Genphysics q2 mod4 Mechanical Wave

Mechanical Engineering (University of San Carlos)

Senior High School

General Physics 1
Quarter 2 – Module 4:
Mechanical Wave

ALTERNATIVE DELIVERY MODE

ADM

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General Physics 1

Quarter 2 – Module 4:

Mechanical Wave

Introductory Message

For the facilitator:

Welcome to the General Physics - Grade12 Alternative Delivery Mode (ADM) Module on Mechanical Wave!

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- Grade 12 Alternative Delivery Mode (ADM) Module on Mechanical Wave!

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.

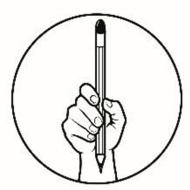
We hope that through this material, you will experience meaningful learning and gain deep understanding of the relevant competencies. You can do it!

What I Need to Know

This module was designed and written to give you better understanding of mechanical waves which is essential in understanding our physical world. Much of what we see and hear is only possible because of vibrations and waves.

At the end of this module, learners are expected to demonstrate an understanding of mechanical wave and be able to:

- define mechanical wave, longitudinal wave, transverse wave, periodic wave, and sinusoidal wave; and
- infer the wave's speed, wavelength, frequency, period, direction, and wave number from the given sinusoidal wave function.



What I Know

DIRECTION: **Read each question carefully and choose the best answer from the given choices.**

1. Which refers to the maximum distance a wave varies from its rest position?
   a. Integer
   b. Amplitude
   c. Wave length
   d. Friction

2. The highest point of a transverse wave is____________.
   a. Compression
   b. Amplitude
   c. Crest
   d. Refraction

3. Which term best describes on the number of waves that can pass a given point per second? It is also measured in Hertz (Hz).
   a. Amplitude
   b. Crest
   c. Frequency
   d. Friction

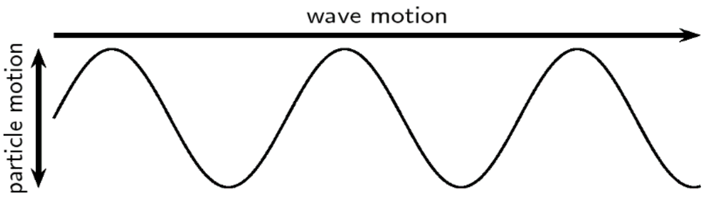
4. It is the unit of measurement for frequency.
   a. Joule
   b. Hertz
   c. Amplitude
   d. Watt

5. A wave that moves back and forth parallel to the direction that it is travelling is ____________________.
   a. Transverse wave
   b. Periodic wave
   c. Longitudinal wave
   d. Mechanical wave

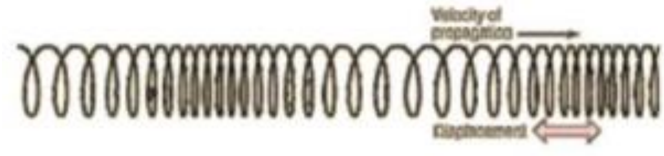
6. A wave that moves at right angles or perpendicular to the direction that it travels is ____________________.
   a. Transverse wave
   b. Mechanical wave
   c. Longitudinal wave
   d. Wave of feeling

7. It is the lowest point of a wave
    a. Crest
    b. Trough
    c. Amplitude
    d. Wavelength

8. _______________ move the particles of the medium perpendicular to the direction of the wave.
    a. Sinusoidal waves
    b. Mechanical waves
    c. Transverse waves
    d. Longitudinal waves



9. _______________ move the particles of the medium parallel to the direction of the wave.
    a. Periodic waves
    b. Sinusoidal waves
    c. Transverse waves
    d. Longitudinal waves



10. It is an area of a longitudinal wave where the particles of the medium are closer together than usual.
    a. rarefaction
    b. trough
    c. crest
    d. compression

11. It is an area of a longitudinal wave where the particles of the medium are more spread out than usual.
    a. rarefaction
    b. frequency
    c. amplitude
    d. compression

Lesson 1 Mechanical Wave

What is your favorite musical instrument? Whether it is a guitar, a violin, a piano, or a flute, the same concepts in waves and in acoustics can explain how they work. In this module, you will see that the sound produced by musical instruments can be described using wave mechanics.

What's In

An **oscillation** or **vibration** is a "wiggle" in time. An example of this is the periodic motion of a pendulum where the bob swings back and forth. A **wave**, on the other hand, is a "wiggle" in both space and time. Examples are water waves, waves on a string, sound waves, and electromagnetic waves.

Consider the following example below, see the difference between a vibration and a wave.

