of evolution.

1) How has the lesson helped you to better understand the different types of evidence for evolution?
2) Which questions were easy to answer – the ones in Component 4B or Component 4C? Why?

Let learners reflect on their learning.

REMINDER: Collect learner worksheets to review and analyze learner's knowledge and understanding.

Science Grade 10 Lesson No. 7

Types of Waves to Transfer Energy

Key Idea

Compression (or longitudinal) waves and transverse waves both carry energy. In longitudinal waves, the vibrations occur parallel to the direction of wave travel; however, in transverse waves, the vibrations occur perpendicular to the direction of wave travel.

Component 1: Short Review (Time: 7 minutes)

- Ask learners to answer the following questions on their worksheet.

  Q1. What type of wave does light used to travel?

  Q2. What are some examples of compression waves (longitudinal waves)?

  Q3. How do the particles move in a compression or longitudinal wave?

- Ask learners to share their answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. Transverse.

Q2.
- *Sound waves*
- *Earthquake (or seismic) waves (p- type)*
- *An explosion blast*
- *Ultrasound waves*
- *A sonic boom (when an aircraft breaks the sound barrier)*

Q3. The particles move back-and-forth in the same direction as the direction that the waves travel in longitudinal waves [Which is different to the movement of particles in transverse waves, where the particles move perpendicular to the direction of wave traveled.]

Component 2: **Lesson Purpose** (Time: 3 minutes)

This lesson focuses on the difference between longitudinal waves and transverse waves, and how they behave to carry energy. This is also a reminder of what you have learned in the previous grades about sounds, lights, and earthquake waves (p- and s- waves)

This lesson may also help learners better understand how the particle model and scientific models to explain further scientific concepts that are difficult to see.

Component 3: Lesson Language Practice (Time: 5 minutes)

Keywords/terms:

longitudinal waves; transverse waves; energy transfer; wavelength

- Ask the learners to practice saying the words.

There may be value in pointing out the component parts of the terms:

- ***longitudinal (****length-wise****), and***
- ***transverse (****across-direction****).***

Component 4*:* Lesson Activity (Time: 25 minutes)

Component 4A

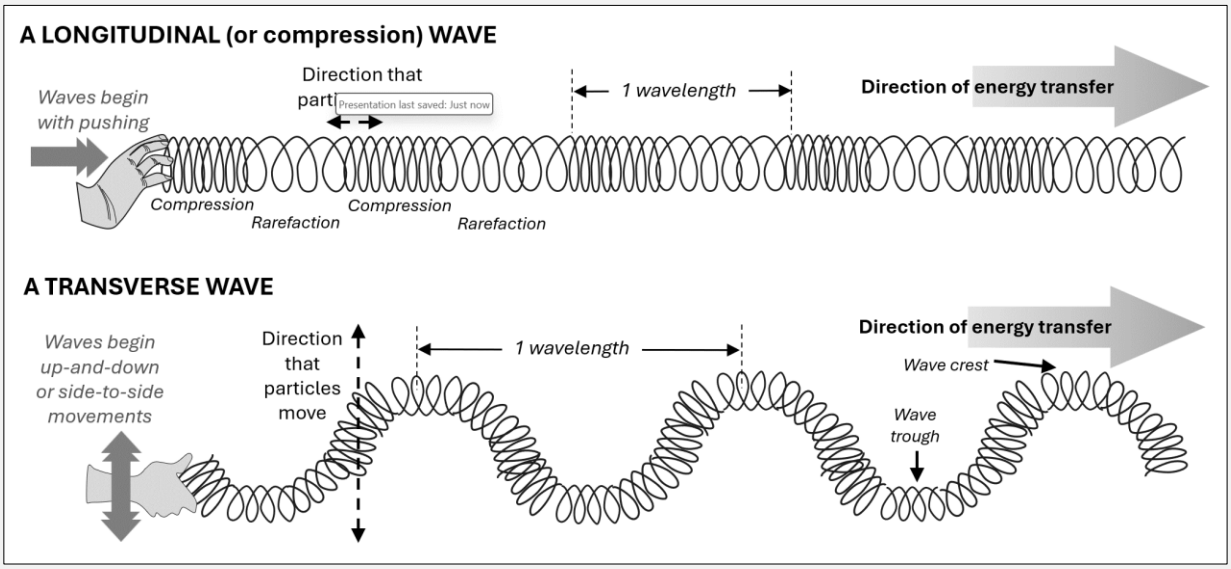
- Refer learners to the main lesson stimulus. Emphasize that the two types of waves that carry all energy in the universe and best illustrated by models. These models help us to understand science phenomena that we cannot directly observe – they are called conceptual models.
- Read the written text. Ask the learners to identify unfamiliar words. They are best explained in the context of the lesson.

TYPES OF WAVES

Longitudinal and *Transverse* waves are the two basic wave types that carry energy from one place to another.

With *Longitudinal* waves, the particles that transfer the energy move back-and-forth along the same axis as the wave. This creates *compressions* and *rarefactions* wave forms along the wave axis. Longitudinal waves always need a material medium (with solid, liquid or gas particles) to move the energy.

With *Transverse* waves*,* the particles move side-to-side in a perpendicular direction (90^{o}) to the direction the energy is being transferred. This creates *crest* and *trough* wave forms along the wave axis. *Transverse* waves do not always need a material medium (solid, liquid or gas particles) to move the energy. Some transverse waves **do** need a medium, such as *waves on the ocean* using water particles to carry the energy, but some transverse waves **do not** need a medium, such as *light waves* that use oscillating electric and magnetic fields to carry the energy and they can do this in empty space or a vacuum. The features of *Longitudinal* and *Transverse* waves are modelled in the following diagrams using a slinky spring (a long, coiled metal spring).



Component 4B

- Read the following questions and ask learners to answer in the space on their worksheet.

  Q1. Which type of waves transfer energy by its particles moving back-and-forth in the same direction that the energy is transferred?

  Q2. What are some features of transverse waves?

  Q3. What do light waves use to travel through empty space and why?

- Observe learners' answers. Ask the learners to share their answers. Give positive feedback. Select a good sample answer for all learners to write down. This may come from the learners or from the following sample answer.

Sample answers:

Q1. Longitudinal waves.

Q2.
- *Their particles move side-to-side.*
- *Their particles move at 90^{o} to the direction the energy is being transferred.*
- *They can travel through solids, liquids and gases.*
- *They do not need a physical medium to carry energy.*
- *They can travel through empty space or a vacuum.*

Q3. Light waves used oscillating electric and magnetic fields to travel through empty space because there are no particles in space to carry the energy.

Component 4C

Read out the following questions and ask learners to answer in the space on their worksheet.

Q1. How many wavelengths can you count in the longitudinal wave model drawn in the stimulus?

Q2. What are some examples of transverse waves?

Q3. **(Optional)** Complete the table on the worksheet to show the differences between longitudinal and transverse waves.

Aspect	**Differences**	
	Longitudinal waves	***Transverse waves***
Particle movement		
Material medium needed		
Wave forms		

- Observe learners' answers. Ask the learners to share their answers. Give positive feedback. Select a good sample answer for all learners to write down. This may come from the learners or from the following sample answer.

Sample answers:

Q1. Five wavelengths (Two before and two after the labelled wavelength)

Q2.
- *Water waves on the ocean*
- *Light waves*
- *Ripples on the surface of water*
- *Secondary waves during an earthquake*
- *Electromagnetic waves*
- *Waves on a string*
- *Stadium or human waves (sometimes call 'Mexican wave'; human waves ore sometimes used in group dancing)*

Q3. Sample table cell responses:

Aspect	Differences	
	Longitudinal waves	***Transverse waves***
Particle movement	*The particles move back-and-forth in the same direction as the wave travels.*	*The particles move side-to-side in a perpendicular direction (90°) to the direction that the wave travels.*
Material medium needed	*Always need a material medium (solid, liquid or gas particles) to move the energy. (mechanical only)*	*Some can travel through a material medium (mechanical) and some can travel without a physical medium (electromagnetic).*
Wave forms	*Compressions and rarefactions*	*Crests and troughs*

Component 5: Lesson Conclusion (Time: 5 minutes)

1. What did you learn from this lesson?
2. What are some things you enjoyed about the lesson?
3. What is something you would like to learn more about in this topic?

REMINDER: Collect learner worksheets to review and analyze learner's knowledge and understanding.

Science Grade 10 Lesson No. 8

How Does Light Energy Travel Through Space?

Key Idea

Light is a form of electromagnetic radiation which travels using transverse waves. Light and other electromagnetic waves do not need a physical medium for the transfer of energy.

Component 1: Short Review (Time: 7 minutes)

- Ask learners to answer the following questions on their worksheets.

  Q1. What are examples of sources of light?

  Q2. How do scientists describe 'light'?

  Q3. What explains why people on Earth notice light from the Sun?

- Ask learners to volunteer answers, giving positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below.

Sample answers:

Q1.
- *It is something that produces light (energy)*
- *The Sun, a light globe, a fire, etc.* (It is fine if the leaners will provide examples – this indicates what the learners might be thinking.)

Q2.
- *It is a form of energy.*
- *It is visible to the human eye.*
- *It is a form of electromagnetic radiation. (This is not an expected answer, but would indicate a knowledgeable learner)*
- *It consists of oscillating electric and magnetic fields (This is not an expected answer, but would indicate a very knowledgeable* learner)

Q3. The sun produces light from oscillations of particles/ions at the Sun's hot surface, then the light travels through empty space and get through the earth's atmosphere during daytime.

Component 2: **Lesson Purpose (**Time: 3 minutes)

This lesson focuses on light energy and way it travels. Further, it will allow learners better understand other forms of energy and the way they travel.

Component 3: Lesson Language Practice (Time: 5 minutes)

Key words/terms:

electromagnetic; medium; charged particles

- Ask the learners to practice saying the words.

Emphasize to the learners the keywords/terms used in the context for better understanding. That is, the word electromagnetic consists the words "electro" and "magnetic". It is related to electricity and magnetism.
The term "medium comes from an English word meaning "something in the middle". Scientifically, it is a material that carries energy from one place to another [e.g. heat energy from a fire to your hand – Heat in Fire ---→ through medium I middle) -→ Hand in Hand]
The term "charged particles" are particles that carry a charge (+ or -).

Component 4*:* Lesson Activity (Time: 25 minutes)

Component 4A

Refer learners to the main lesson stimulus pointing out that it includes a text and a diagram to describe how light as a form of energy travels in transverse waves.

