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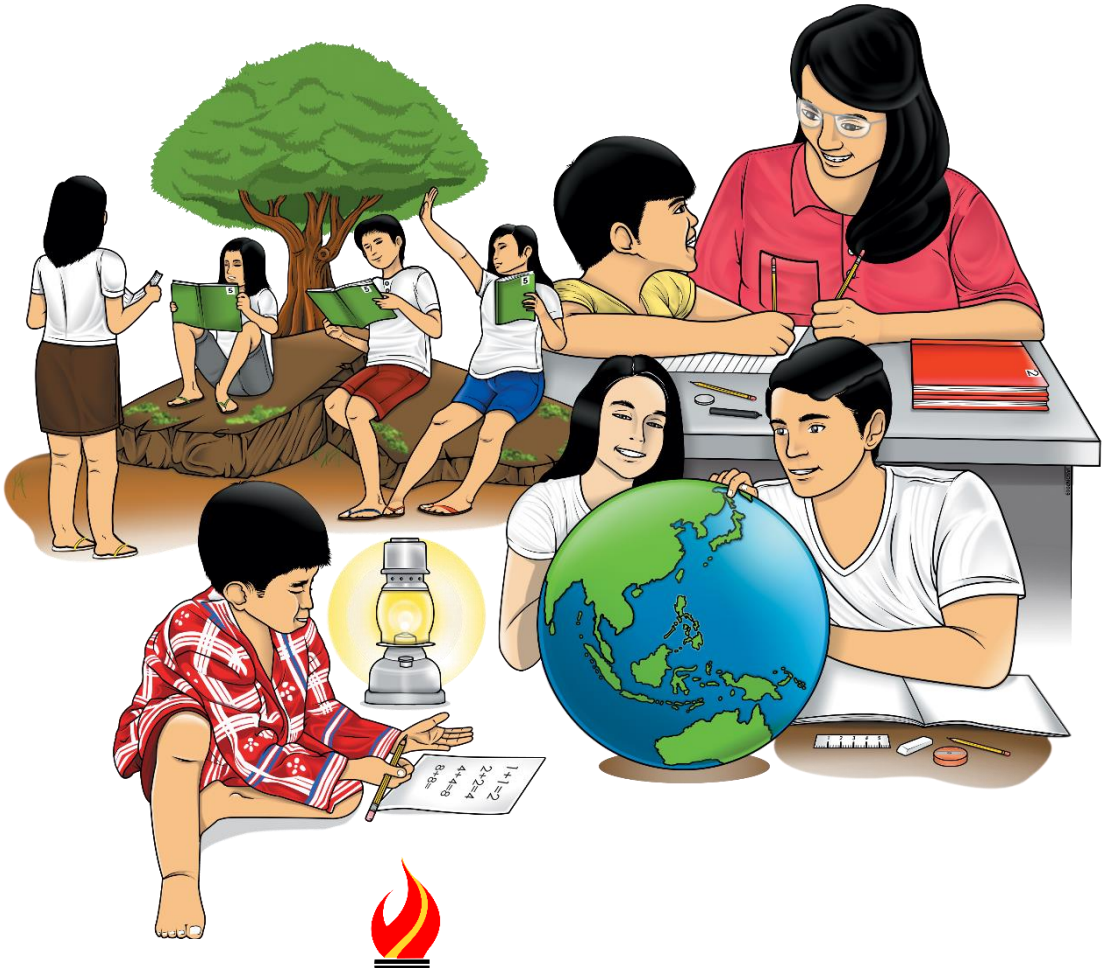
Science
Quarter 2 – Module 3:
Earthquake Waves



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Science
Quarter 2 – Module 3: Earthquake Waves

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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

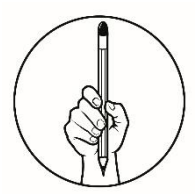
Thank you.

What I Need to Know

This module was designed and written with you in mind. It is here to help you to master earthquake waves. The scope of this module permits it to be used in many different learning situations. The language used recognizes the diverse vocabulary level of students. The lessons are arranged to follow the standard sequence of the course. But the order in which you read them can be changed to correspond with the textbook you are now using.