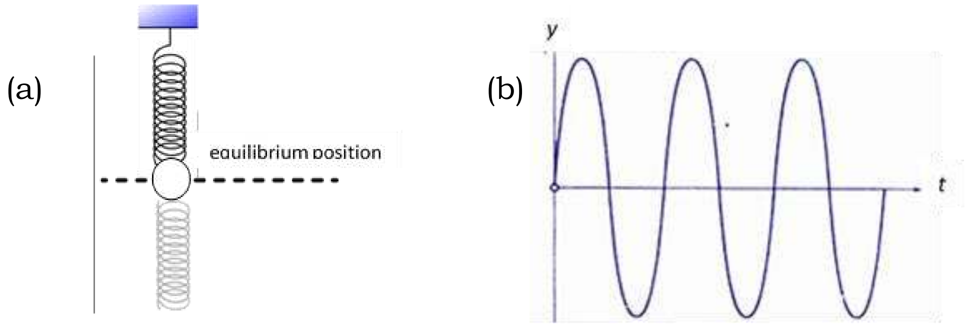
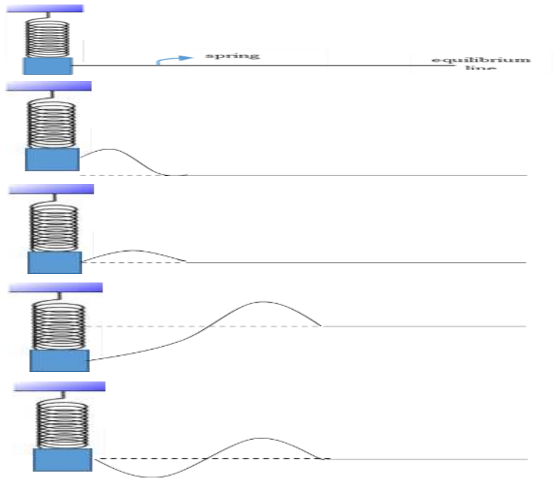


Figure 1
(a) The oscillation of a bob that hangs on a spring,
(b) the position-time graph of its oscillation

Figure 1a shows the initial position of the bob when it is at rest and in equilibrium. This is called the ***equilibrium point.*** As it moves up and down, it oscillates about its equilibrium point. Figure 1b shows its position along the y-axis as a function of time. You can see that the pattern propagates in the dimension of time.

Suppose you connect this bob to a string as shown in the figure on the left,



When the system is in a state of equilibrium and at rest, the initial length of the string is called **equilibrium line**. As the bob moves up and down, the oscillating motion of the bob is transmitted or propagated throughout the string, forming a **wave**. Therefore, a wave propagates in both the dimension of space and time.

Notes to the Teacher

This module prepares the learners to understand that mechanical wave requires a medium to propagate

What's New

Waves on a string and sound waves are just some examples of mechanical waves. The waves on a string use the string as a medium. Thus, sound waves use particles of matter in order to propagate. On the other hand, electromagnetic waves don't require a medium to propagate, that is why the light coming from the sun reaches Earth even through the space between the sun and Earth is relatively empty.

Three important things about mechanical waves you need to know.

1. Disturbance travels or propagates with a definite speed in a medium called **wave speed** as denoted by ***v***.
2. Only the pattern or disturbance travels in space but not the medium itself.
3. Energy is needed to set a mechanical wave into motion.
   Thus, *waves transport energy but not matter.*

Types of Mechanical Waves based on the relative directions of propagation and motion of particles:

1. **Transverse Waves**

   Suppose that a slinky is stretched out in a horizontal direction across the classroom and that a pulse is introduced into the slinky on the left end by vibrating the first coil up and down, the energy will begin to be transported through the slinky from left to right. As the energy is transported from left to right, the individual coils of the medium will be displaced upwards and downwards. Thus, the particles of the medium move ***perpendicular*** to the direction that the pulse moves.