Light travelling from the Sun to the Earth

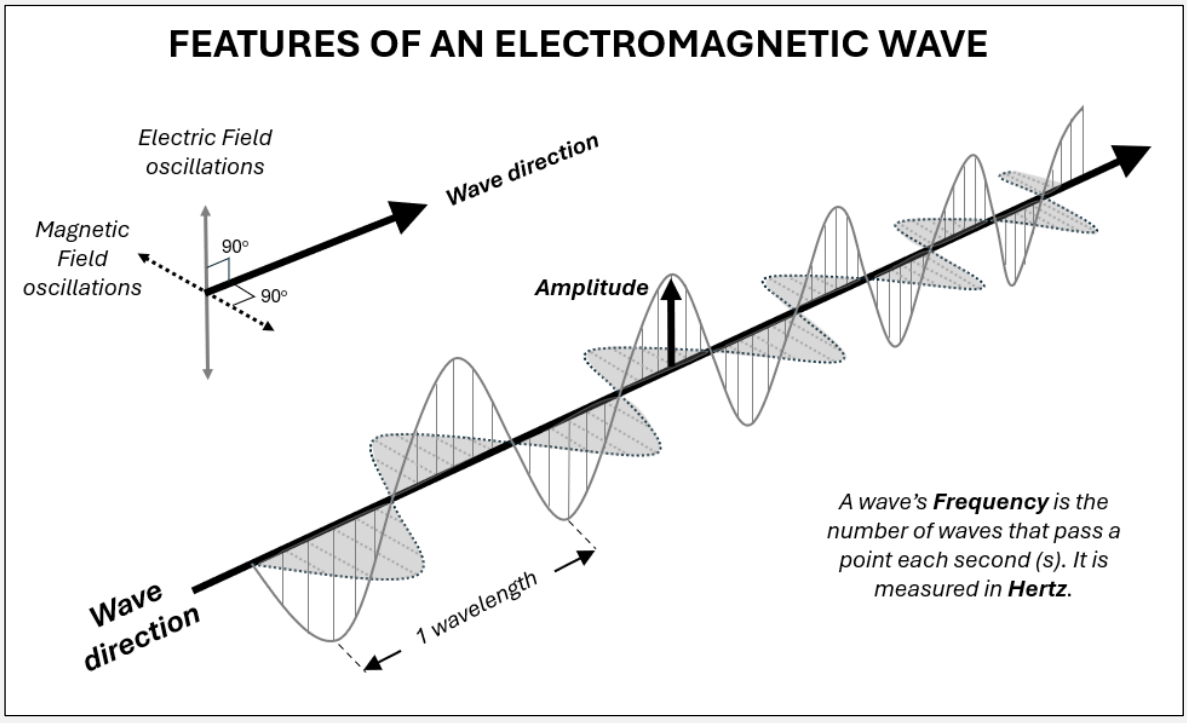
Light has to travels about 150 million kilometers from the Sun to the Earth through empty space. It takes about 8 minutes and 20 seconds – that means it travels **VERY FAST**!

Most of the waves that humans can sense on Earth are waves that need a material medium to travel through. These waves include *water waves*, *sound waves* and *earthquake waves*.

But light waves can travel without a physical medium – they can travel through empty space. Light is a type of **electromagnetic wave** that is made up of both **electric** and **magnetic energy** oscillating very quickly. All electromagnetic waves are produced by the vibration or acceleration of charged particles, such as electrons or ions. When charged particles vibrate or accelerate, they emit electromagnetic energy. The more vibration or acceleration, the more energy is emitted.

The types of electromagnetic waves are determined by the speed of oscillation that produced them – *radio waves* oscillate more slowly than *light*, while *X-rays* oscillate much more quickly than *light*.

An electromagnetic wave can be modelled as a wave of changing electric and magnetic fields with the electric and magnetic oscillations operating at 90^{o} from each other and at 90^{o} to the direction the wave is traveling.



A A light wave's amplitude determines how intense or bright it is.. The ***frequency*** and ***wavelength*** of light determines its color and energy.

If we compare Red, Green and Violet light:

Red light has a frequency of about **450 THz** and a wavelength of about **700 nm**,

Green light has a frequency of about **550 THz** and a wavelength of about **550 nm**,

Violet light has a frequency of about **700 THz** and a wavelength of about **400 nm**,

[1 terahertz (THz) = 1 trillion hertz; 1 nanometer (nm) = 1 billionth of a meter]

Component 4B

- Read the following questions and ask learners to answer in the space on their worksheet.

  Q1. How fast in kilometers per second (km/s) does light travel to reach the Earth from the Sun? An approximate speed worked out from the stimulus will provide a good answer if you do not recall the answer.

  Q2. What physical aspects are used to describe a transverse wave?

  Q3. Describe the relationship between the movement of particles and the direction the energy is being transferred in a transverse wave?

- Observe learners' answers. Ask the learners to share their answers. Give positive feedback. Select a good sample answer for all learners to write down. This may come from the learners or from the following sample answer.

Sample answers:

Q1. The speed of light in a vacuum is approximately 299,792299,792 kilometers per second. Light from the Sun takes roughly 8 minutes and 20 seconds to travel to Earth. So, the approximate speed of light from the Sun to Earth is about 299,792299,792 kilometers per second.

Q2.
- *The wavelength.*
- *The amplitude.*
- *The frequency.*
- *The direction.*
- *The speed or velocity of the wave.*

  (Some learners may suggest the direction of the magnetic or electric fields which would be acceptable but not expected answers; Some learners may suggest the color, which is fine if referring to the frequency of wavelengths)

Q3. In transverse waves, the particles move side-to-side or in a perpendicular direction (90^o) to the direction the energy is being transferred.

Component 4C

- Read out the following questions and ask learners to answer in the space on their worksheet using the information from the stimulus information or from their own knowledge.

  Q1. What is the approximate frequency of green light compared to red or violet light?

  Q2. What are some examples of the things that light can travel through that indicate travels as a transverse wave and rather than a longitudinal wave?

  Q3. **(Optional)** Use the information in the stimulus to state the relationship between *frequency* and *wavelength* of colored light?

- Observe learners' answers. Ask the learners to sharer their answers. Give positive feedback. Select a good sample answer for all learners to write down. This may come from the learners or from the following sample answer.

Sample answers:

Q1.
- *550 terahertz (550Thz)*

  (Check if learners provide the correct units; if they provided 550 without units – they may be incorrectly reading the *wavelength*!)

Q2.
- *Space;* or *empty space.*
- *A vacuum.*
- *Air.*
- *Clear or frosted glass.*
- *Clear plastic* or *Thin plastic.*

(To answer the question fully, the learners would need to include 'Space, or 'a vacuum'.)

*Q3. As the **frequency increases**, the **wavelength decreases**. This can be seen as light goes from 450Thz (red) to 550 Thz (green) to 700 Thz (violet) that wavelength goes from 700 nm to 550nm to 400 nm.*

Component 5: Lesson Conclusion (Time: 5 minutes)

Remind learners that good learners reflect on their learning.

The focus of this lesson was on learning about light as a form of energy and the way it travels.

- Ask learners to answer the following questions either by class discussion or writing the answers in their worksheet.

Q1. Has this lesson helped you better understand light as a form of energy and the way it travels? If so, how?

Q2. Has this lesson helped you remember what electromagnetic radiation is? If so, how?

Q3. What was hard to do or understand in the lesson?

REMINDER: Collect learner worksheets to review and analyze learner's knowledge and understanding.

Science Grade 10 Lesson No. 9

What Parts of White Light Have the Most Energy?

Key Idea

Violet light has the shortest wavelength of the colors that make up the visible light spectrum and so it has the highest energy of the colored lights.

Component 1: Short Review (Time: 5 minutes)

- Ask learners to answer the following questions on their worksheet.

  Q1. What do you know about rainbows and how they form?

  Q2. What are the colors of the rainbow?

  Q3. What other forms of energy are closely associated with light energy? Can you give an example?

- Ask learners to share their answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1.
- *They are often formed before or after there is a storm cloud.*
- *Sunlight spreads into colors in an arch shape near a cloud; through some rain.*
- *Sunlight splits into colors when the light passes through rain drops.* (Expect and embrace a wide range of answers; being careful to reinforce good or related ideas)

Q2.
- *Red,*
- *Orange,*
- *Yellow,*
- *Green,*
- *Blue,*
- *Indigo,*
- *Violet.*

Q3.
- Heat energy is closely associated with light energy – you can see light and feel heat from the Sun at the same time.
- *At discos/dance events, sometimes the DJ will put an ultraviolet light flashing with the white and colored lights.*
- *When an infrared heater is turned on, we can see red light coming from it too*

Component 2: **Lesson Purpose (**Time: 5 minutes)

This lesson deals on how white light can be broken into its component colors. Violet light bends more than red light since it has the highest energy and the shortest wavelength.

This lesson may help learners to recall the lessons about frequency and wavelength.

Component 3: Lesson Language Practice (Time: 5 minutes)

Keywords/terms:

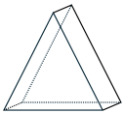
wavelength; frequency

- Ask the learners to practice saying the words.

Component 4*:* Lesson Activity (Time: 25 minutes)

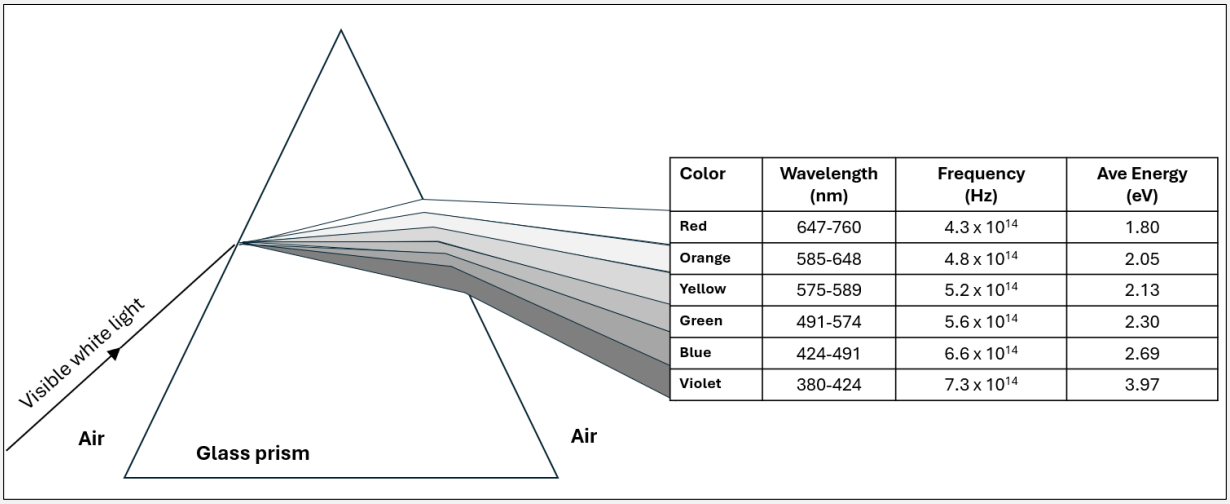
Component 4A

Refer learners to main lesson. Emphasize that this lesson includes information about how white light can be broken into its component colors when it passes through a clear prism, with violet light bending more than red light.

- Help learners to recognize or recall a triangular prism. 

Splitting Visible Light into Its Colors

As white light enters a glass prism from the air, it bends and spreads into different bands of color. The various colors have different *wavelengths* (i.e. distances between waves, measured in *nanometers*) and different *frequencies* (i.e. numbers of waves that pass a point in one second, measured in *Hertz*).



