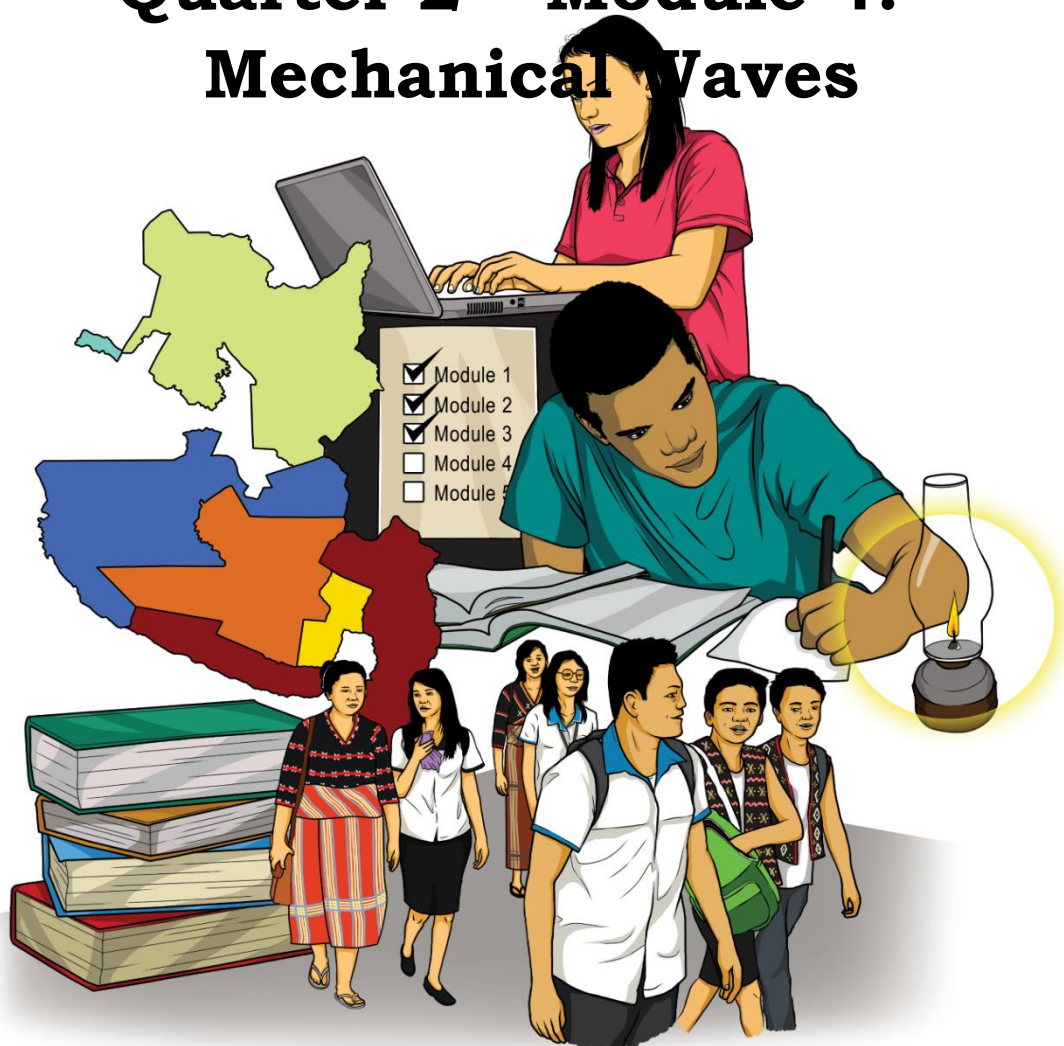




# General Physics 1

## Quarter 2 – Module 4: Mechanical Waves



**General Physics 1– Grade 12**  
**Self-Learning Module (SLM)**  
**Quarter 2 – Module 4: Mechanical Waves**  
**First Edition, 2020**

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# **General Physics 1**

**Quarter 2 – Module 4:  
Mechanical Waves**

# Introductory Message

For the facilitator:

Welcome to the General Physics 1 12 Self-Learning Module (SLM) on **Mechanical Waves!**

This module was collaboratively designed, developed and reviewed by educators both from public and private institutions to assist you, the teacher or facilitator in helping the learners meet the standards set by the K to 12 Curriculum while overcoming their personal, social, and economic constraints in schooling.