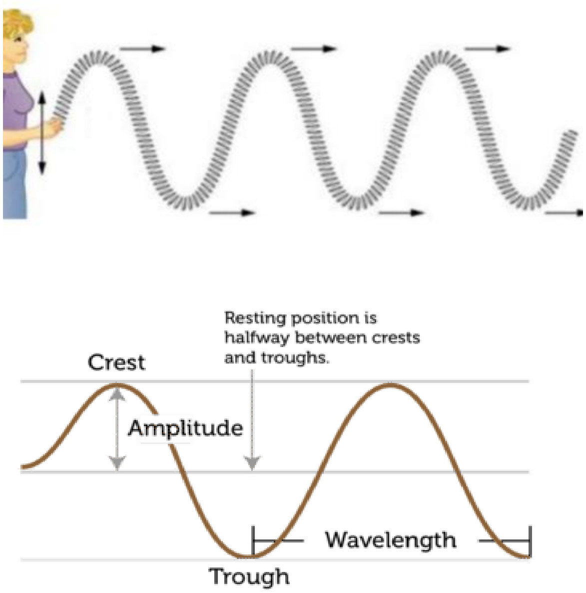


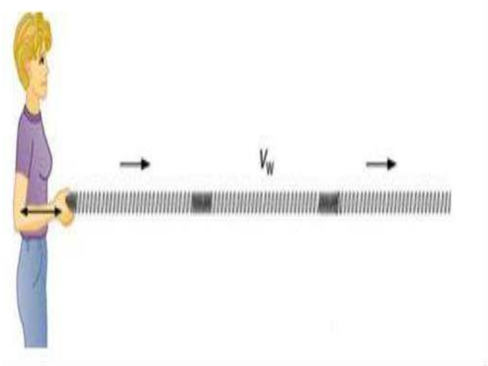
Figure 3: Transverse waves in a slinky

As shown in figure 3, the parts of a transverse wave are the following:

a. **Equilibrium line –** the stable position or resting position of a medium (e.g. string or spring) when it is in equilibrium
b. **Crest –** the highest point in a transverse wave
c. **Trough –** the lowest point in a transverse wave
d. **Amplitude** – the distance from the equilibrium line to the crest or trough.

2. Longitudinal Wave

Suppose that a slinky is stretched out in a horizontal direction across the classroom and that a pulse is introduced into the slinky on the left end by vibrating the first coil left and right, the energy will begin to be transported through the slinky from left to right. As the energy is transported from left to right, the individual coils of the medium will be displaced leftwards and rightwards. Thus, the particles of the medium move ***parallel*** to the direction that the pulse moves.



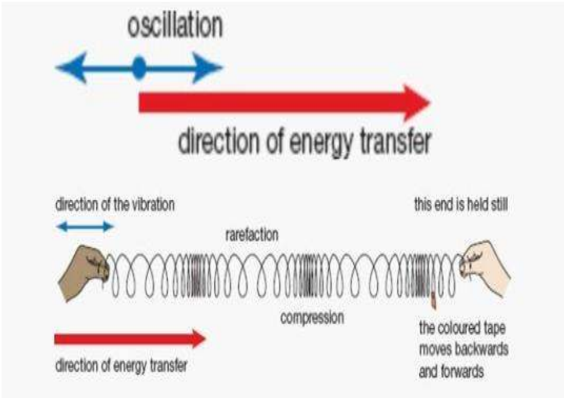


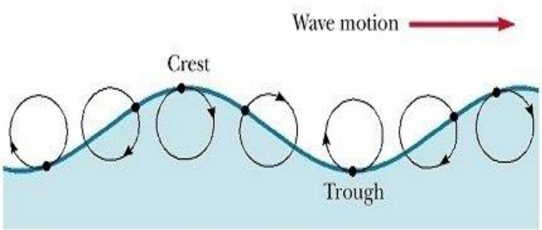
Figure 4: Longitudinal Waves along a slinky

As shown in figure 4, the parts of a longitudinal wave are the following:

a. **Compression –** the region of high particle density
b. **Expansion** or **Rarefaction –** the region of low particle density

3. Both Transverse and Longitudinal Wave

In some cases, the displacements of the particles have both transverse and longitudinal component. These are also called **Rayleigh surface waves** as shown in the right figure.



Combined transverse and longitudinal motion in water waves

Periodic Motion

Since each point in a wave is oscillating, vibration of particles should also be emphasized. The oscillation of an object around a point is an example of periodic motion. **Periodic motion** is a motion that is regular and repeating. Further, objects that vibrate and their vibrations are said to be periodic.

The back-and-forth swing of the pendulum in a long case (grandfather clock) clock, the swaying movement of a rocking chair, and the repetitive beat of your heart are some of those many examples that you use or see every day that does periodic motion.

Considering figure 6. A light source projects the shadow of the ball on a horizontal plane. This shadow is oscillating along an x-axis.