Color	Wavelength (nm)	Frequency (Hz)	Ave Energy (eV)
Red	647-760	4.3×10^{14}	1.80
Orange	585-648	4.8×10^{14}	2.05
Yellow	575-589	5.2×10^{14}	2.13
Green	491-574	5.6×10^{14}	2.30
Blue	424-491	6.6×10^{14}	2.69
Violet	380-424	7.3×10^{14}	3.97

There is a relationship between the **wavelength**, the **frequency** and the **amount of energy** that light has and this relationship can be seen in the table above.

The amount of energy that light has is directly related to its frequency – as frequency increases, the energy increases. At the same time, the wavelength decreases.

Scientists describe this relationship using technical mathematical language as:

"Wavelength is ***inversely proportional*** to Frequency but is ***directly proportional*** to Energy."

Component 4B

- Read the following questions and ask learners to answer in the space on their worksheet.
  Q1. What shape is the glass prism?

  Q2. What happens to light when it enters the glass prism shown in the stimulus?

  Q3. What is the relationship between the wavelength and the frequency of light?
- Observe learners' answers. Ask the learners to sharer their answers. Give positive feedback. Select a good sample answer for all learners to write down. This may come from the learners or from the following sample answer.

Sample answers:

Q1. Triangular

Q2.
- *It bends;*
- *It bends and spreads into its colors;*
- *Different colors bend at different angles;*
- *Violet light bends most, Red light bends least.*

Q3. As the frequency increases, the wavelength decreases.

Component 4C

- Read the following questions and ask learners to answer in the space on their worksheet.

  Q1. What is the wavelength range for Orange light?

  Q2. Which colors fall within the range of frequencies between 5.2 x 10^{14} Hz and 8.0 x 10^{14} Hz?

  Q3. **(Optional)** Describe scientifically the relationship between Energy, Frequency and Wavelength?

- Observe learners' answers. Ask the learners to share their answers. Give positive feedback. Select a good sample answer for all learners to write down. This may come from the learners or from the following sample answer.

Sample answers:

Q1. The wavelength range for orange light is 585nm – *648nm.*

Q2.
- *Green,*
- *Blue, and*
- *Violet.*

Q3. Energy is directly proportional to Frequency and inversely proportional to Wavelength.

Component 5: Lesson Conclusion (Time: 5 minutes)

This lesson focused on learning about how white light is broken into its component colors.

1. Could you find any answers in the Stimulus text provided for questions in Component **4B** or **4C**? Which ones?

> e.g., It can be helpful to explain to learners that it is good learning technique to look for answers that might be given in a text or stimulus. This also helps understanding what is needed to answer

Learners can find direct answers to 4C Qs 1, and 2.

2. What connections or differences do you notice between questions in **4B** and **4C.**

3. Did you find it easier to answer the questions in Component **4B** or **4C**? Why?

REMINDER: Collect learner worksheets to review and analyze learner's knowledge and understanding.

Science Grade 10 Lesson No. 10

The Electromagnetic Spectrum

Key Idea

The *electromagnetic spectrum* (*EMS*) comprises a continuous range of electromagnetic waves categorized by properties according to their ranges of wavelengths and frequencies.

Component 1: Short Review (Time: 7 minutes)

- Ask learners to answer the following questions on their worksheet.

  Q1. What are *electromagnetic waves*?

  Q2. What are some examples of *electromagnetic waves*?

  Q3. Why do scientists study electromagnetic waves?
- Ask learners to share answers. Givie positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. They are a type of wave or radiation that travels in transverse waves.

Q2.
- *Radio waves,*
- *Microwaves,*
- *Infrared radiation,*
- *Visible light,*
- *Ultraviolet radiation,*
- *X-rays, and*
- *Gamma radiation,*

Q3. Because they can be harmful to living things and at the same time, they can be useful for applications and to research about the nature of matter in the Universe.

Component 2: **Lesson Purpose (**Time: 3 minutes)

This lesson is about getting to know about the full electromagnetic spectrum (EMS) which comprises a continuous range of electromagnetic waves categorized by properties and their ranges of wavelengths and frequencies.

The lesson may also help learners to understand and use *scientific notation*.

Component 3: Lesson Language Practice (Time: 5 minutes)

Keywords/terms:

spectrum; spectra; radiation; x-rays; gamma rays

- Ask the learners to practice saying the words.
- Help learners to see that *spectrum* is the full range; *spectra* is a part of the range. Radiation is a more general term that is sometimes used to mean *spectrum* or *energy.*
- Some learners might need help to see what the numbers mean – can they say which are **big** numbers and which are **small** numbers? Help learners understand why scientists use s*cientific notation* for very big and very small numbers.

Component 4*:* Lesson Activity (Time: 25 minutes)

Component 4A

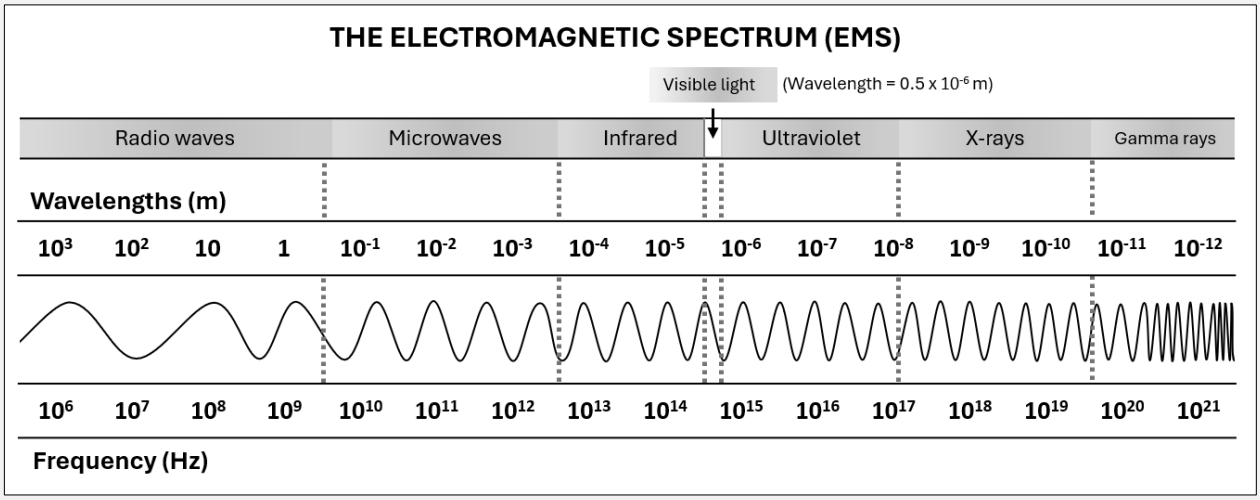
- Refer learners to the main lesson stimulus pointing out that it includes *a diagram* that depicts *numerical data* around a *symbolic representation* of the wave-shapes for the different regions of the electromagnetic spectrum.

THE ELECTROMAGNETIC SPECTRUM (EMS)

Different types of electromagnetic waves exist with an enormous range of different wavelengths and frequencies. This continuous range of wavelengths and frequencies is known as the **electromagnetic spectrum**. The entire range of the spectrum is often broken into specific regions including *radio waves, microwaves, infrared, visible light, ultra-violet, x-rays,* and *gamma radiation.*

The subdividing of the entire spectrum into smaller spectra is done mostly on the basis of how each region of electromagnetic waves interacts with matter.

The diagram below depicts the electromagnetic spectrum and its various regions.



The longer wavelength, lower frequency regions are located on the far left of the spectrum and the shorter wavelength, higher frequency regions are on the far right.

Component 4B

- Read the following questions and ask learners to answer in the space on their worksheet.
  Q1. If a wave has a wavelength of 10^{-2} m, which type of radiation would it be?

  Q2. Which electromagnetic waves have frequencies higher than the frequency of visible light?

  Q3. What is the best way to describe gamma rays in terms of their frequency and wavelength?
- Observe learners' answers. Ask the learners to share their answers. Give positive feedback. Select a good sample answer for all learners to write down. This may come from the learners or from the following sample answer.

Sample answers:

Q1. Microwave radiation.

Q2.
- *ultra-violet,*
- *X-rays, and*
- *gamma rays.*

Q3. Gamma rays have a high-frequency and a short-wavelength.

Component 4C

- Read the following questions and ask learners to answer in the space on their worksheet.

  Q1. Which wave types of the electromagnetic spectrum have the longest wavelength?

  Q2. Complete the following table with the approximate values for the wavelength and frequencies for *Microwaves* and *Infrared radiation*? [Two values have been added for you.]

	Microwaves		***Infrared radiation***	
Wave type	From:	To:	From:	To:
Wavelength range (In meters)	10^0			
Frequency range (in hertz)		10^{12}		

  Q3. **(Optional)** Why do you think that the location of Visible light has been shown above the other types of waves?

- Observe learners' answers. Ask the learners to share their answers. Give positive feedback. Select a good sample answer for all learners to write down. This may come from the learners or from the following sample answer.

Sample answers:

Q1. Radio waves

Q2. Suggested table response:

	Microwaves		***Infrared radiation***	
Wave type	From:	To:	From:	To:
Wavelength range (In meters)	10^0	10^{-3}	10^{-4}	10^{-5}
Frequency range (in hertz)	10^{10}	10^{12}	10^{13}	10^{14}

Q3. Because it has a very narrow range of wavelengths and frequencies.

Component 5: Lesson Conclusion (Time: 5 minutes)

1. What did you learn from this lesson?
2. What are some things you enjoyed about the lesson?
3. What is something you would like to learn more about in this topic?

REMINDER: Collect learner worksheets to review and analyze learner's knowledge and understanding.

Science Grade 10 Lesson No. 11

The Sizes of Electromagnetic Waves

Key Idea

The sizes of electromagnetic waves, as determined by their wavelengths, affect their uses and applications in various ways.

Component 1: Short Review (Time: 5 minutes)

- Ask learners to answer the following questions on their worksheet.

  Q1. What does application mean?

  Q2. What are some applications of light energy?

- Q3. What effects might an electromagnetic wave's size have on its capabilities?

  Ask learners to share their answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. A *use for something.*

Q2.
- *It is used for seeing*
- *It is used for photography*
- *People use light to make light gates – if you step into the n=bean, an alarm ring.*
- *It is used for adding color and atmosphere in dance halls.*

Q3.
- *If it is too big, some obstacles might stop it.*
- *If it is a certain size, it might bounce off objects in unpredictable ways.*
- *If it is too small it might not hit anything.*

Component 2: **Lesson Purpose (**Time: 3 minutes)

This lesson is about understanding how the sizes of electromagnetic waves relates to their uses and applications in various ways.

The lesson may also help learners to be better at using s*cientific notation* for very big and very small numbers. The stimulus provides supportive information by giving both s*cientific notation* and *decimal notation.*

Component 3: Lesson Language Practice (Time: 5 minutes)

Keywords/terms:

applications; penetrate/penetration; size range

- Ask the learners to practice saying the words. Help with meanings

Talk out the words, pointing out that many verbs are converted to nouns in Science because they are recognized by the scientific community as general processes that apply across different areas of science.