After going through this module, you are expected to:

Explain how earthquake waves provide information about the interior of the earth. *(Week 3, S8ES-IIc-17)*



What I Know

Directions: Choose the letter of the correct answer. Write your answers on a separate sheet of paper.

1. What is the main cause of seismic waves?
   A. Earthquake
   B. Thunder
   C. Traffic
   D. Volcano

2. What type of wave is P wave?
   A. Electromagnetic
   B. Longitudinal
   C. Transverse
   D. Ultrasonic

3. Why is there an abrupt change in the speed of seismic waves as they travel inside the Earth? It is because seismic waves are _____.
   A. colliding
   B. overtaking the compressional waves
   C. passing through a material with the same density
   D. going into a material with different properties and densities

4. Which of the following travels the fastest and is detected first in the seismic station?
   A. Love wave
   B. Surface wave
   C. Primary wave
   D. Secondary wave

5. Which kind of waves does NOT travel through a liquid?
   A. Love
   B. Primary
   C. Secondary
   D. Surface

6. What type of seismic waves are responsible for a destructive earthquake?
   A. Love
   B. Primary
   C. Secondary
   D. Surface

7. How do rock particles move during the passage of primary waves?
   A. no motion
   B. in circular motion
   C. back and forth parallel to the direction of the waves
   D. back and forth perpendicular to the direction of the waves

8. If P wave passes through solid to liquid media, what will happen to its velocity?
   A. increases
   B. decreases
   C. speeds up
   D. stays the same

9. What consist of a body wave?
   A. primary and Love waves
   B. surface and primary waves
   C. secondary and surface waves
   D. primary and secondary waves

10. What is the most destructive seismic wave?
   A. Primary
   B. Secondary
   C. Shear
   D. Surface

11. Which statement is correct?
   A. S waves are slower than P waves.
   B. P waves are slower than S waves.
   C. P waves have the same speed as the S waves.
   D. It is not possible to record the speed of S and P waves.

12. In which media can primary waves travel?
   A. both liquids and solids
   B. in liquids but not in solids
   C. in solids but not in liquids
   D. neither in solids nor in liquids

13. Which statement is true about P and S waves?
   A. P waves and S waves are the same.
   B. P waves are the slower waves that arrive second at the seismic station after S waves.
   C. P waves are the fastest waves that arrive first at the seismic station before S waves.
   D. P waves are the primary waves that move side to side as they travel from the earthquakes focus.

14. What type of seismic waves that can travel through crust?
    A. Body
    B. Primary
    C. Secondary
    D. Surface

15. Which of the following statements best describes the outer core?
    A. The outer core is thought to be liquid.
    B. P waves do not travel through the outer core.
    C. P waves and S waves can travel through the outer core.
    D. P waves travel through the outer core at a higher velocity than S waves.

Lesson 1 Seismic Waves

You can see a light wave refracting from surfaces or reflecting from mirrors. You can also notice how a still water produces waves once dipped by a finger. This wave is a motion that propagates up and down or side to side and can be diverted by different media it travels. Waves are all around us, and the Earth produces waves as well.

What are the different types of seismic waves that occur inside the Earth and how do they propagate? Do their propagation change as they pass through the different layers of the Earth? What are the implications of these behaviors in describing the interior of the Earth? Read the module and answer the activities to find out!

What's In

Activity 1. Quake-events

Directions: Rearrange the events in the order of their occurrence using the numbers 1 to 6. Write your answers on a separate sheet of paper.

Events	Order
A. The rock underground suddenly breaks along a fault.	
B. Sudden release of energy causes the seismic waves that make the ground shake.	
C. When two blocks of rocks or two plates are rubbing against each other, they stick a little.	
D. The rocks are still pushing against each other but not moving.	
E. When rock breaks, earthquake occurs.	
F. The rock breaks because of pressure that builds up.	

What's New

Activity 2. When the Land Moves

Directions: Read the short story and answer the questions that follow.
Write your answers on a separate sheet of paper.