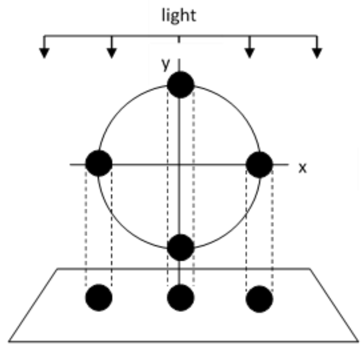


Fig. 6: A ball moving in uniform circular motion

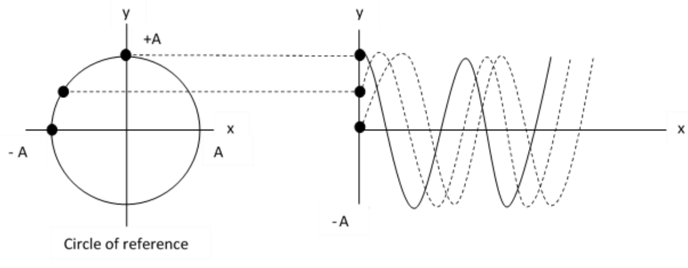
The number of complete revolutions or cycles of the ball around the circle per unit of time is called the **frequency**, denoted by *f*. This corresponds to the shadow of the ball making one complete vibration or oscillation. The unit of frequency is the number of cycles, revolutions, or vibrations per second. The SI unit for this is **hertz** (Hz). The period or ***T*** is the amount of time required for a body to make one complete revolution. Thus, frequency is the reciprocal of period. Mathematically it is:

$$f = \frac{1}{T} \text{ and } T = \frac{1}{f}$$

Sinusoidal Waves

Another kind of wave, in which the particles move in simple harmonic motion, is called **sinusoidal wave**. Let's consider a particle moving in uniform circular motion with its projection along the y-axis in simple harmonic motion.

As this particle moves in a simple harmonic motion, the succeeding particles follow, thus forming a wave. Meanwhile, figure 7 shows the **circle of reference** that serves as the basis for the motion of the sinusoidal wave.



The distance between two successive identical points in a sinusoidal wave is called **wavelength,** denoted by the symbol **λ**. The SI unit for wavelength is meter (m). Two successive crests or troughs is 1 λ**,** and two successive regions of compressions or rarefactions is 1λ in longitudinal waves.

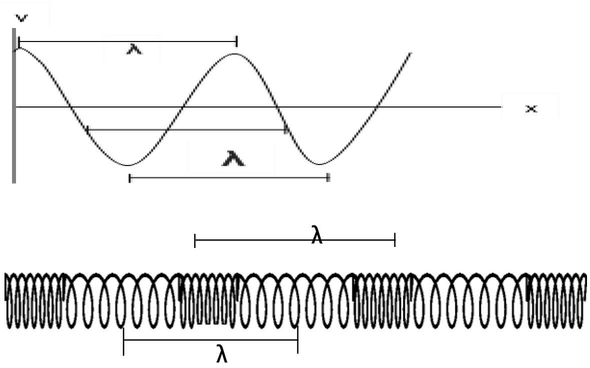
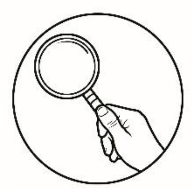


Fig. 8: Representation of wavelength of the wave



What is It

The wave travels with constant wave speed (*v*). This pattern advances a distance of one wavelength (λ) for a time interval of one period (T). So in wave motion, *v* is given as

$$\boldsymbol{v = \frac{\lambda}{T} = \lambda f \ (eq.1)}$$

Consider the sinusoidal transverse wave in figure 8 above, a particle at position *x* is displaced to a position *y* perpendicular to the *x*-axis. Each particle has different positions y at different. Thus, the value of *transverse displacement y* depends on which particle at a particular time you are referring to. So y is a function of both x and t:

$$\boldsymbol{y \rightarrow y\,(x,\ t)}$$

This mathematical expression that describes the motion of a wave is called **wave function.** The wave functions for a sinusoidal transverse wave traveling toward a x-axis for cases when x = 0 particle is **initially <u>at the crest</u>** and at the **<u>equilibrium position</u>** are the following respectively:

$$\mathbf{y(x,\ t) = A\ cos(kx \pm \omega t)\ and\ y(x,\ t) = A\ Sin(kx \pm \omega t + \Phi)\ (eq.2)}$$

where: y = height of a wave along y-axis and measured in meter (m)

x = distance along x-axis measured in meter (m)

t = time in second (s)

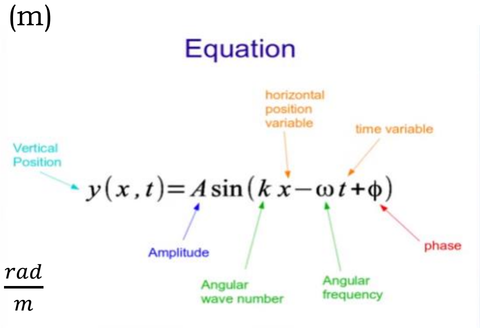
A = amplitude

k = wave number (k = $\frac{2\pi}{\lambda}$) (eq.3) measured in $\frac{rad}{m}$

ω = (omega) angular frequency (2πf) (eq.4)

= measured in $\frac{rad}{sec}$

Φ = (phi) phase constant = $\frac{\pi}{2}$



NOTE:

Use + for wave traveling in negative direction and − for wave traveling on positive direction.