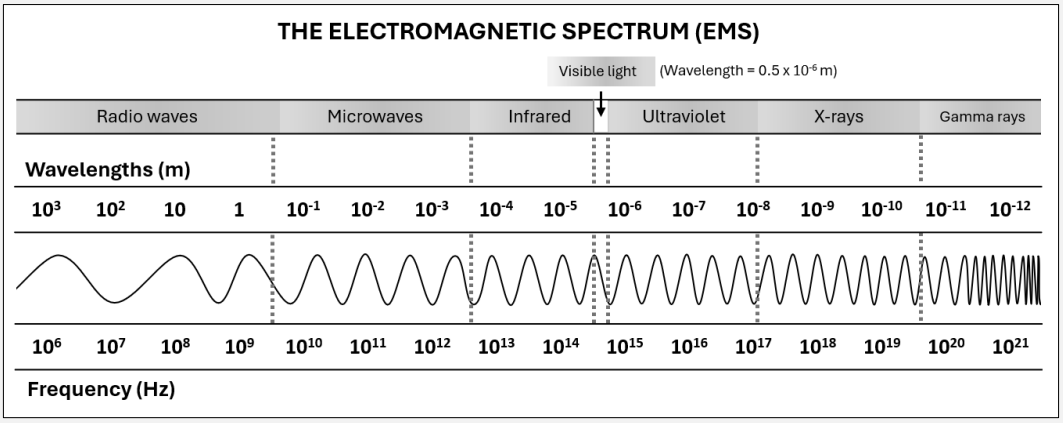
It's important that learners recognize what a 'range' is when referring to numbers.

Component 4*:* Lesson Activity (Time: 25 minutes)

Component 4A

- Refer learners to the main lesson stimulus pointing out that it includes the table from Lesson 10 to help recall the features of the EMS.

The Sizes of EMS Waves Determine Their Color



The table from Lesson 10 to help your understanding of the EMS

The length of electromagnetic waves influence their uses and applications by determining their ability to penetrate materials, how they interact with matter, and how they perform specific functions, such as communication, imaging, heating, sterilization, and scientific research. For example, look at the wavelength range for *waves* in the following table. Because radio waves are very long, their lengths often match the size of the obstacles and they can go around them, including very big objects such as buildings and mountains. This makes them very good for carrying information over very long distances.

Types of EMS	**Wavelength range** (in meters)	**Wavelength range** (in meters)	**Typical sizes/size ranges**	**Penetration** Through:
Radio waves	$10^3 – 10^0$	1,000 - 1.0	Range: a volcano; building; size of human; umbrella length	walls, foliage; forest; buildings, small mountains.
Microwaves	10^0 - 10^{-3}	1.0 v 0.001	Range: umbrella; wristwatch face; Fingernail; a small insect	clouds, fog, light foliage. Some materials, like plastic, glass, and certain fabrics. (Not metals)
Infrared	10^{-4} - 10^{-5}	0.0001 - 0.00001	width of a human hair	thin fabrics and plastics. (Not insulation)
Visible light	10^{-5} - 10^{-6}	0.00001 - 0.000001	a body cell	transparent materials, e.g. glass and water. (Not opaque things)
Ultraviolet	10^{-6} - 10^{-8}	0.000001 - 0.00000001	a molecule; a virus	air, skin, certain materials.
X-rays	10^{-8} - 10^{-11}	0.00000001- 0.00000000001	an atom	soft live tissue, fabrics, and thin metals.
Gamma rays	10^{-11} - 10^{-12}	0.00000000001 - 0.000000000001	an atomic nucleus	human tissue; fabrics, paper, thin metals. (Not thick lead or concrete.)

The ability of electromagnetic waves to penetrate or go around materials depends on their wavelength and energy.

Component 4B

- Read the following questions and ask learners to answer in the space on their worksheet.

  Q1. If a wave had a wavelength that was about the same length as a Philippine peso, what type of wave would it be?

  Q2. What are some things that radio waves will penetrate or go around?

  Q3. Why can radio waves go around very big objects such as buildings and mountains?

- Observe learners' answers. Ask the learners to volunteer their answers, giving positive feedback. Select a good sample answer for all learners to write down. This may come from the learners or from the following sample answer.

Sample answers:

Q1. A microwave.

Q2.
- *Walls,*
- *Foliage,*
- *A forest,*
- *Around buildings,*
- *Around small mountains.*

Q3.
- *Because radio waves are very long – their length often matches the size of the obstacles.*
- *They can also bend around obstacles.*

Component 4C

- Read the following questions and ask learners to answer in the space on their worksheet.

  Q1. What does the table show as the average length of a radio wave?

  Q2. Which wave types are smaller than a body cell?

  Q3. **(Optional)** Why might X-rays and gamma rays be able to go through soft human and living tissue?

- Observe learners' answers. Ask the learners to share their answers. Give positive feedback. Ask the learners to volunteer their answers, giving positive feedback. Select a good sample answer for all learners to write down. This may come from the learners or from the following sample answer.

Sample answers:

Q1. About 500m long (The approximate range is from 1m-1000m, therefore average length is about 500m)

Q2.
- *Ultraviolet rays,*
- *X-rays, and*
- *Gamma rays.*

Q3. X-rays and gamma rays are able to go through soft human and living tissue because they are much, much smaller than body cells or their molecules.

Component 5: Lesson Conclusion (Time: 5 minutes)

1. What did you learn from this lesson?
2. What are some things you enjoyed about the lesson?
3. What is something you would like to learn more about in this topic?

REMINDER: Collect learner's worksheets to review and analyze learner's knowledge and understanding.

Science Grade 10 Lesson No. 12

Applications and Harmful Aspects of EMS

This is a CONSOLIDATION LESSON

Component 1: Short Review (Time: 7 minutes)

- Ask learners to answer the following questions on their worksheet.

  Q1. What does harmful mean?

  Q2. What are some beneficial applications of electromagnetic radiation?

  Q3. How does wavelength and frequency relate on the electromagnetic spectrum?

- Ask learners to share answers. Givie positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1.
- *Can cause damage to people and things.*
- *Can make people sick.*

Q2.
- *Light and heat from the Sun*
- *Microwaves are good for heating food up;*
- *Radio waves are good for communicating over long distances.*
- *X-rays can show if you have a broken bone.*
- *Gamma rays can kill cancer cells.*

Q3.
- *As the frequency increases, the wavelength decreases, or*
- *As the wavelength decreases, the frequency increases.*

Component 2: **Lesson Purpose (**Time: 3 minutes)

The lesson may help learners to better understand that the electromagnetic spectrum comprises harmful and beneficial radiation, depending on how it is understood and used.

The lesson should provide more contexts for leaners to apply their knowledge of the electromagnetic spectrum.

The lesson should reinforce their ability to interpret *scientific tables* and *extract* relevant information from them

Component 3: Lesson Language Practice (Time: 5 minutes)

- Read out difficult or unfamiliar words or phrases and ask the learners to read them to themselves and then out loud as a class, e.g.:

  ions; ionizing radiation;* radiotherapy; *DNA

- Check that learners understand these terms. Ask the learners to practice saying the words.

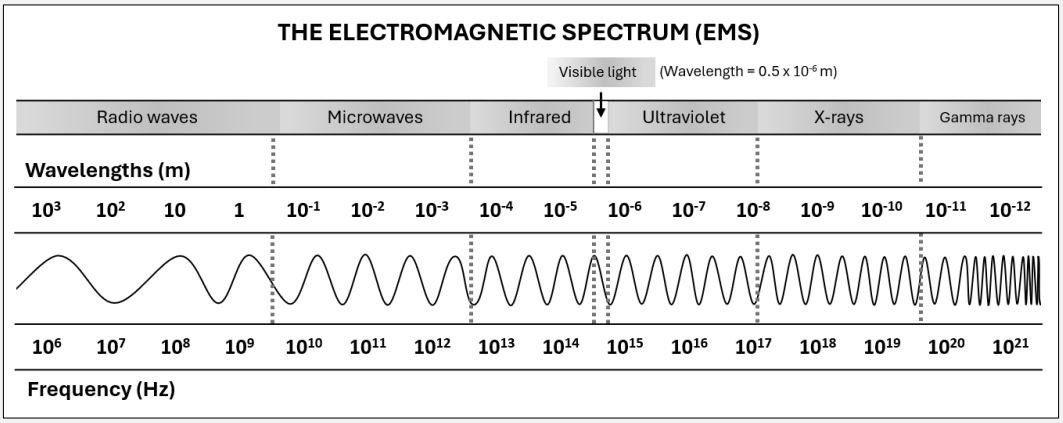
The terms provided are ones that can be deconstructed to help understand their meaning.

Component 4*:* Lesson Activity (Time: 25 minutes)

Component 4A

- Refer learners to the main lesson stimulus about common applications of electromagnetic radiation, as well as its harmful effects. Point out that it includes the table from Lesson 10 to help recall the features of the EMS. Check if they can see the connections between the study of physics and the study of life science (Biology) in this lesson.

THE EMS – It Can Be Both Good and Harmful



The table from Lesson 9 to help your understanding of the EMS

Type of EMS	**Wavelength range** (in meters)	**Ionizing?**	**Common everyday applications**
Radio waves	$10^3 – 10^0$	**No**	AM radio; FM Radios; Radio broadcasting; Television communication; Short wave radios;
Microwaves	10^0 - 10^{-3}	**No**	Satellite television; Radar systems; Wi-Fi; Microwave ovens;
Infrared	10^{-4} - 10^{-5}	**No**	Remote controller; Intruder alarms Night vision goggles; heat from radiator; remote temperature sensing,
Visible light	10^{-5} - 10^{-6}	**No**	For human and animal vision; Optic fibers; Light bulbs; cameras; for photography and cinematography,
Ultraviolet	10^{-6} - 10^{-8}	**Yes**	Sunbeds; sterilization of medical equipment; Dental curing; fluorescence detection
X-rays	10^{-8} - 10^{-11}	**Yes**	Baggage scanning; X-ray images; CT scans; PET scans; scientific research
Gamma rays	10^{-11} - 10^{-12}	**Yes**	Engineering applications; Radiation therapy; Cancer treatment;

Is Electromagnetic Radiation that is Ionizing Harmful to Living Things?

Ionizing radiation, such as gamma rays, have high energy and can penetrate deeply into living tissues. When ionizing rays interact with atoms in the body, they can ionize atoms, meaning they can knock electrons out of atoms, creating charged particles known as ions. These ions can directly damage cellular components including the DNA of cells. DNA damage can cause cancer. Ionizing radiation can also interact with water molecules in cells, damaging cell components.

Because gamma rays are ionizing, they are used in radiotherapy by doctors to treat cancers in patients. When a fine stream of gamma rays are directly targeted on cancer cells, they can knock out the DNA of cells which prevents them from dividing and multiplying in a patient's body.

Component 4B

- Read the following questions and ask learners to answer in the space on their worksheet.

  Q1. What is ionizing radiation?

  Q2. What can infrared radiation be used for?

  Q3. Explain how people can protect themselves from UV rays to stop being sunburned.

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. Ionizing radiation is the type of EMS waves that can turn the electrons in atoms to charged particles called ions. These ions can damage the cells of living things.