One sunny morning, Carl and his friends were having a picnic in the garden. They were talking and laughing. It had been a long time since they saw each other that they were excited to spend time together. Then suddenly, everything seemed to move. They felt dizzy. The electric wires began to swing. Lights went out and people around them began to panic. What was happening?

What they were experiencing was the rock beneath the Earth's surface suddenly moving. There was an earthquake. The ground shook, things on land moved, and then the movement just stopped as quickly as it began.

Carl and his friends were frightened. Once the shaking stopped, they decided to go home. They plan to have another picnic later when everything is safe.

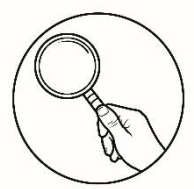
Illustrated by: Kit Venzon B. Lagura

Questions:

1. What are the common observations that an earthquake is likely to happen?
   _____

2. What do you think is the reason of this occurrence? _____

Rubric	
4	Answer is well-organized and completely explained the details.
3	Answer is organized and some details are explained.
2	Answer is not organized and details are unclear.
1	Answer does not make sense and shows no details.



What is It

Earthquake is the shaking of the Earth crust that occurs naturally or by human activities. This is also part of the geological processes that result to the formation of oceans, valleys, mountains, and plains. Over the last 100 years, scientists have learned a great deal about these processes, causes, measures, and occurrences of an earthquake. By studying earthquake, scientists were able to discover more about the Earth.

What causes Earthquake?

An earthquake occurs because of geologic forces inside the Earth. These inner forces build up slowly and eventually become so strong that may cause underground rocks to break.

When this happens, tremendous energy is released causing the ground to move and shake. These waves of energy travel through the Earth are called seismic waves.

Seismic waves behave in different ways, depending on what they encounter along the way.

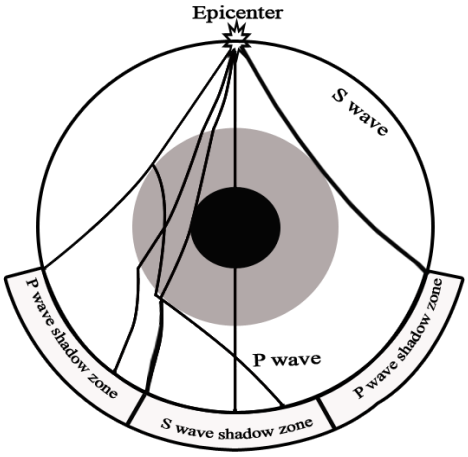


Figure 1. The behavior of seismic waves reveals what the Earth looks like inside.

Illustrated by: Angelo Zaldy C. Francia

What are Seismic Waves?

Seismic waves are the waves of energy that travel either along or near the Earth's surface. This energy that travels through the Earth is recorded by seismographs.

Types of Earthquake Waves

1. body waves
2. surface waves

Body Waves

The body waves are seismic waves that travel through the interior of the Earth. These waves are of higher frequency than surface waves. The two types of body waves are primary and secondary waves.

Primary Waves

The first type of body waves are the **P waves** or **primary waves**. These are the fastest kind of seismic waves, and consequently, the first to arrive at a seismic station and recorded in the seismograph. The P waves can move through solid rocks and fluids, like water or the liquid layers of the Earth. They push and pull the rocks as they move through just like the sound waves that push and pull the air.

P waves are also known as **compressional or longitudinal waves** because of the pushing and pulling they do. P waves vibrate parallel to the direction and travelling in a push-pull motion. Primary waves can travel at a velocity of about 4 to 6 km/s depending on the nature of the material it passes through.

Secondary Waves

The second type of body waves are the **S waves** or **secondary waves**. These are waves that arrive second, after P waves are being detected in the seismic station and recorded in the seismograph. S waves are slower than P waves and can only move through solid rocks, not through any liquid medium. This concludes that the Earth's outer core is liquid due to this property of the S wave. These waves move rock particles up and down, or side-to-side perpendicular to the direction that the waves are traveling in. S waves are also known as **transverse or shear waves**, which create the shaking of the ground back and forth perpendicular to the direction the waves are moving. S waves have a velocity of 3 to 4 km/s.