Notice that the two wave functions involved cosine and sine functions. This is why these waves are called sinusoidal waves. The difference between the two waves functions depend on the initial position of the x=0 particle, whether it is initially at the **crest** (**cosine function**) or at the **equilibrium point** (**sine function**).

Example 1: Write a wave function describing a wave traveling at 10.0 m/s with an amplitude 0.800 m and wavelength 0.320 m for the following cases:

1. The wave is traveling toward the x –axis
   a. With point x=0 initially at the maximum upward position
   b. With point x=0 initially at the equilibrium point
2. The wave is traveling toward the –x-axis
   a. With point x=0 initially at the maximum upward position
   b. With point x=0 initially at the equilibrium point

Solution:

Given: v=10.0 m/s A=0.800m
λ= 0.320 m

❖ First, compute the important quantities such as the angular frequency and the wave number. From the definition of angular frequency and wave speed.

ω= 2πf (angular frequency)

ω= 2π ($\frac{v}{\lambda}$) eq.1

=2π ($\frac{10.0\ m/s}{0.320\ m}$) = **196 rad/sec**

k = $\frac{2\pi}{\lambda}$ (eq.3)

= $\frac{2\pi}{0.320\ m}$ = **19.6 rad/m**

- This, together with the amplitude A=0.800m, can be simply substituted to the earlier derived wave functions, enumerated as follows:

For 1a.) y(x, t)=Acos(kx-ωt)	For 2a.) y(x, t)=Acos(kx+ωt)
y(x, t)=(0.800m)Cos[(19.6rad/m)x – (196 rad/s)t	**y(x, t)=(0.800m)Cos[(19.6rad/m)x + (196 rad/s)t**
For 1b.) y(x, t)=Asin(kx-ωt+Φ)	For 2b.) y(x, t)=Asin(kx-ωt+Φ)
y(x, t)=(0.800m)Sin[(19.6rad/m)x – (196 rad/s)t+$\frac{\pi}{2}$	**y(x, t)=(0.800m)Sin[(19.6rad/m)x + (196 rad/s)t+$\frac{\pi}{2}$**

Example 2: A sinusoidal wave is described by the following wave function:

y(x, t)=(0.800m)Cos[(19.6rad/m)x – (196 rad/s)t

Find the transverse displacement at x=0.360 m and at t=0.150s.

Solution:

Simply substitute the given information in the wave function.

y(x, t)=(0.800m)Cos[(19.6rad/m)x – (196 rad/s)t
y(x, t)=(0.800m)Cos[(19.6rad/m)(0.360m) - (196 rad/s)(0.150s)]
y(x, t)= -0.751

Caution: Make sure that your calculator is in radian mode. The computed value for y means that it is below the equilibrium line.

Example 3: Let's say that for a wave of a string the equation is:

$$y(x,t) = (0.8 \text{ cm}) \sin[(1.5 \text{ m}^{-1})x - (4.0 \text{ s}^{-1})t] + \Phi$$

(a) Determine the wave's amplitude, wavelength, and frequency.

(b) Determine the speed of the wave.

(c) Determine the direction of propagation of the wave.

(d) Determine the maximum transverse speed of the string.

Solution

(a) The wave's amplitude, wavelength, and frequency can be determined from the equation of the wave:

$y(x,t) = \mathbf{(0.8\ cm)}\sin[(\mathbf{1.5\ m^{-1}})x - (\mathbf{4.0\ s^{-1}})t] + \Phi$

A = 0.8 cm → 0.008 m

k = 1.5 rad/m

ω= 4.0 rad/s

The wavenumber k is whatever is multiplying the x:
$k = 1.5\ m^{-1}$

$y(x,t) = (0.8\ cm)\sin[(\mathbf{1.5\ m^{-1}})x - (4.0\ s^{-1})t] + \Phi$

k = 1.5 rad/m

$k = \frac{2\pi}{\lambda} \therefore \lambda = \frac{2\pi}{k} = \frac{2\pi}{1.5\ rad/m} = \mathbf{4.2\ m}$

The angular frequency w is whatever is multiplying the t.
ω = 4.0 rad/s

$y(x,t) = (0.8\ cm)\sin[(1.5\ m^{-1})x - (\mathbf{4.0\ s^{-1}})t] + \Phi$

$f = \frac{\omega}{2\pi} = \frac{4.0\ rad/s}{2\pi} = \mathbf{0.64\ Hz}$

(b) The wave speed can be found from the frequency and wavelength:

$v = f\lambda$

$= 0.64\ Hz\ (4.2\ m)$

$= \mathbf{2.4\ m/s}$

(c) To find the direction of propagation of the wave, just look at the sign between the x and t terms in the equation. In our case we have a minus sign:

$y(x,t) = (0.8\ cm)\sin[(1.5\ m^{-1})x - (4.0\ s^{-1})t] + \Phi$

REMEMBER:

A **negative** sign means the wave is traveling in the **+x direction**.