Q2.
- *To operate a TV Remote controller,*
- *As the sensor for intruder alarms,*
- *For night vision goggles;*
- *For heat from a fire or electric radiator;*
- *For remote temperature sensing.*

Q3. People can protect themselves from UV rays by applying sun protection cream which will provide a barrier to stop UV rays from penetrating their skin.

Component 4C

- Read the following questions and ask learners to answer in the space on their worksheet.

  Q1. What is the wavelength range for ultraviolet light?

  Q2. What electromagnetic radiation types are ionizing?

  Q3. **(Optional)** Explain why gamma rays can be both good and bad for people?

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. 10^{-6} meters - 10^{-8} meters.

Q2.
- *Ultraviolet,*
- *X-rays, and*
- *Gamma rays.*

Q3. Gamma rays can penetrate deeply into living tissues, creating dangerous ions that can directly damage cellular components including the DNA of cells, which in turn can interfere with DNA replication and transcription, potentially leading to unwanted mutations and chromosomal abnormalities and even causing cancer. But Gamma rays can be used for good as doctors can directly target cancer cells with a stream of gamma rays stop the cells from dividing and multiplying in a patient's body.

Component 5: Lesson Conclusion (Time: 5 minutes)

Remind learners that good learners reflect on their learning.

The focus of this lesson was on learning about the harmful and beneficial effects of the electromagnetic spectrum.

- Ask learners to answer the following questions either by class discussion or by writing the answers on their worksheet.

  Q1. Has this lesson helped you to better understand that the electromagnetic spectrum comprises harmful and beneficial radiation*? If so, how?*

  Q2. Has this lesson helped you to remember what electromagnetic radiation is? If so, how?

  Q3. What was hard to do or understand in the lesson?

REMINDER: Collect learner worksheets to review and analyze learner's knowledge and understanding.

Science Grade 10 Lesson No. 13:

Bonds

Key Idea

The concept that the formation of a chemical bond results in a chemical change is fundamental to the study of chemical reactions.

Component 1: Short Review (Time: 7 minutes)

- Ask learners to answer the following questions on their worksheets

  Q1. If compounds have two or more different types of atoms, how do they stay together?

  Q2. What do we call the electrons that bond with other atoms?

  Q3. How would you describe a chemical bond?

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. They stay together because they form bonds.

Q2. They are called valence electrons.

Q3. A chemical bond is a very strong force of electrostatic attraction between atoms.

Component 2: **Lesson Purpose** (Time: 3 minutes)

This lesson is about how atoms combine to form chemical bonds.

The lesson may also help learners to better understand and describe the meaning of a diagram.

Component 3: Lesson Language Practice (Time: 5 minutes)

- Read difficult or unfamiliar words or phrases and ask the learners to read them to themselves and then out loud as a class, e.g.:

  bonds; diagram

- Ask the learners to practice saying the words.

- Ask learners to select one of the words above and write a sentence using the word in a scientific sense, and then write a sentence using the word in an everyday sense.

Sample Answers

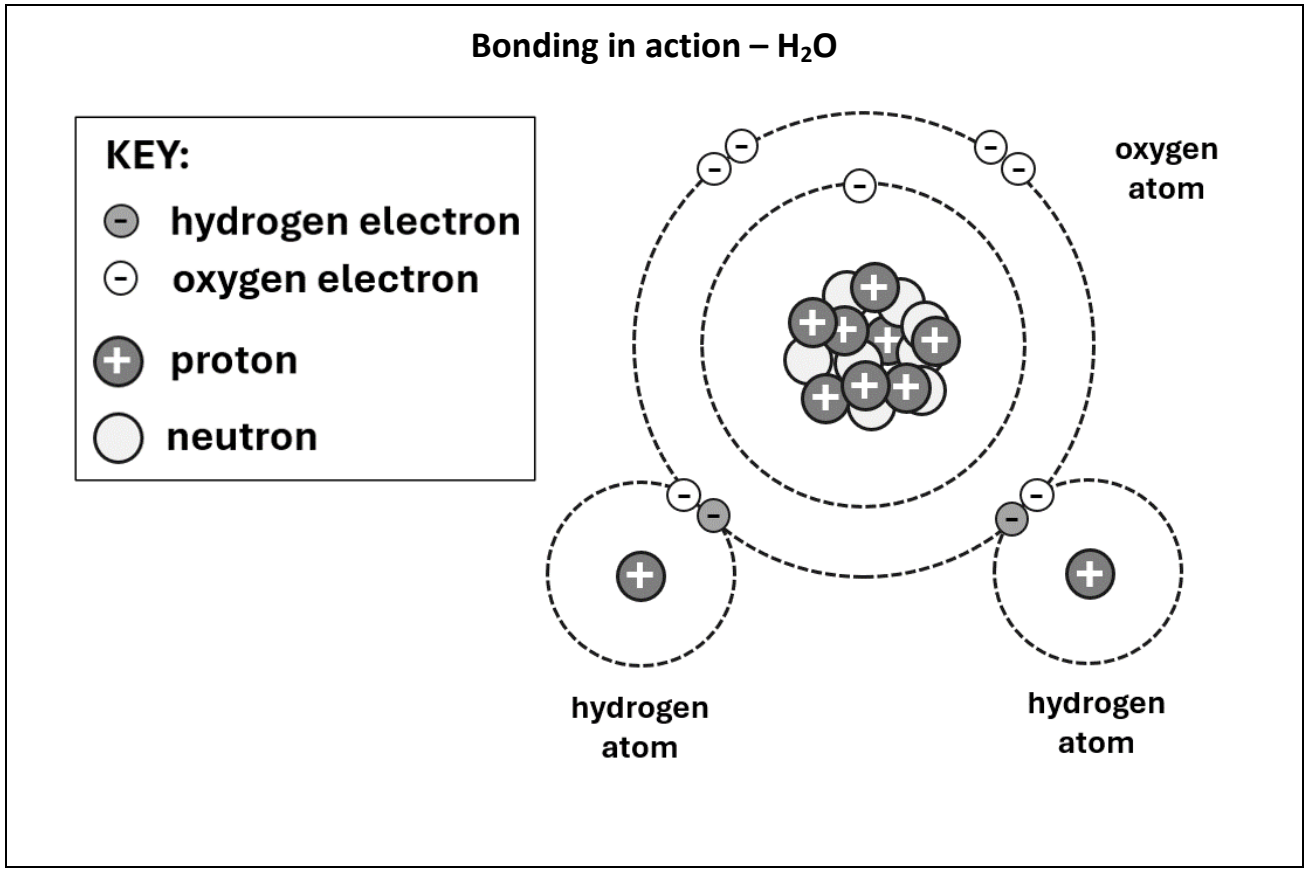
A chemical bond is the transfer or sharing of valence electrons between atoms.

You can bond two pieces of paper together using glue.

Component 4*:* Lesson Activity (Time: 25 minutes)

Component 4A

- Refer learners to the main lesson stimulus, pointing out that it includes *symbolic representations* of a chemical bond.
- Read the written text. Ask the learners if there are any words that they are not familiar with and give descriptions of any words that may be problematic.



Component 4B

- Read the following questions and ask learners to answer in the space on their worksheet.

  Q1. What does the diagram tell you about oxygen?

  Q2. What does the diagram tell you about hydrogen?

  Q3. What does the diagram tell you about the new substance formed?

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. The diagram shows that oxygen has 6 electrons in its outer shell, two of them are being used in bonds.

Q2. The diagram shows that oxygen needs two hydrogen atoms because it needs two electrons, and the hydrogen atom only has one to share.

Q3. The diagram tells you that the new substance has two atoms of hydrogen for each atom of oxygen.

Component 4C

- Read the following questions and ask learners to answer in the space on their worksheet.

  Q1. What is the new substance made by the formation of the bond between oxygen and hydrogen?

  Q2. If the new substance is made up of hydrogen and oxygen, can we get oxygen back?

  Q3. **(Optional)** How does the diagram better explain the concept of a chemical bond?

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. The new substance that is formed is called water.

Q2. The reaction can only be reversed by a chemical reaction such as electrolysis, i.e. using an electric current.

Q3. The diagram shows the importance of the valence electrons in the formation of bonds, so the number of electrons in the outer shell is critical to the formation and breaking of bonds. In the case of water, it shows electrons being shared between the atoms of hydrogen and oxygen, therefore the diagram represents a covalent bond.

Component 5: Lesson Conclusion (Time: 5 minutes)

Ask learners to answer the following questions either by class discussion or by writing the answers in their worksheet.

The focus of the lesson was on understanding chemical bonds more deeply.

1. How has the lesson helped you to better understand chemical bonding?
2. Which questions were easy to answer – the ones in Component 4B or Component 4C? Why?

Let learners reflect on their learning.

REMINDER: Collect learner worksheets to review and analyze learner's knowledge and understanding.

Science Grade 10 Lesson No. 14

Types of Bonds

Key Idea

The type of bond formed determines whether the result is a covalent or an ionic compound.

Component 1: Short Review (Time: 7 minutes)

- Ask learners to answer the following questions on their worksheets.

  Q1. Are all chemical bonds the same?

  Q2. Name at least two types of bonds.

  Q3. What type of chemical bond is there in water? Explain.

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. No, there are a few different types of chemical bonds.

Q2. There are covalent, ionic, and metallic bonds in chemistry.

Q3. In water the bonds between atoms of hydrogen and oxygen are covalent because the electrons are being shared.

Component 2: **Lesson Purpose** (Time: 3 minutes)

This lesson is about the different types of chemical bonds.

The lesson may also help learners better understand that not all chemical compounds are the same.

Component 3: Lesson Language Practice (Time: 5 minutes)

- Read difficult or unfamiliar words or phrases and ask the learners to read them to themselves and then out loud as a class, e.g.:

configuration; charge

- Ask the learners to practice saying the words.

- Ask learners to select one of the words above and write a sentence that would explain its meaning in a scientific sense, and then write a sentence that would explain its meaning in an everyday sense.

Configuration in chemistry is the way we write the positions of electrons in different orbits for an atom.

The configuration of the stars is an example of the use of the word outside chemistry.