This learning resource hopes to engage the learners into guided and independent learning activities at their own pace and time. Furthermore, this also aims to help learners acquire the needed 21st century skills while taking into consideration their needs and circumstances.

In addition to the material in the main text, you will also see this box in the body of the module:



## ***Notes to the Teacher***

This contains helpful tips or strategies that will help you in guiding the learners.

As a facilitator you are expected to orient the learners on how to use this module. You also need to keep track of the learners' progress while allowing them to manage their own learning. Furthermore, you are expected to encourage and assist the learners as they do the tasks included in the module.

For the learner:

## Welcome to the General Physics 1 12 Self-Learning Module (SLM) on **Mechanical Waves!**

The hand is one of the most symbolized part of the human body. It is often used to depict skill, action and purpose. Through our hands we may learn, create and accomplish. Hence, the hand in this learning resource signifies that you as a learner is capable and empowered to successfully achieve the relevant competencies and skills at your own pace and time. Your academic success lies in your own hands!

This module was designed to provide you with fun and meaningful opportunities for guided and independent learning at your own pace and time. You will be enabled to process the contents of the learning resource while being an active learner.

This module has the following parts and corresponding icons:



### ***What I Need to Know***

This will give you an idea of the skills or competencies you are expected to learn in the module.



### ***What I Know***

This part includes an activity that aims to check what you already know about the lesson to take. If you get all the answers correct (100%), you may decide to skip this module.



### ***What's In***

This is a brief drill or review to help you link the current lesson with the previous one.



### ***What's New***

In this portion, the new lesson will be introduced to you in various ways such as a story, a song, a poem, a problem opener, an activity or a situation.



### ***What is It***

This section provides a brief discussion of the lesson. This aims to help you discover and understand new concepts and skills.



### ***What's More***

This comprises activities for independent practice to solidify your understanding and skills of the topic. You may check the answers to the exercises using the Answer Key at the end of the module.



### ***What I Have Learned***

This includes questions or blank sentence/paragraph to be filled in to process what you learned from the lesson.



### ***What I Can Do***

This section provides an activity which will help you transfer your new knowledge or skill into real life situations or concerns.



### ***Assessment***

This is a task which aims to evaluate your level of mastery in achieving the learning competency.



### ***Additional Activities***

In this portion, another activity will be given to you to enrich your knowledge or skill of the lesson learned.

This also tends retention of learned concepts.



### ***Answer Key***

This contains answers to all activities in the module.

At the end of this module you will also find:

### ***References***

This is a list of all sources used in developing this module

The following are some reminders in using this module:

1. Use the module with care. Do not put unnecessary mark/s on any part of the module. Use a separate sheet of paper in answering the exercises.
2. Don't forget to answer *What I Know* before moving on to the other activities included in the module.
3. Read the instruction carefully before doing each task.
4. Observe honesty and integrity in doing the tasks and checking your answers.
5. Finish the task at hand before proceeding to the next.
6. Return this module to your teacher/facilitator once you are through with it.

If you encounter any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator. Always bear in mind that you are not alone.

We hope that through this material, you will experience meaningful learning and gain deep understanding of the relevant competencies. You can do it!



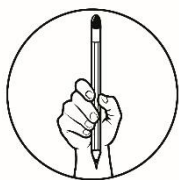
## ***What I Need to Know***

In every single way, we live in a world of waves- from the simple water waves generated when we throw an object in basin, the music as we strum a guitar. The space around us is filled with waves-microwaves from our cellular phones, light waves from the sunlight.

In our present day, it has now been more than 100 days since WHO was notified of the first cases of what we now call COVID-19, and much has changed since we launched the first Strategic Preparedness and Response Plan two months ago. The global spread of the virus has overwhelmed health systems, and caused widespread social and economic disruption. One of the main things we've learned is that the faster all case are found, tested and isolated, the harder we make it for this virus to spread. This is now the wave of virus where save lives and mitigate the economic impact of the pandemic.