A **positive** sign means the wave is traveling in the **-x direction**.

∴ The direction of propagation of a wave is +x direction.

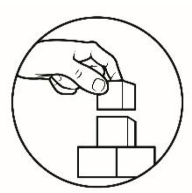
(d) To determine the maximum transverse speed of the string, remember that all parts of the string are experiencing simple harmonic motion. We showed that in SHM the maximum speed is: v_{max}= Aω.

v_{max}= Aω

In this case we have A=0.8 cm or 0.008 m, so:

= (0.8 cm) (4.0 rad/s) or (0.008 m) (4.0 rad/s)

=3.2 cm/s or **0.032 m/s**



What's More

Solve the following problems. Write your answers with its corresponding solutions in a separate sheet of paper.

1. The wave function that describes a certain transverse wave at initial time t=0 is

$$y(x,\ t)=(7.20mm)\sin 2\pi\left(\frac{x}{0.3m} - \frac{t}{0.0400\ s}\right)$$

   Find the wave's (a) amplitude, (b) wavelength, (c) frequency, (d) speed of propagation, (e) period, (f) wave number, and (g) direction of propagation.

2. Given the equation of the wave:

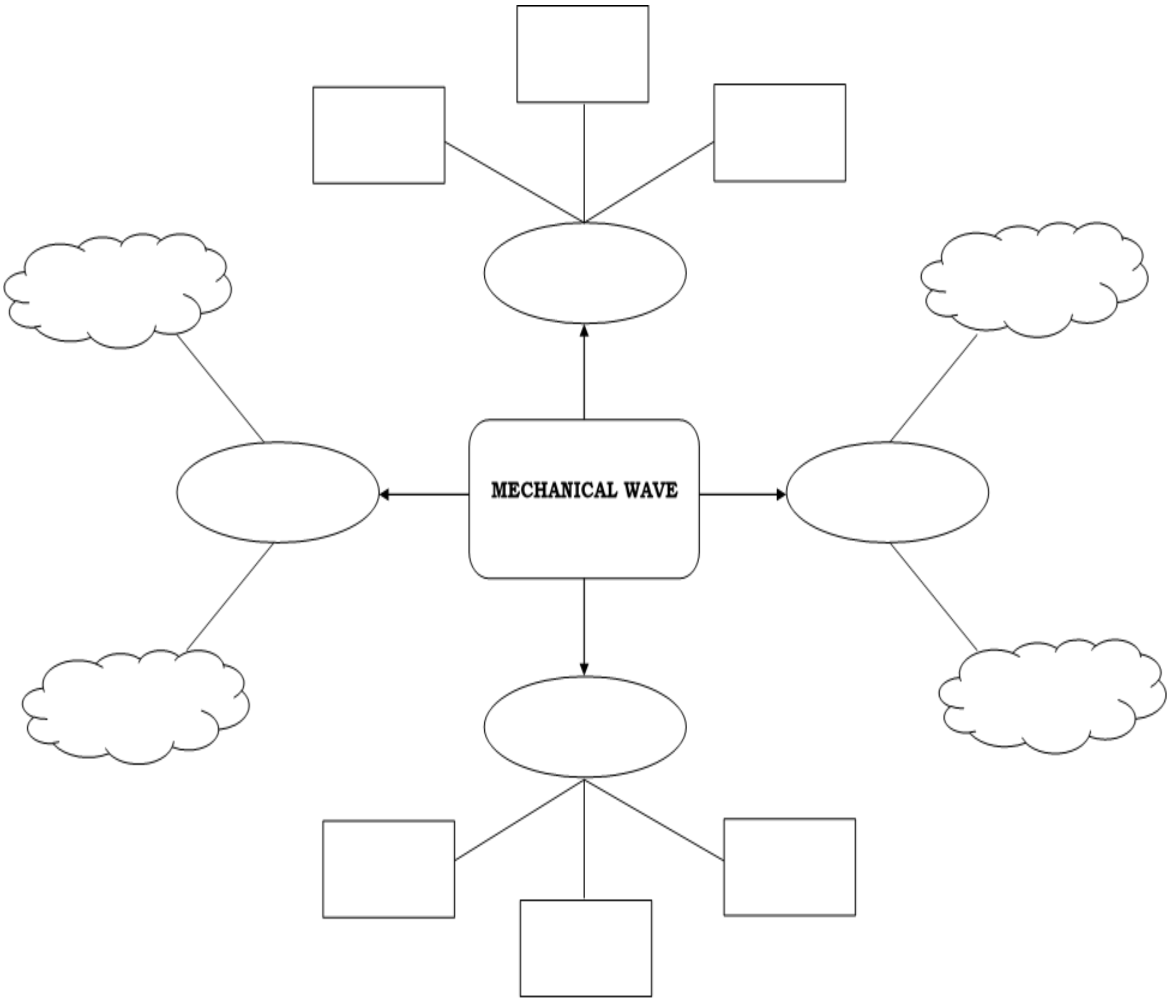
$$y(x,\ t)=1.0m\cos(2\pi m^{-1}\ x - \frac{\pi}{3s}\ t)$$