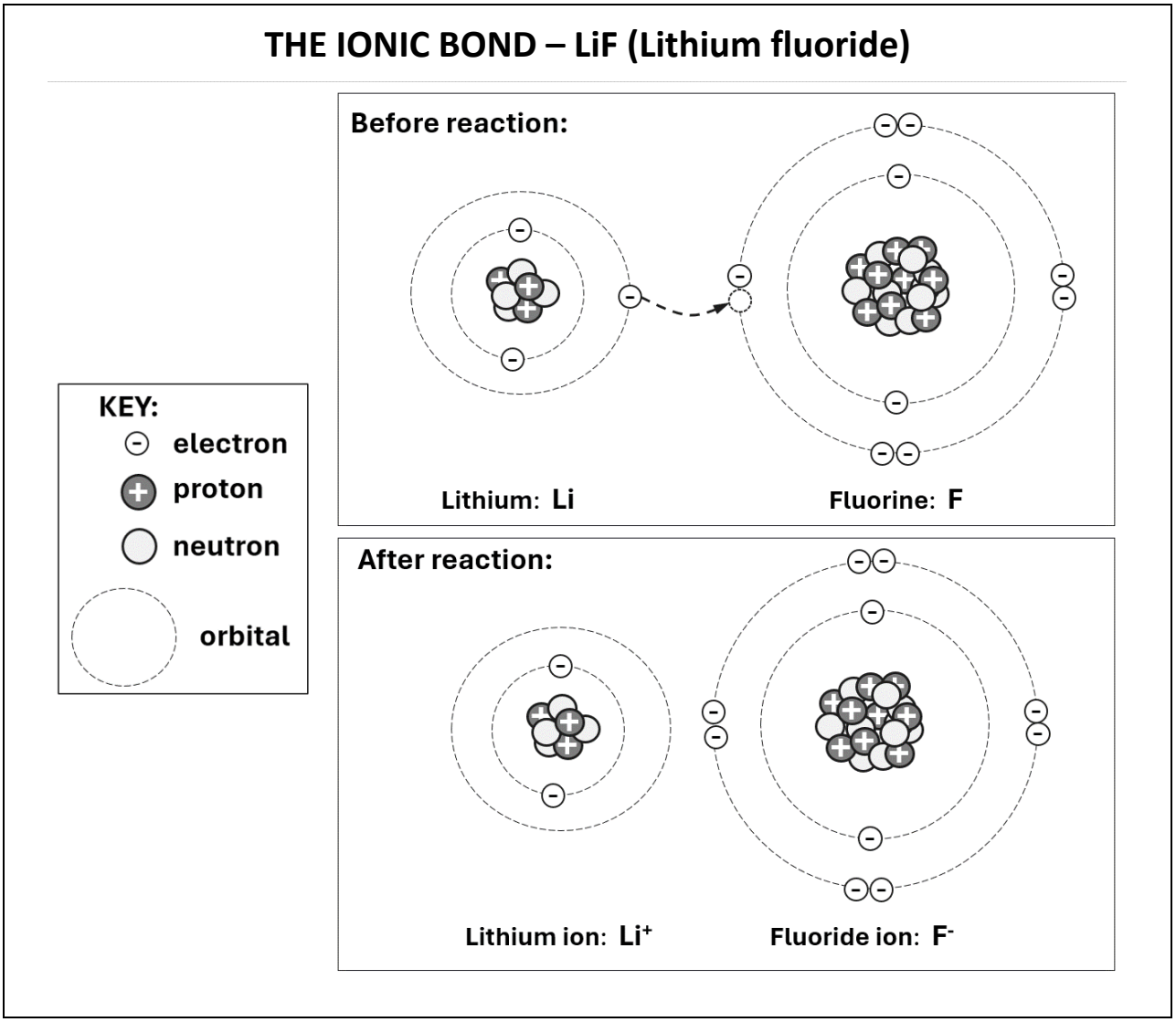
A charge in chemistry refers to electric or magnetic positive and negative charges on sub-atomic particles.

The "charge of the light brigade" is an alternative use of the word charge outside of science.

Component 4*:* Lesson Activity (Time: 25 minutes)

Component 4A

- Refer learners to the main lesson stimulus pointing out that it shows *symbolic representations* of the formation of a type of chemical bond.
- Read the written text. Ask the learners if there are any words that they are not familiar with and give descriptions of any words that may be problematic.



Component 4B

- Read the following questions and ask learners to answer in the space on their worksheet.

  Q1. If lithium is in group 1 and period 2 of the periodic table what would be its electron configuration?

  Q2. How many electrons does the diagram above show for fluorine in the outer shell? What would be its configuration?

  Q3. What has happened to the outer shell for both lithium and fluorine after the reaction?

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. The electron configuration for the lithium atom is $1s^2$, $2s^1$

Q2. The diagram shows fluorine having 7 electrons in its outer shell or a configuration of $1s^2$, $2s^2$, $2p^5$.

Q3 Lithium has transferred its electron from the outer shell to the outer shell of fluorine, so lithium has not enough electrons in its outer shell and fluorine has an extra one.

Component 4C

- Read the following questions and ask learners to answer in the space on their worksheet.

  Q1. What is the new substance formed when lithium and fluorine bond together?

  Q2. What is the charge shown in the diagram for lithium and fluorine?

  Q3. **(Optional)** As we know that atoms are supposed to have a neutral charge, what are lithium and fluorine shown in the diagram, called, and why?

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. The new substance formed is called lithium fluoride.

Q2. Lithium seems to have a positive charge and fluorine seems to have a negative charge.

Q3. Lithium with a positive charge and fluorine with a negative charge are called ions and that is because when they bond together, they form an Ionic bond and the atom which loses or gains electron are called Ions.

Component 5: Lesson Conclusion (Time: 5 minutes)

- The focus of this lesson was on different types of chemical bonds.

- Ask learners to answer the following questions either by class discussion or by writing the answers on their worksheet.

  Q1. Has this lesson helped you to better understand chemical bonding? If so, how?

  Q2 What was hard to do or understand in the lesson?

Let learners learners reflect on their learning.

REMINDER: Collect learner worksheets to review and analyze learner's knowledge and understanding.

Science Grade 10 Lesson No. 15

Making and breaking bonds

Key Idea.

In chemistry, changes in materials are described as being either reversible or irreversible.

Component 1: Short Review (Time: 7 minutes)

- Ask learners to answer the following questions on their worksheets.

  Q1. What sort of change happens when ice melts into water?

  Q2. What sort of change happens when an ionic or a covalent bond is formed?

  Q3. What is a chemical reaction, and how is it different with a physical change?

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. When ice melts, it undergoes a physical change and called a change of state, from solid to liquid.

Q2. When a covalent bond or an ionic bond Is formed the change is called a chemical change.

Q3. A chemical reaction is where chemical bonds are broken or formed, whereas a physical change does not involve chemical bonds. A chemical change cannot be reversed by physical means.

Component 2: **Lesson Purpose** (Time: 3 minutes)

This lesson is about the concept of a chemical reaction or chemical change.

The lesson may also help learners better understand the difference between chemical and physical changes.

Component 3: Lesson Language Practice (Time: 5 minutes)

- Read difficult or unfamiliar words or phrases and ask the learners to read them to themselves and then out loud as a class, e.g.:

reaction

- Ask the learners to practice saying the words.

  Ask learners to write a sentence that would explain its meaning in the scientific or technical sense and then to write another sentence using the same word that would explain its meaning in an everyday sense.

  Sample Answers

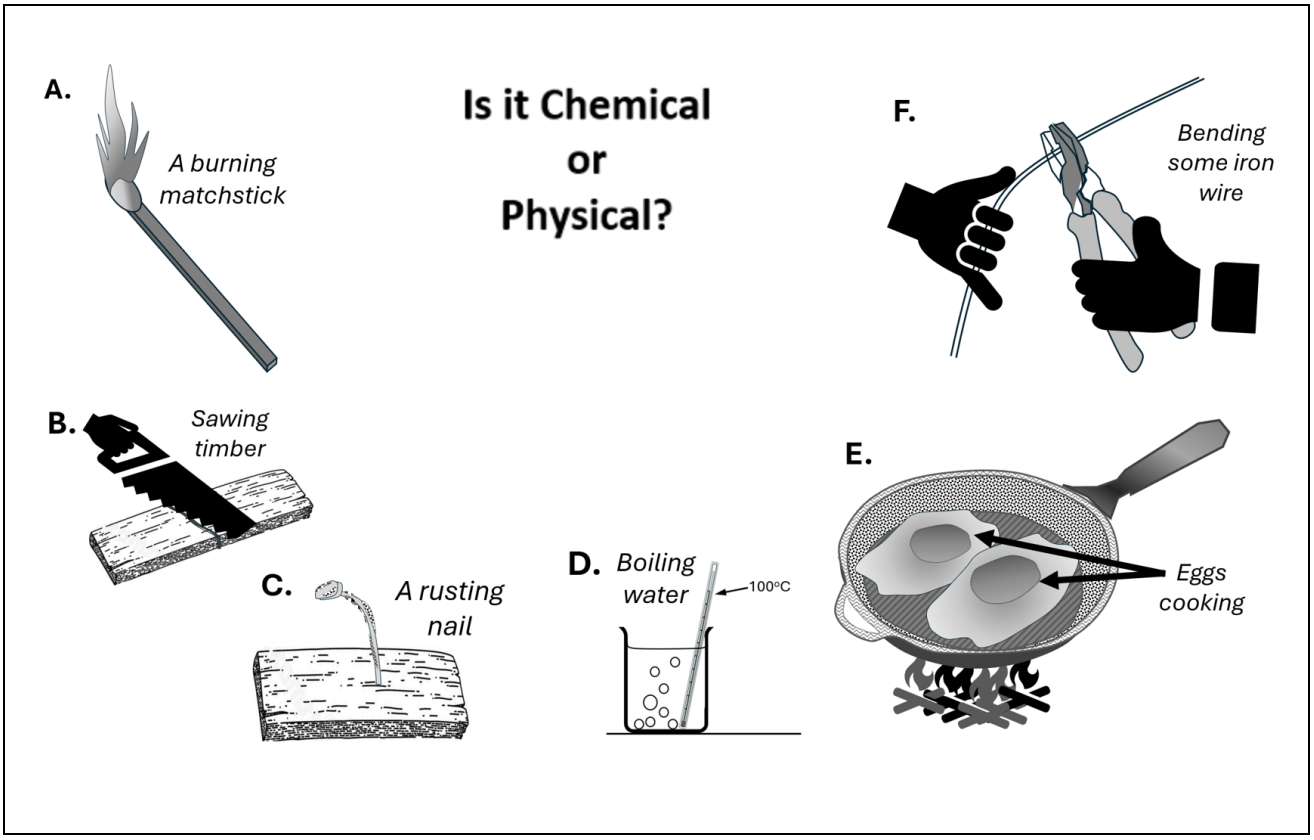
  The word reaction in chemistry means that atoms of different elements and compounds have either shared or transferred electrons with each other, and this produces a chemical change in the substances involved.

The word reaction can be used, for example, "When she was presented with the flowers, her reaction was one of great surprise".

Component 4*:* Lesson Activity (Time: 25 minutes)

Component 4A

- Refer learners to the main lesson stimulus, pointing out that it includes *diagrammatic representations* of changes both physical and chemical.
- Read out the written text. Ask the learners if there are any words that they are not familiar with and give descriptions of any words that may be problematic.



Component 4B

- Read the following questions and ask learners to answer in the space on their worksheet.
-

  Q1. What is happening in the diagram labeled D?

  Q2. Which diagrams show only physical changes?

  Q3. Which diagrams show only chemical changes and explain why?

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. In the box labeled D someone is boiling some water.

Q2. Diagrams *labeled B, D and F.*

Q3. Diagrams A, C, and E show chemical change because in E, for example, once the egg is cooked, you can never make it uncooked again, and the same is true with a burning matchstick; once it's burned, you can't get the matchstick back or the nail once it has rusted. These changes are called irreversible.