Surface Waves

Surface waves travel only through the crust. These are of lower frequency than body waves, and are easily distinguished on a seismograph. Though they arrive after body waves, it is the surface waves that are almost entirely responsible for the destruction associated with earthquakes. There are two types of surface waves, the Love wave and Rayleigh wave.

Love Waves

The first type of surface wave is called **Love wave**, named after Augustus Edward Hough Love, a British mathematician who worked out the mathematical model for this kind of wave in 1911. This wave is the fastest surface wave and moves the ground from side-to-side. Love waves produce entirely horizontal motion. It can travel a velocity of 4 km/s and create more shaking.

Rayleigh Waves

The second type of surface wave is the **Rayleigh wave**, named after John William Strutt, Lord Rayleigh, a British scientist who predicted the existence of this kind of wave in 1885. This wave rolls along the ground just like a wave rolls across

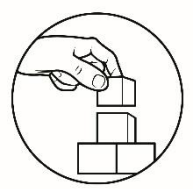
a lake or an ocean. It moves the ground side-to-side and up and down in the same direction that the wave is moving. Most of the trembling felt from an earthquake is due to the Rayleigh wave, which can be much larger than the other waves.

What can seismic waves tell us?

The different types of seismic waves can tell us more about the nature of the Earth's interior.

For instance, seismologists use the seismic waves such as the P waves and S waves to determine the distance from the source of an earthquake by getting the direction and the difference in the time of arrival of the waves. When the seismic waves travel deeper into the crust, the quake will speed up. This means that at depth, the rocks are denser. When it reaches the upper part of the mantle, the waves will slow down. This means that the rocks are partially molten.

As the waves reach the core, one kind of seismic waves called the secondary waves, will disappear thus, the outer core is liquid. At a certain depth, the waves are reflected and refracted. This means that the Earth must be layered.



What's More

Activity 3. Getting into Puzzle

Directions: Find the words in the puzzle from the list inside the box and answer the questions that follow. Write your answers on a separate sheet of paper.

surface	secondary	P waves	solid
primary	seismic wave	S waves	liquid

E	A	R	H	I	S	V	T	M	S	E	C	O	N	D	A	R	Y	M	N
T	G	D	F	S	E	I	S	M	I	C	W	A	V	E	D	S	A	E	C
E	A	S	C	H	I	K	O	C	A	S	O	H	V	H	J	K	L	D	E
S	U	R	F	A	C	E	L	A	S	P	W	A	V	E	S	U	O	H	F
H	O	I	E	W	R	F	I	T	S	A	A	V	F	E	I	O	P	I	G
G	E	I	A	S	E	F	D	B	D	A	R	S	L	I	Q	U	I	D	G
T	G	D	F	S	E	I	S	M	I	C	W	A	V	E	D	S	A	E	C
P	R	I	M	A	R	Y	I	T	S	A	A	V	F	E	I	O	P	I	G
H	O	I	E	W	R	F	I	T	S	S	W	A	V	E	S	S	A	E	C

1. The _____ wave is the fastest wave to travel.

2. The P waves can travel through _____, liquids, and gases.

3. P waves are also known as _____ waves.

4. Secondary waves cannot travel through _____ and gases.

5. The _____ wave is the most destructive wave.

Notes to the Teacher

Provide extra copies of this activity for students' use.

Activity 4. Let's Talk About Waves

A. Directions: Read the paragraph and complete the table below. Write your answers on a separate sheet of paper.

Seismic waves are also known as earthquake waves. There are two main types of earthquake waves: body waves and surface waves. The body waves have two types: primary waves (P waves) and secondary waves (S waves). Primary waves travel the fastest of all the waves. They are also unique in the aspect that they travel through all states of matter - solid, liquid, and gas. P waves are considered push-pull waves. They push and pull the rock as it moves through just like sound waves that push and pull the air. Secondary waves are not as fast as P waves. They cannot travel through liquids and gases. S waves travel in a side to side motions, like a piece of rope that you wiggle.