In this module, you will understand the concept of waves. Specifically, you will:

1. differentiate underdamped, overdamped, and critically damped motion.
2. define mechanical wave, longitudinal wave, transverse wave, periodical wave, and sinusoidal wave.
3. from a given sinusoidal wave function infer the speed, wavelength, frequency, period, direction, and wave number.
4. apply the inverse-square relation between the intensity of waves and the distance from the source.



## What I Know

Before we begin with our lesson, let us check how much do you know about potential energy and conservative force by answering the following questions. Choose the **letter** of the correct answer. Write your answers on the learning activity sheets provided for you.

\_\_\_\_\_ 1. What is the relationship of the restoring force of a body undergoing simple harmonic motion to the displacement?

- a. direct
- b. inverse
- c. direct square
- d. inverse square

\_\_\_\_\_ 2. What is the maximum displacement of a body in simple harmonic motion?

- a. period
- b. frequency
- c. wavelength
- d. amplitude

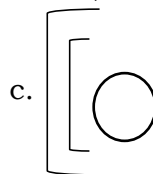
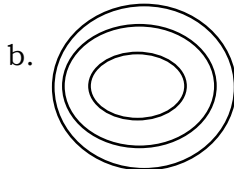
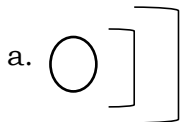
\_\_\_\_\_ 3. What factors affect the period of a simple pendulum?

- I. Acceleration due to gravity
- II. Mass of the bob
- III. Length of the string
- a. I and II
- b. I and III
- c. II and III
- d. I, II and III

\_\_\_\_\_ 4. Which one of the following statements is true for both transverse and longitudinal wave?

- a. It can be refracted.
- b. It can travel through a vacuum.
- c. It can have similar wavelengths.
- d. It can travel with the same speed.

\_\_\_\_\_ 5. If you tap lightly the rim of a glass of water, what will be the wave pattern formed on the water's surface?



\_\_\_\_\_ 6. This another word for the material that waves move through?

- a. crest
- b. trough
- c. amplitude
- d. medium

\_\_\_\_\_ 7. This is the position where the material is not disturbed?

- a. crest
- b. trough
- c. rest position
- d. medium



- \_\_\_\_\_ 8. This is the number of wave cycles that happens in a matter of one second?
- a. wavelength
  - b. amplitude
  - c. period
  - d. frequency
- \_\_\_\_\_ 9. This is the energy that causes a vibration to move through a medium?
- a. electromagnetic radiation
  - b. wave
  - c. frequency
  - d. amplitude
- \_\_\_\_\_ 10. This is the distance from the rest positions to the crest?
- a. amplitude
  - b. frequency
  - c. wavelength
  - d. period
- \_\_\_\_\_ 11. This type of wave has both transverse and longitudinal wave and it separate the two different media the waves travel through?
- a. Transverse wave
  - b. Longitudinal wave
  - c. Surface wave
  - d. Tidal wave
- \_\_\_\_\_ 12. This is the distance from crest to crest?
- a. amplitude
  - b. frequency
  - c. period
  - d. wavelength
- \_\_\_\_\_ 13. This type of wave occurs where wave motion moves parallel to the material?
- a. Transverse wave
  - b. Longitudinal wave
  - c. Surface wave
  - d. Tidal wave
- \_\_\_\_\_ 14. This type of wave occurs where wave motion moves perpendicular to the material.
- a. Transverse wave
  - b. Longitudinal wave
  - c. Surface wave
  - d. Tidal wave
- \_\_\_\_\_ 15. A particle oscillates with undamped simple harmonic motion. Which one of the following statements about the acceleration of the oscillating particle is true?
- a. It is least when speed is greatest.
  - b. It is always in the opposite direction to the velocity .
  - c. It is proportional to the frequency.
  - d. It decreases as the potential energy increases.

## Lesson

# 1

# Mechanical Waves

Learning Objectives:

1. Distinguish types of mechanical waves.
2. Determine wave velocity in different media.
3. Solve problems regarding mechanical waves.



## What's In

How did you fare in the test? As you go through this module, you will deepen your understanding in our topic and do better in the next test.

There are number of interesting effects in physics which may be explained in terms of wave motion. Let us be familiar with some terms that you will encounter in this module by doing the next activity.