   What is: a.) wavelength, b.) frequency, c.) angular frequency, d.) period, and e.) velocity

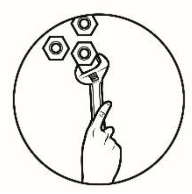
What I Have Learned

Let's Cheer Wave!

A concept map is a visual organizer that can enrich students' understanding of a new concept. Using your acquired knowledge from this module, construct your own concept map/mind map to deepen your understanding and comprehension. Think of a word/s, or phrase/s that is/ are related to the word "Mechanical Wave". A sample of template below may serve as your guide.



RUBRICS FOR CONCEPT MAP				
Performance Indicators	**Partial 2 points**	**Progressing 3 points**	**Proficient 4 points**	**Exemplary 5 points**
Concepts	Insufficient number of concepts selected relating to topic Arrangement of concepts illustrates no understanding of conceptual relationships	Minimal but acceptable number of concepts selected, with some relationships to the topic Arrangement of concepts demonstrates simple understanding of subordinate conceptual relationships	Most concepts relating to topic were selected Arrangement of concepts demonstrates and understanding of subordinate conceptual relationships	Most concepts and all significant concepts selected and they clearly relate to the topic Arrangement of concepts demonstrates complete understanding of subordinate conceptual relationships
Hierarchical Structure	Concepts are displayed in a linear sequence. Little or no sense of hierarchical structure	Limited hierarchical structure used	Concepts connected in a hierarchical structure	Concepts connected in a hierarchical structure leading to more specific concepts
Interconnectivity among concepts	Evidence of understanding of few relationships and how limited number of concepts are linked to other concepts	Evidence of understanding of some relationships and how some concepts are linked to other concepts	Evidence of understanding of most relationships and how most concepts are interlinked with other concepts	Evidence of understanding relationships and how all concepts are interlinked with many other concepts
Critical thinking and communication	Map provides evidence of limited critical thinking; the type of concept map allows for basic level of understanding	Map provides evidence of moderate critical thinking; the concept map selected allows for moderate level of understanding	Map provides some evidence of mostly complex and substantial critical thinking; appropriate selection of concept map that allows for proficient level of understanding	Map provides evidence of complex and sophisticated critical thinking; most appropriate selection of type of concept map that allows for exceptional level of understanding



What I Can Do

THINK OUT OF THE BOX

You do periodic motions when you make repeated movements or actions in particular periods of time. When you do tasks repeatedly or you practice constantly, you have the tendency to master these tasks. *What activities are you doing periodically? Are these periodic activities good or bad? How do they affect you?*

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THINK OUT OF THE BOX

Sinusoidal waves are characterized by the upward and downward movement of particles. In the same way, there may be times when you're up, and moments when you feel you're falling. What important is that you continue to move on and learn from these experiences. *Each particle in a wave follows the motion of its neighboring particle. What about you? Are you a good follower? Explain through citing actual situations where you considered yourself a good follower.*

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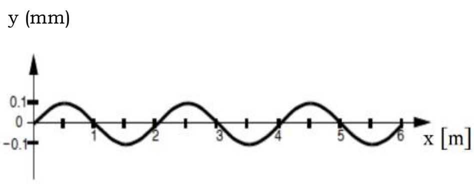
RUBRICS FOR ESSAY QUESTIONS				
Criteria	**Unsatisfactory** **2 pts**	**Needs Improvement** **3 pts**	**Satisfactory** **4 pts**	**Outstanding** **5 pts**
Content & Development	- The content is incomplete. -The major points are not clear. -The specific examples are not used.	- The content is not comprehensive and /or persuasive. - The major points are addressed, but not well supported. -The responses are inadequate or do not address topic. -The specific examples do not support topic.	- The content is accurate and persuasive. - The major points are stated. -The responses are adequate and address topic. - The content is clear. -The specific examples are used	- The content is comprehensive, accurate, and persuasive. - The major points are stated clearly and are well supported. - The responses are excellent, timely and address topic. -The content is clear. -The specific examples are used.
Organization & Structure	- Organization and structure detract from the message. - The writing is disjointed and lacks transition of thoughts.	- The structure of the paper is not easy to follow. - The transitions need improvement. - The conclusion is missing, or if provided, does not flow from the body of the paper.	-The structure is mostly clear and easy to follow. -The transitions are present. -The conclusion is logical.	-The structure of the paper is clear and easy to follow. -The transitions are logical and maintain the flow of thought throughout the paper. -The conclusion is logical and flows from the body of the paper.
Grammar, Punctuation & Spelling	-The paper contains numerous grammatical, punctuation, and spelling errors.	-The paper contains few grammatical, punctuation and spelling errors.	-The rules of grammar, usage, and punctuation are followed with minor errors. Spelling is correct.	-The rules of grammar, usage, and punctuation are followed; spelling is correct.