Surface waves such as Love waves (L waves) are the slowest waves. They move along the Earth's surface similar to the way the waves travel in the oceans, up and down. They are the most destructive waves because of the damages they create directly to the Earth's surface.

Comparison of Different Types of Seismic Waves

Earthquake Waves	Also known as	Speed	Medium Travelled	Motion
A. Body waves				
primary wave	1.	3.	5.	push-pull
secondary wave	S waves	4.	solids	7.
B. Surface waves				
Love wave	2.	slowest	6.	8.

B. Directions: Write **T** if the statement is true and **F** if it is false.

_____1. The primary wave is the slowest wave among the seismic waves.

_____2. The secondary wave can travel through all states of matter.

_____3. The most destructive wave is the surface wave.

_____4. The primary wave is the first wave that can be detected.

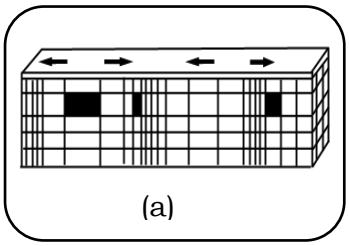
_____5. The two types of surface waves are the primary waves and Love waves.

Activity 5. Let's Match It

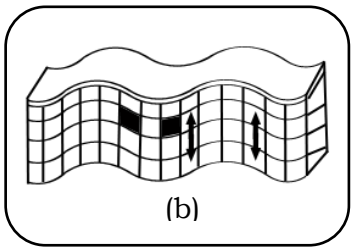
A. Directions: Match the following types of seismic waves with their corresponding types of motion.

1. primary waves	A. side-by-side horizontal
2. secondary waves	B. circular motion
3. surface waves	C. up and down
	D. push and pull

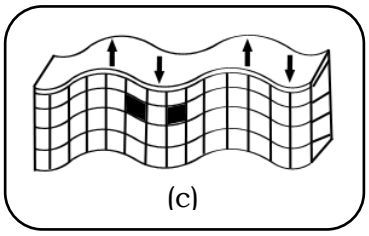
B. Directions: Identify each illustration as to what types of waves. Write your answers on a separate sheet of paper. (Hint: arrows indicate its movement.)



1. _____



2. _____



3. _____

(a-c) Illustrated by: Victor Genesis O. Odtohan

Question:

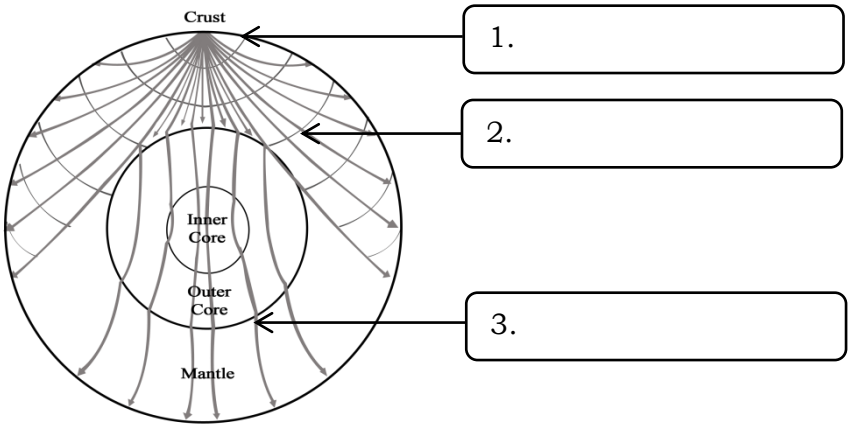
Among the three types of waves, what is the most destructive? Why?

_____
_____
_____

Rubric	
4	Answer is well-organized and completely explained the details.
3	Answer is organized and some details are explained.
2	Answer is not organized and details are unclear.
1	Answer does not make sense and shows no details.

Activity 6. Perfect Match

A. Directions: Identify the types of seismic waves that travel inside the Earth. Write your answers on a separate sheet of paper.



Cross section of the Earth's Interior

Illustrated by: Kit Venzon B. Lagura

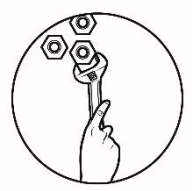
Directions: Match Column A with Column B and Column B with Column C. Write the letters of the correct answers on a separate sheet of paper.