### Activity 1. Crossword Puzzle

Underline the related words that you know inside the box. The words may be running in all possible directions horizontally, vertically, or diagonally. Write your answer on activity sheets provided for you.

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

Words: periodic motion, amplitude, period, frequency, pendulum, oscillation, and resonance

Good Job! It seems that you are now familiar with the terms from the previous lesson about waves. This time let us perform again another activity.



## ***What's New***

### **Activity 2. Just swing**

Direction: Look for a swing and ride on it. Let it swing for many times or as you like. Then, answer the following guide questions.

1. What did you observe on the motion of a swing? \_\_\_\_\_

---

---

Congratulations! we have now discussed the concepts of wave motion. This module will give you a detailed discussion on waves.



## ***What is It***

### **The Nature of Waves**

Whenever a medium is disturbed, there is a corresponding observable change in it. When you throw a small stone into the river, the water is disturbed and circular waves are formed.

Consider a boy at the side of the river where a toy boat is floating at a distance not within the reach of the boy. The boy wants to move the boat. How will he do that?

One way to do it is to disturb the water to create waves. The waves will eventually move the boat.

### **Types of Waves**

There are two types of waves: the *transverse waves* and the *longitudinal waves*. These are *mechanical waves* that require a medium for propagation. Water waves and rope waves are examples of transverse waves. On the other hand, light wave is an example of *electromagnetic wave*, which does not require any medium for propagation.

Recall what you did when you generate waves in a rope. When you disturb one end of the rope, how did the rope waves travel with respect to the direction of wave motion? Yes, rope waves travel in a direction perpendicular to the direction of wave motion. This kind of wave is what we call transverse wave.

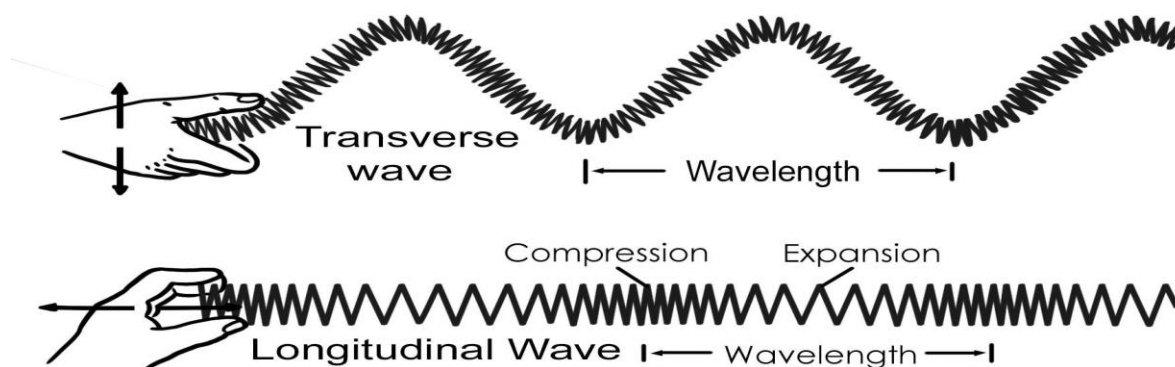


Figure 1. Illustration of transverse and longitudinal waves

## Characteristics of Waves

Water waves are easily produced and observed. By touching one point on the surface you can see the peaks of the waves form circles and move outwards from the source of the disturbance.

Some of the characteristics used to describe transverse wave motion are enumerated below:

- The high points are called **crests or peaks** while the low points are called **troughs**.
- The **amplitude** is the maximum displacement from the rest position. It is the height of the crest or depth of a trough measured from the normal undisturbed position.
- The **wavelength,  $\lambda$** , is the distance between two successive crests or two successive troughs. It is also equal to the distance between any two identical points on successive waves, for example points A and B, and points C and D.
- The frequency,  $f$ , is the number of crests or troughs that pass a point per second. This is equivalent to the number of complete waves generated per second. Frequency is measured in terms of hertz (Hz).
- The period,  $T$ , is the time taken to generate one complete wave. It is also the time taken for the crests, or any given point on the wave, to move a distance of one wavelength.

$$T = 1/f$$

- The speed,  $v$ , of the wave is the distance moved by a wave in one second. Since the wave crest travels a distance of one wavelength in one period, the wave speed,

$$v = \lambda/T \text{ or } v = f\lambda$$

**Sample Problem:**

The frequency of some approaching ocean waves is 2 Hz and the length between two wave crests is 3 m. What is the speed of the ocean waves moving towards the shore?