Component 4C

- Read the following questions and ask learners to answer in the space on their worksheet.

  Q1. Is electrolysis a chemical reaction?

  Q2. What happens when an ionic bond is formed?

  Q3. **(Optional)** How do scientists describe a chemical reaction?

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. Yes, electrolysis is a chemical reaction.

Q2. When an ionic bond is formed, atoms from two different elements transfer electrons from one to the other and form ions.

Q3. Scientists describe a chemical reaction as where chemical bonds are formed and or broken and this results in new substances being formed which cannot be changed back by physical means. These changes are called irreversible.

Component 5: Lesson Conclusion (Time: 5 minutes)

- The focus of this lesson was on chemical reactions.
  .
- Ask learners to answer the following questions either by class discussion or by writing the answers on their worksheet.

  Q1. Has this lesson helped you better understand what a chemical reaction is? If so, how?

  Q2. Has this lesson helped you remember the difference between a chemical and a physical change? If so, how?

Let learners reflect on their learning.

REMINDER: Collect learner worksheets to review and analyze learner's knowledge and understanding.

Science Grade 10 Lesson No. 16

Signs of a Reaction

Key Idea

Chemists use a number of different indicators to identify when a chemical reaction has taken place.

Component 1: Short Review (Time: 7 minutes)

- Ask learners to answer the following questions on their worksheets.

  Q1. Is the process of baking a cake a chemical reaction?

  Q2. What evidence of a chemical reaction can you see when baking a cake?

  Q3. What other types of evidence can be used to indicate chemical reactions?

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. Yes, it is.

Q2. You can see that something new has been made; that is, a new substance has been formed.

Q3. There are a few other things like a gas being given off, a precipitate is formed, or a change in color or temperature etc.

Component 2: **Lesson Purpose** (Time: 3 minutes)

This lesson is about different types of evidence for chemical reactions.

The lesson may also help learners better understand the difference between chemical and physical changes based on the evidence.

Component 3: Lesson Language Practice (Time: 5 minutes)

- Read difficult or unfamiliar words or phrases and ask the learners to read them to themselves and then out loud as a class, e.g.:

evidence

- Ask the learners to practice saying the words.

Meanings of unfamiliar words.

- *Evidence can be described as Information or facts that support the proposition made.*

Component 4*:* Lesson Activity (Time: 25 minutes)

Component 4A

- Refer learners to the main lesson stimulus, pointing out that Part A includes two (2) *tables.* Table 1 shows examples of *processes* and Table 2 shows examples of *types of evidence* that allow us to recognize a chemical reaction occurring.

How Do We Know?

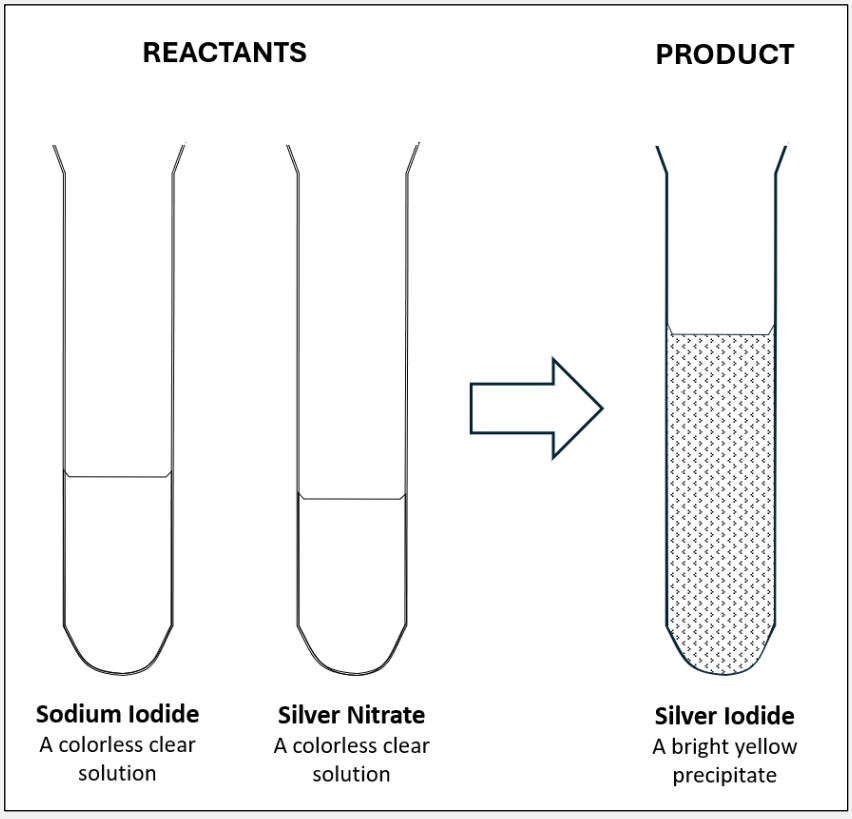
PART A. Use the tables below to answer the questions in 4B.

Table 1	No.	The process
	1	Milk curdling
	2	Burning wood in a barbecue
	3	Lighting fireworks
	4	Adding vinegar to baking soda
	5	Burning coal

Table 2	No	Evidence for a chemical reaction
	A	gas is given off
	B	a precipitate is formed
	C	light is given off
	D	new substance formed
	E	Heat is given out

PART B. Use the diagrams below to answer the questions in 4C.

In the laboratory, a very interesting chemical reaction happens when you add a colorless clear solution of sodium iodide with a colorless clear solution of silver nitrate. What happens is shown below.



Component 4B

- Read the following questions and ask learners to answer in the space on their worksheet.

- Use the information in the tables shown in the stimulus in **Part A** to answer the next three questions.

  Q1. Which one of the examples of evidence in T**able 2** would show that lighting? fireworks' is a chemical reaction.

  Q2. Which process shown in T**able 1** above would have evidence that a 'new substance is formed', and which process would have evidence that 'a gas is given off'?

  Q3. Do you think that one of the above processes in T**able 1** would have more than one piece of evidence that it is a chemical reaction? Explain.

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. The evidence is that light is emitted/given out.

Q2. The burning of wood shows that a new substance is formed, also when milk curdles it forms a precipitate and that is a new substance, and when you pour vinegar over baking powder/soda bubbles (or a gas) are given off.

Q3. Yes, for example, burning coal would give out heat, as well as a gas (carbon dioxide) and light and the ash that's left, a new substance is formed. OR lighting fireworks emits light, but you can also see a new substance by what is left of the firework after it has been lit and burned away.

Component 4C

- Read the following questions and ask learners to answer in the space on their worksheet.
- Use the information in the diagram shown in the stimulus in **Part B** to answer the next three questions.

  Q1. If Sodium is in group 1 and Iodine is in group 7 of the periodic table what would be the formula of sodium iodide?

  Q2. If sodium iodide is a colorless solution and so is silver nitrate what might be the yellow precipitate, that is, the new substance formed?

  Q3. **(Optional)** If the formula for sodium nitrate is $NaNO_3$ what is the valency of the NO^-_3 ion?

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. The formula for sodium iodide would be NaI.

Q2. It might be sodium nitrate or silver iodide.

Q3. The valency of the nitrate ion would be -1^-.

Component 5: Lesson Conclusion (Time: 5 minutes)

- The focus of this lesson was on the types of evidence of chemical reactions.
- Ask learners to answer the following questions either by class discussion or by writing the answers on their worksheet.

  Q1. Has this lesson helped you to better understand the importance of evidence? If so, how?

  Q2. Has this lesson helped you to remember the different types of evidence? If so, how?

Let learners know that good learners reflect on their learning.

REMINDER: Collect learner worksheets to review and analyze learner's knowledge and understanding.

Science Grade 10 Lesson No. 17

Rates of Reaction

Key Idea

The rate of a chemical reaction can be critical to its successful use. Valid and reliable investigations identify the dependent and independent variable and control other variables.

Component 1: Short Review (Time: 7 minutes)

- Ask learners to answer the following questions on their worksheets.

  Q1. Give an example of a chemical reaction that is almost instantaneous.

  Q2. What are two chemical reactions that you might see happen over time?

  Q3. For one of the examples you have given, what is the evidence that a chemical reaction has taken place?

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. Lighting fireworks happens instantly.

Q2. You can see iron rusting and that takes time and milk curdling, or fruit rotting also takes time.

Q3 In the case of fireworks there might have been heat or light given out and a new substance was formed. In the case of rusting iron, you can see clearly that a new substance has formed, that is rust.

Component 2: **Lesson Purpose** (Time: 3 minutes)

This lesson is about how the rate of chemical reactions can be altered.

The lesson may also help learners better understand the processes of chemical reactions.

Component 3: Lesson Language Practice (Time: 5 minutes)

- Read difficult or unfamiliar words or phrases and ask the learners to read them to themselves and then out loud as a class, e.g.:

  surface area; variable; dependent variable; independent variable; valid; reliable

- Ask the learners to practice saying the words.

Meanings of possibly unfamiliar words.

The Surface Area: The total area of the surface of a three-dimensional object.

The word variable in science means anything that can be changed within an experiment.

The dependent variable is the one that changes based on the independent variable's outputs.

The independent variable is the variable that is controlled by the experimenter.

An experiment is valid if it tests what it is meant to test. The appropriate variables must be controlled.

An experiment is considered reliable if the results are consistent across many repetitions.

Component 4*:* Lesson Activity (Time: 25 minutes)

Component 4A

- Refer learners to the main lesson stimulus, pointing out that it includes *a graph* that represents the results of an investigation that helps explain what is happening in an experiment.
- Read the written text. Ask the learners if there are any words that they are not familiar with and give descriptions of any words that may be problematic.

HOW CAN WE MAKE IT HAPPEN FASTER?