A	B	C
Type of Wave	*Particle Motion*	*Can travel through…*
1. primary wave	A. transverse horizontal motion travel in perpendicular to the direction of propagation	D. surface of the Earth only
2. secondary wave	B. alternating transverse motion perpendicular to the direction of propagation	E. crust only
3. surface wave	C. alternating compression and dilation in the same direction as the wave is propagating	F. crust, mantle and core

What I Have Learned

Directions: Fill in the blanks with the correct term to complete the statements. Write your answers on a separate sheet of paper.

1. Seismic waves are also known as _____.
2. When the seismic waves travel deeper into the crust, the quake will _____.
3. The waves that travel the fastest are _____.
4. The type of wave that travels only in solid medium is known as _____.
5. _____ waves, also known as L waves are the slowest waves.
6. _____ releases energy that travels through and around the earth in seismic waves.
7. _____ are of lower frequency than body waves.
8. One type of surface wave is _____ which creates more shaking.
9. Primary waves can travel a velocity of _____.
10. _____ is the velocity of secondary waves.



What I Can Do

Activity 7. Let's Think First

Directions: Below are possible situations during an earthquake. Choose the letter of the appropriate action and write your answers on a separate sheet of paper.

1. If you are outside of your house, move away from the buildings.

A	I will do it.
B	I will just run anywhere.

2. If you are inside your house, get cover under a table.

A	I will do it.
B	I will not do it.

3. If you are in a moving car, what will you say to the driver?

A	Just keep driving.
B	Please stop.

4. Drop to the ground and protect your head.

A	I will do it.
B	I will not think about it.

5. Prepare a disaster emergency kit beforehand.

A	I will do it.
B	I will not do it.

Assessment

Directions: Choose the letter of the correct answer. Write your answers on a separate sheet of paper.

1. What wave causes earthquake to occur?
   A. Electromagnetic
   B. Radio
   C. Seismic
   D. Sound

2. What does P in a P wave stand for?
   A. Parallel
   B. Partial
   C. Perpendicular
   D. Primary

3. What kind of seismic wave arrives last at seismic station?
   A. Love
   B. Primary
   C. Secondary
   D. Surface

4. Which type of wave vibrates parallel to the direction and travels in a push-pull motion?
   A. Love
   B. Primary
   C. Secondary
   D. Surface

5. Which of the following statements best describes primary wave?
   A. It travels through a vacuum.
   B. It causes rock particles to vibrate.
   C. It is the slowest, largest and causes the most destruction.
   D. It travels the fastest and causes rock material to move back and forth.

6. Which type of seismic wave moves rock particles up and down, or side-to- side perpendicular to the direction the waves are traveling in?
   A. Love
   B. Primary
   C. Secondary
   D. Surface

7. What type of seismic wave is S wave?
   A. Electromagnetic
   B. Longitudinal
   C. Transverse
   D. Ultrasonic

8. Which type of seismic waves can travel through crust, mantle, and core?
   A. Love
   B. Primary
   C. Secondary
   D. Surface

9. In which of the following media can secondary waves travel?
   A. gases only
   B. solids only
   C. liquids only
   D. solids, liquids and gases

10. Which of the following statements is NOT true about the secondary wave?
   A. S waves travel slower that P waves.
   B. S waves can travel through solid rocks.
   C. S waves move rock particles up and down.
   D. S waves can travel both in solid rocks and in liquid medium.

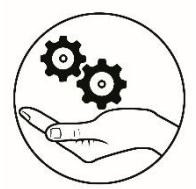
11. What kind of waves can travel through a liquid?
   A. Love
   B. Primary
   C. Secondary
   D. Surface

12. Which describes the motion of Love wave?
   A. circular motion
   B. push and pull
   C. side-to-side
   D. up and down

13. Which correctly describes Rayleigh waves?
   A. It can penetrate the outer and inner core.
   B. It rolls along the ground like a wave rolls along the ocean.
   C. It is faster than a Primary Wave.
   D. It is faster than an S wave but slower than P wave.