Given:

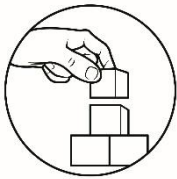
$$f = 2 \text{ Hz}$$

$$\lambda = 3 \text{ m}$$

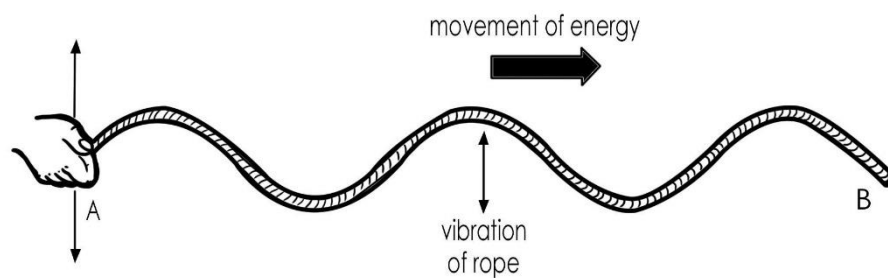
Formula:  $v = f \lambda$

$$= 2 \text{ Hz} \times 3 \text{ m}$$

$$= 6 \text{ m/s}$$

***What's More*****Activity 3. Waves on a rope!**

1. Hold one end of a horizontally stretched rope or spring, and with a quick up and down motion of your hand, shake a pulse into the rope.

**Transverse wave on a rope**

Guide Question:

a. How does the rope move?

2. Now, you could have moved your hand from side to side rather than up and down?

Guide Question:

b. What with the rope's movement?

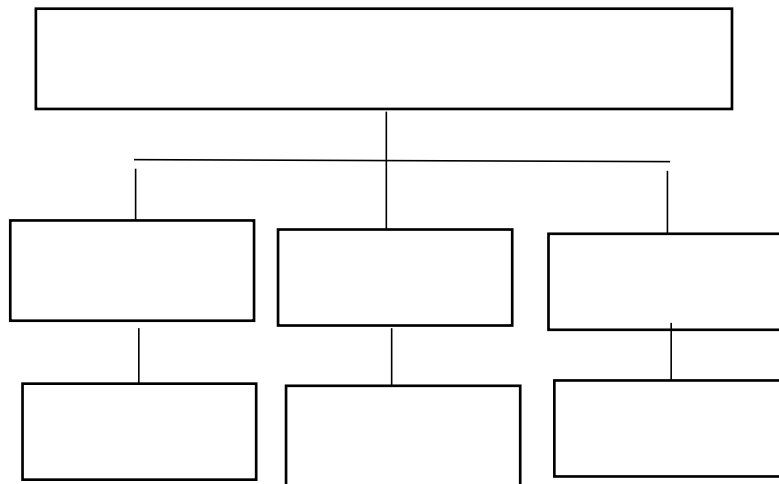


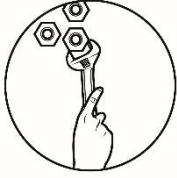
## ***What I Have Learned***

### **Activity 4. Concepts in a box**

*Direction: Compute the diagram by filling-up the missing box.  
Choose the words from the choice given:*

<b>Mechanical Waves</b>
<b>Longitudinal Waves</b>
<b>Transverse Waves</b>
<b>Surface waves</b>
<b>Velocity in solid, liquid and gas</b>
<b>Deep and shallow surface waves</b>





## ***What I Can Do***

We're almost done with our first lesson. As an extended activity, your next task is to solve a work problem.

### **Activity 6. Work it out!!**

Let us see if you can follow the solutions given in the sample problems. Below are simple problems for you to solve.