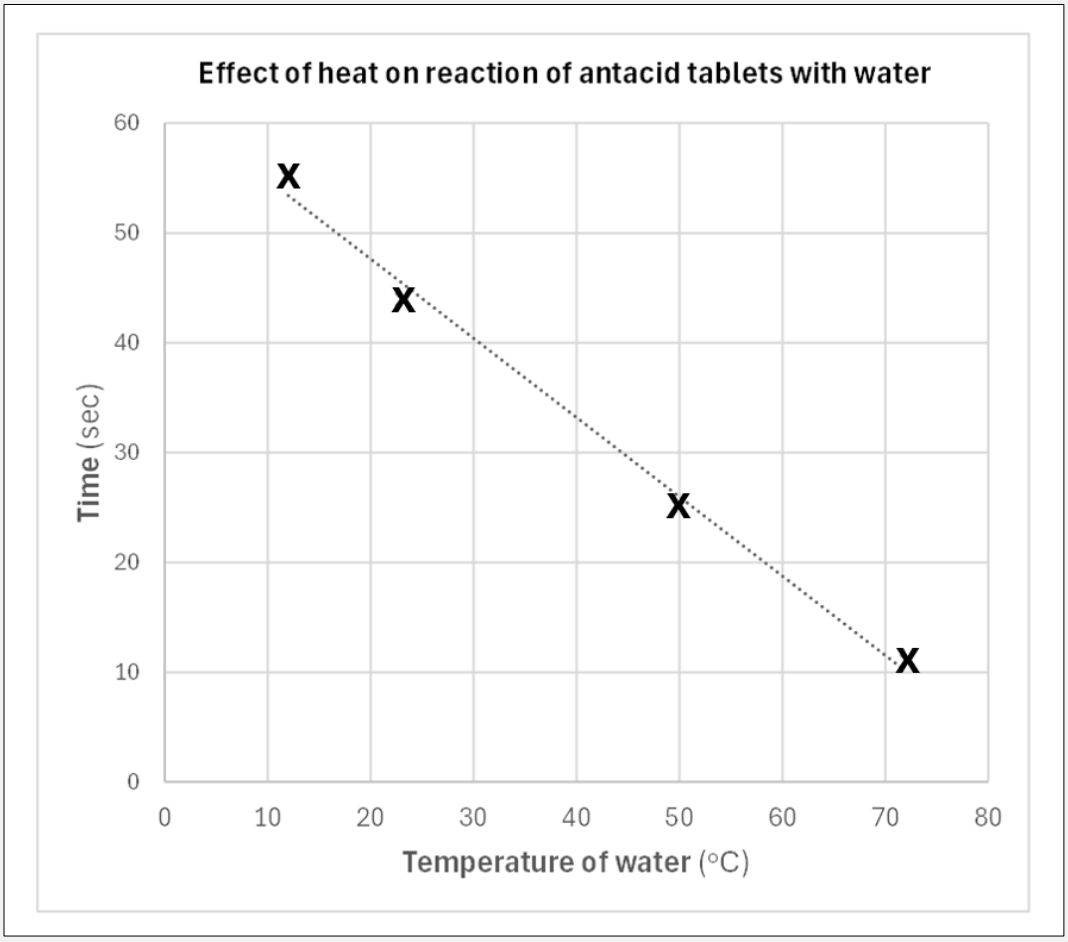
A group of Grade 10 learners had discovered in chemistry that you can make reactions go faster by adding heat or by making the particles smaller, so they decided to investigate this themselves.

One of the learners, Joseph, asked his mother if they could use her kitchen for a while they were doing some homework. Another learner, Maria, said she would write everything down so they could show their teacher.

The learners decided to see if effervescent antacid tablets would react faster in warm water than in cold water. The learners wanted to be sure that their investigation would be valid and reliable.

They used just one tablet in each case and used the water at three different temperatures. They timed, using a stopwatch, how long it took for the tablet to react completely.

The learners produced the graph below.



Component 4B

- Read the following questions and ask learners to answer in the space on their worksheet.

  Q1. What should the learners used to measure the independent variable, that is, the temperature?

  Q2. Which variables, or what sort of things, should the learners make sure are the same so that the experiment is a fair test.

  Q3. What other way could the learners have tried to make the reaction go faster?

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. *They should use a thermometer.*

Q2. The *learners should make sure that they use the same type of tablet each time, the same volume of water, the same stopwatch, and the same thermometer.*

Q3. Reactions *can be made to go faster by increasing the surface area, which means they could try breaking the tablet in half, in quarters, and then crumbling it.*

Component 4C

- Read the following questions and ask learners to answer in the space on their worksheet.

  Q1. What might be an appropriate aim for the learners' experiment?

  Q2. How could the learners make sure their experiment is reliable?

  Q3. **(Optional)** Use the graph to write an appropriate conclusion for their experiment.

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).
  .

Sample answers:

Q1. To show that increasing the temperature of the water makes the antacid tablets react faster.

Q2. The results would be more reliable if they were to repeat the process 3 times for each water temperature.

Q3. The results have shown that the reaction of antacid tablets in water is much faster than the temperature of the water increases.

Component 5: Lesson Conclusion (Time: 5 minutes)

- The focus of this lesson was on what changes the rate of a chemical reaction.
- Ask learners to answer the following questions either by class discussion or by writing the answers on their worksheet.

  Q1. Has this lesson helped you better understand how rates of reaction can be changed*? If so, how?*

  Q2. What was hard to do or understand in the lesson?

Let learners learners reflect on their learning.

REMINDER: Collect learner worksheets to review and analyze learner's knowledge and understanding.

Science Grade 10 Lesson No. 18

Chemical Reactions in Nature

Key Idea

Chemical reactions occur in nature, and many are essential to life including photosynthesis and respiration, decomposition, and combustion.

Component 1: Short Review (Time: 7 minutes)

- Ask learners to answer the following questions on their worksheets.

  Q1. What is the most important difference between plants and animals?

  Q2 Where does the process of photosynthesis occur?

  Q3. Is the process of photosynthesis a chemical reaction?

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. The biggest difference is that plants make their own food whereas animals eat plants or other animals to get their food.

Q2. The process of photosynthesis mostly takes place in the green leaves of plants.

Q3. When plants make their own food, through photosynthesis, it is a chemical reaction.

Component 2: **Lesson Purpose** (Time: 3 minutes)

This lesson is about identifying chemical reactions that occur in nature.

The lesson may also help learners better understand the place of chemical reactions in their lives.

Component 3: Lesson Language Practice (Time: 5 minutes)

- Read out difficult or unfamiliar words or phrases and ask the learners to read them to themselves and then out loud as a class, e.g.:

  Photosynthesis; respiration; decomposition

- Ask the learners to practice saying the words.

The meaning of possibly unfamiliar words is described in the stimulus.

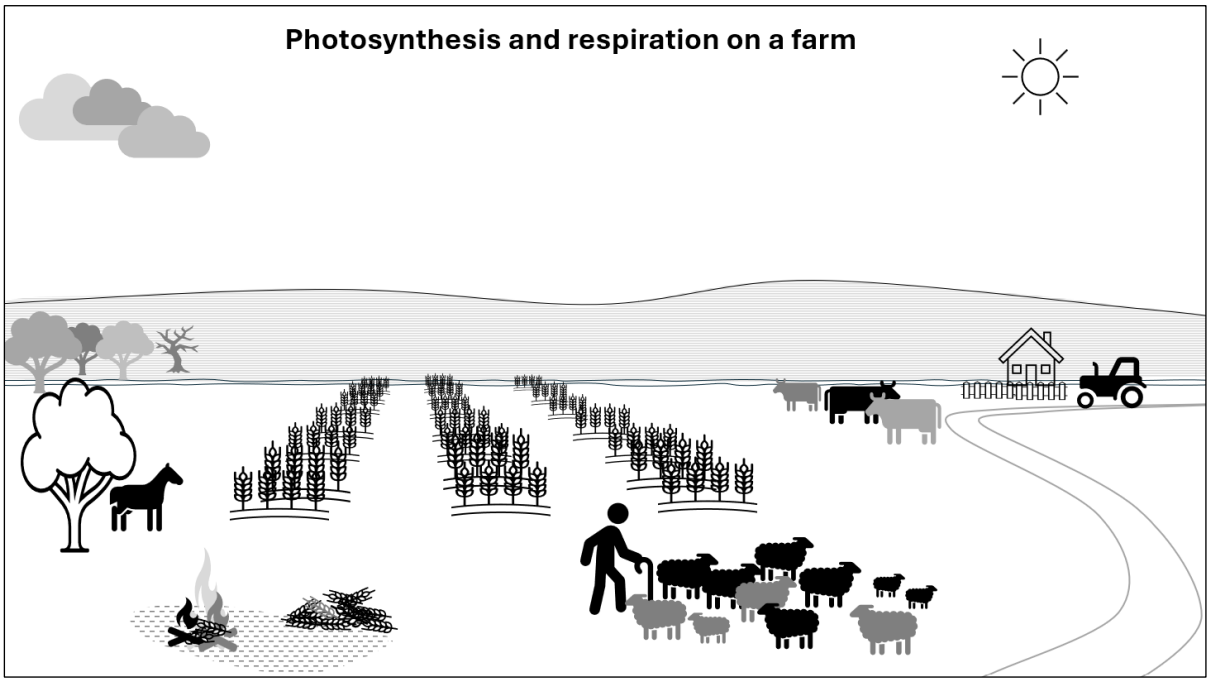
Component 4*:* Lesson Activity (Time: 25 minutes)

Component 4A

- Refer learners to the main lesson stimulus, pointing out that it includes *symbolic representations of a natural landscape where chemical reactions take place* that help explain what is happening.
- Read the written text. Ask the learners if there are any words that they are not familiar with and give descriptions of any words that may be problematic.

Do Chemical Reactions Occur in the Environment?

Many of the chemical reactions that happen in nature are vital for the survival of living things.
Some of the most important for our survival are *photosynthesis*, *respiration*, d*ecomposition,* and *combustion*. In a chemical reaction, the two or three elements or compounds that react together are called the *reactants,* and the new substances formed are called the products.



Notes

Photosynthesis occurs in the chloroplasts of plants and converts light energy into chemical energy, and produces food (glucose) from carbon dioxide in the air and water in the ground.

$$\text{Carbon dioxide + water} \xrightarrow[\text{chlorophyl}]{\text{light}} \text{glucose + oxygen}$$

Respiration is the process of using glucose to obtain energy and could be seen as a combustion reaction. It happens in the cells of plants and animals.

$$\text{Glucose + oxygen} \longrightarrow \text{carbon dioxide + water + } \textit{energy}$$

Decomposition is the breakdown of dead matter by bacteria and fungi, and their respiration puts carbon dioxide and water back into the atmosphere.

Component 4B

- Read the following questions and ask learners to answer in the space on their worksheet.

  Q1. What are the names of the reactants in photosynthesis?

  Q2. What is the role of light in photosynthesis?

  Q3. One of the products of photosynthesis is oxygen, why is that so important?

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. The names of the reactants are carbon dioxide and water.

Q2. Light is needed for photosynthesis because it provides the energy for the photosynthesis reaction to occur.

Q3. Oxygen is vital to most living things as it plays a critical role in the process of respiration and many living things like humans need oxygen in the air we breathe, to stay alive.

Component 4C

- Read the following questions and ask learners to answer in the space on their worksheet.

  Q1. Where does the reaction of respiration occur?

  Q2. What is a combustion reaction? Give an example.

  Q3. **(Optional)** One of the products of photosynthesis is glucose, why is that so important?

- Ask learners to share answers. Give positive feedback. Read out a sample answer for all learners to listen to and write down. (This may come from one of the learners or from the sample answers below).

Sample answers:

Q1. It happens in the cells of plants and animals.

Q2. A combustion reaction is a chemical reaction where a substance reacts with oxygen gas and releases energy, maybe heat or light, e.g. a fire.

Q3. Glucose is the base from which other carbohydrates are made, such as sugars, starches, and fiber.

Component 5: Lesson Conclusion (Time: 5 minutes)

- The focus of this lesson was on chemical reactions in nature.
- Ask learners to answer the following questions either by class discussion or by writing the answers in their worksheet.

  Q1. Has this lesson helped you better understand the importance of chemical reactions for the living world? If so, how?

  Q2 What was hard to do or understand in the lesson?

Let learners reflect on their learning.

REMINDER: Collect learner worksheets to review and analyze learner's knowledge and understanding.

For inquiries or feedback, please write or call:

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