14. What is the velocity of a surface wave?
   A. 4 km/s
   B. 5 km/s
   C. 3 to 4 km/s
   D. 3 to 5 km/s

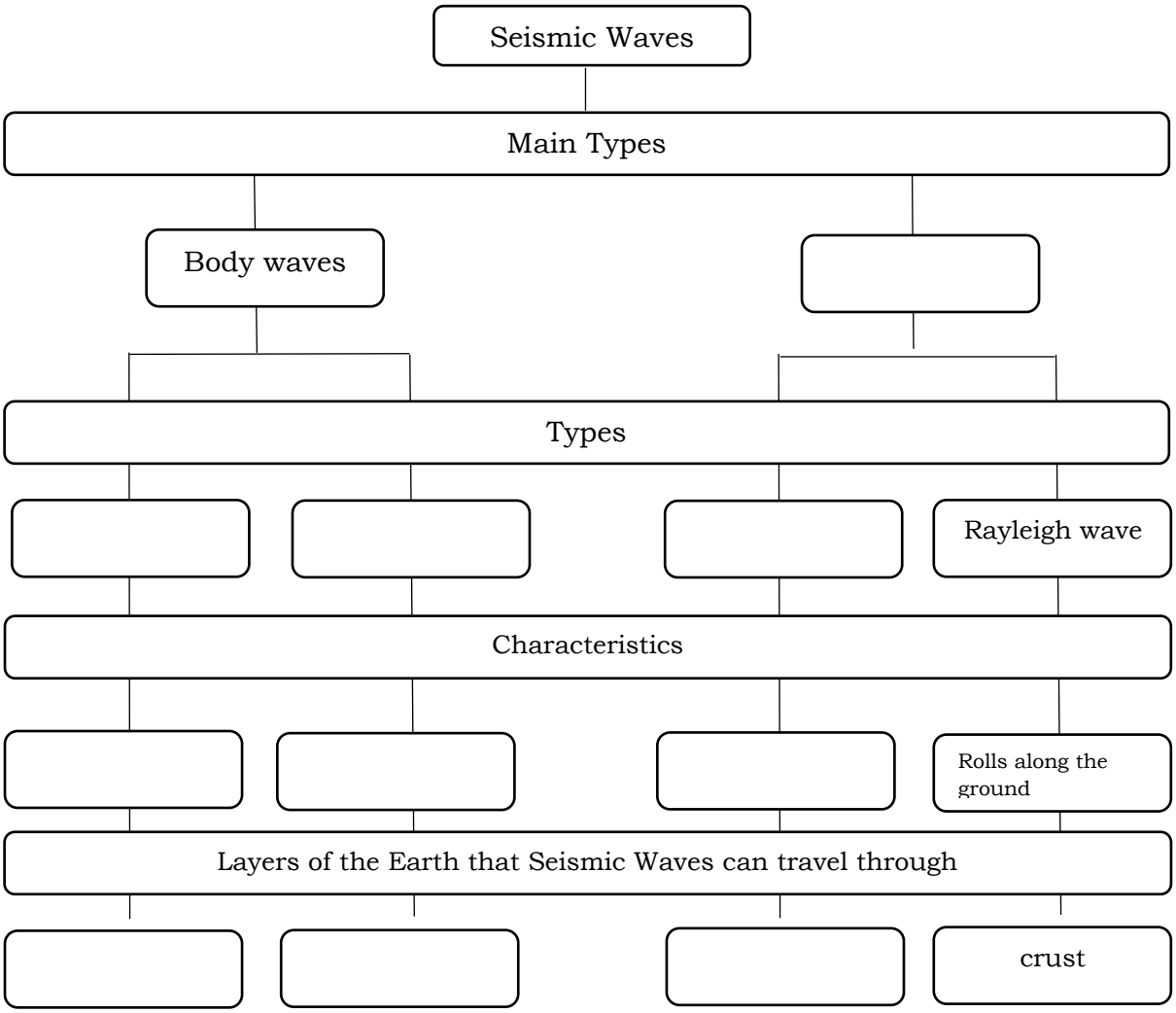
15. Why do S waves travel in solids only?
   A. Solids have enough shear strength.
   B. Solids have minerals and properties.
   C. Solids have particles closely packed together.
   D. Solids have rigid structure and resistant to the force applied.