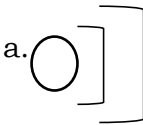
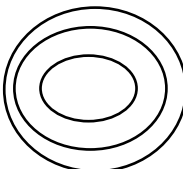
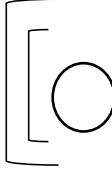
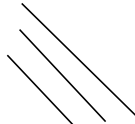
Problems:

1. What is the velocity of the wave in a guitar string having a length of 0.65 m and a mass of 3.5 g when subjected to a tension of 250 N?
2. While fishing, you notice that eight crests pass a given point in a time interval of 10s. You approximate the distance between two crests to be 1.2 m. Calculate the
  - a) Speed of water waves and
  - b) Depth of water



## Assessment

**Multiple Choice.** Choose the letter of the correct answer. Write the chosen letter on a **separate sheet of paper**.

- \_\_\_\_ 1. What is the relationship of the restoring force of a body undergoing simple harmonic motion to the displacement?
- a. direct
  - b. inverse
  - c. direct square
  - d. inverse square
- \_\_\_\_ 2. What is the maximum displacement of a body in simple harmonic motion?
- a. period
  - b. frequency
  - c. wavelength
  - d. amplitude
- \_\_\_\_ 3. What factors affect the period of a simple pendulum?
- IV. Acceleration due to gravity
  - V. Mass of the bob
  - VI. Length of the string
- a. I and II
  - b. I and III
  - c. II and III
  - d. I, II and III
- \_\_\_\_ 4. Which one of the following statements is true for both transverse and longitudinal wave?
- a. It can be refracted.
  - b. It can travel through a vacuum.
  - c. It can have similar wavelengths.
  - d. It can travel with the same speed.
- \_\_\_\_ 5. If you tap lightly the rim of a glass of water, what will be the wave pattern formed on the water's surface?
- a. 
- b. 
- c. 
- d. 
- \_\_\_\_ 6. This another word for the material that waves move through?
- a. crest
  - b. trough
  - c. amplitude
  - d. medium
- \_\_\_\_ 7. This is the position where the material is not disturbed?
- a. crest
  - b. trough
  - c. rest position
  - d. medium



- \_\_\_ 8. This is the number of wave cycles that happens in a matter of one second?
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## Answer key

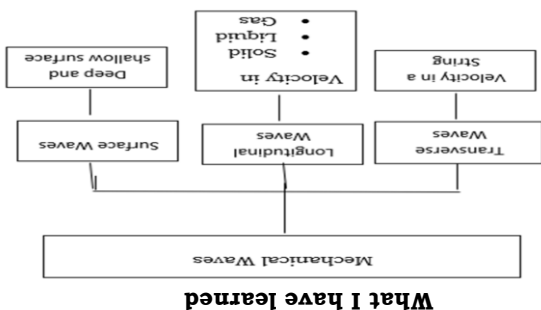
Post Assessment			
1. a	6. d	11. c	
2. d	7. c	12. d	
3. b	8. d	13. b	
4. d	9. b	14. a	
5. b	10. a	15. a	

**Activity 5. Work it out!**

**Solution:**

1. Linear Mass:  $\mu = \frac{\text{mass}}{\text{length}} = \frac{3.5 \times 10^{-3} \text{ kg}}{0.65 \text{ m}}$   
 $\mu = 5.4 \times 10^{-3} \text{ kg/m}$

2. **Solution:**  
 Given:  $\lambda = 1.2 \text{ m}$   
 a.  $V = f \lambda$   
 $= (0.80 \text{ Hz}) (1.2 \text{ m})$   
 $V = 0.96 \text{ m/s}$   
 b.  $V = \sqrt{gh}$   
 $0.96 \text{ m/s} = \sqrt{9.8 \text{ m/s}^2 h}$   
 $h = 0.094 \text{ m}$



Pre-Assessment			
1. a	6. d	11. c	
2. d	7. c	12. d	
3. b	8. d	13. b	
4. d	9. b	14. a	
5. b	10. a	15. a	

What's In:

## References

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Valdes, Delia Cordero-Navaza and Bienvenido J. 1996. *Physics Textbook*. Phoenix Publishing House.

**EDITOR'S NOTE**

This Self-learning Module (SLM) was developed by DepEd SOCCSKSARGEN with the primary objective of preparing for and addressing the new normal. Contents of this module were based on DepEd's Most Essential Learning Competencies (MELC). This is a supplementary material to be used by all learners of SOCCSKSARGEN Region in all public schools beginning SY 2020-2021. The process of LR development was observed in the production of this module. This is version 1.0. We highly encourage feedback, comments, and recommendations

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