Additional Activities

Activity 8. Bundle Up

Directions: Write the necessary information to complete the concept on seismic waves on the graphic organizer. Write your answers on a separate sheet of paper.



Question:

Which type of seismic waves are useful to seismologists in the study of the Earth's interior? Explain your answer in 2 or 3 sentences.

_____

_____

Rubric	
4	Answer is well-organized and completely explained the details.
3	Answer is organized and some details are explained.
2	Answer is not organized and details are unclear.
1	Answer does not make sense and shows no details.

Notes to the Teacher

Provide extra copies of this activity for students' use.

Answer Key

What's New

Activity 2: When the Land Moves

Possible answers:

A. There was an earthquake

B. Because of the sudden movement of rocks beneath the surface of the Earth.

What's In

Activity 1: Quak-events

1. 1
2. 2
3. 3
4. 4
5. 6
6. 5

What I Know

1. A	11. A	
2. B	12. C	
3. D	13. C	
4. C	14. D	
5. C	15. A	
6. D		
7. C		
8. B		
9. D		
10. D		

What's More

Activity 3: Getting into Puzzle

E	A	R	H	I	S	V	T	M	S	E	C	O	N	D	A	R	Y	M	N
T	G	D	F	S	E	I	S	M	I	C	W	A	V	E	D	S	A	E	C
E	A	S	C	H	I	K	O	C	A	S	O	H	V	H	J	K	L	D	E
S	U	R	F	A	C	E	L	A	S	P	W	A	V	E	S	U	O	H	F
H	O	I	E	W	R	F	I	T	S	A	A	V	F	E	I	O	P	I	G
G	E	I	A	S	E	F	D	B	D	A	R	S	L	I	Q	U	I	D	G
T	G	D	F	S	E	I	S	M	I	C	W	A	V	E	D	S	A	E	C
P	R	I	M	A	R	Y	I	T	S	A	A	V	F	E	I	O	P	I	G
H	O	I	E	W	R	F	I	T	S	S	W	A	V	E	S	S	A	E	C

1. P waves
2. Solid
3. Primary
4. Liquid
5. Surface

What I have learned

1. Earthquake waves
2. Three types
3. Primary waves
4. Secondary waves
5. Surface waves
6. Earthquake
7. Surface wave
8. Love wave
9. 4 to 6 km/s
10. 3 to 4 km/s

Activity 6: Perfect Match

1. Surface wave
2. S- waves
3. P-waves

II.

1. C- D
2. B- E
3. A- F

Activity 5: Let's find my mate

A.

1. D
2. C
3. A

B.

1. P waves
2. S waves
3. Surface waves

* Surface waves, because of its movement which is up and down.

Activity 4: Let' Talk About Wave

Earthquake Wave	**Also known As (AKA)**	**Speed**	**Travel Through**	**Medium**
A.Body wave				
Primary wave	1. P waves	3. Fastest	5. Solid, Liquid, Gas	Push- pull
Secondary wave	S waves	4. Middle Speed	Solids	7. Side to side
B.Surface wave				
Love wave	2. L waves	Slowest	6. Earth surface	8. Up and down

1. F 2. F 3. T 4. T 5. F

Assessment

1. C
2. D
3. D
4. B
5. D
6. C
7. C
8. B
9. B
10. D
11. B
12. C
13. B
14. A
15. A

What I Can Do

Activity 7: Let's think first

1. A
2. A
3. B
4. A
5. A

Question:

Body waves are the type of waves that are useful for seismologist in their study of the earth's interior because they are the only type of waves that give information about the deep interior of the Earth.

References

Department of Education, Science 8 Learner's Module, First Edition 2013, Page 135

Department of Education, Science 10 Learner's Module, First Edition 2015, Page 43

Department of Education, Integrated Science, Reprint Edition 2012, Page 175

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