Assessment

A. Choose the letter of the best answer.

1. A transverse wave travels to the left through a medium. The individual particles in the medium move:
   a. to the right
   b. to the left
   c. up/down
   d. the particles in the medium do not move

2. Considering the given figure below, determine the amplitude.



   a. 0.1 mm
   b. -0.1 mm
   c. 1 m
   d. 2 m

3. Find the wavelength in the given figure on number 2.
   a. 2 m
   b. 1 m
   c. 0.1 mm
   d. -0.1 mm

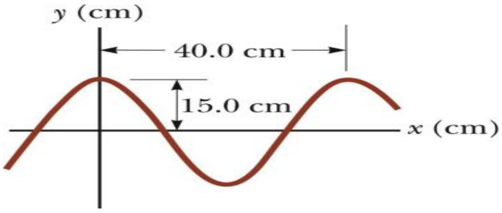
4. How is the wave period related to frequency?
   a. Direct proportional
   b. Inversely proportional
   c. Not related
   d. Correlated

5. Which of the following refers to a motion that is regular and repeating?
   a. Vibration
   b. Oscillation
   c. Periodic
   d. Transverse

B. A transverse wave on a taut string is modeled with the wave function
$y(x, t) = A\sin(kx - \omega t)$
$= (0.25\text{m})\sin(6.48\text{m}^{-1}\, x - 1.47\text{s}^{-1}\, t)$
Find the: (a) amplitude, (b) wavelength, (c) period, (d) direction of propagation and (e) speed of the wave.

Additional Activities

1. A sinusoidal wave traveling in the positive x direction has an amplitude of 15.0 cm, a wavelength of 40.0 cm, and a frequency of 8.00 Hz. The vertical position of an element of the medium at t=0 and x=0 is also 15.0 cm.
   a) Find the wave number k, period T, angular frequency ω, and speed v of the wave.
   b) Write a general expression for the wave function.



2. Given the wave equation y(x, t) = 2.0 Sin(3.0x – 4.0t + $\frac{\pi}{2}$)m, where x is in meter and t is in second. Find the:
   a. Amplitude
   b. Frequency
   c. Wavelength
   d. Speed
   e. Initial height at x=1.0m

RUBRICS FOR PROBLEM SOLVING					
Criteria & Rating	**5**	**4**	**3**	**2**	**1**
Strategic Approach (S)	The approach chosen is clearly shown, clearly written & all elements are valid.	Valid approach with minor errors that don't disrupt understanding	Valid approach with multiple errors that impede understanding	Invalid approach that demonstrates little understanding of the problem.	There is little or no understanding of how to approach the problem.
Physics Concepts (P)	Appropriate concepts that are fully understood (symmetries, conserved quantities, etc.), clearly	Appropriate concepts that are mostly understood but employed with errors	Appropriate concepts identified, but not employed or understood	At least one concept identified but unable to demonstrate understanding	Little or no understanding of physics concepts

	stated & employed correctly				
Mathematical Concepts (M)	Correct starting equations; All mathematical steps are clearly shown and they flow easily toward the correct answer	Correct starting equations. All mathematical steps are clearly shown but minor errors yield wrong answer. OR Correct starting equations with correct final result but the mathematical steps are hard to follow	Correct starting equations. The mathematical steps are hard to follow and errors begin to impede application	Can identify at least one equation, but unable to apply them	Incorrect equations; demonstrates little or no understanding of mathematical concepts involved
Answer (A)	100% correct answer – analytically (IA) numerically (IA) & conceptually (IA)	Correct answer analytically (IA), but not numerically (IA)	Incorrect answer, but on the right path	Unable to reach a correct answer on this path	No answer

Answer Key

What I Know:

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

What's More:

1. a. 7.20×10^{-3}m
   b. 0.3m
   c. 25 Hz
   d. 7.5 m/s
   e. 0.04s
   f. $\frac{2\pi}{0.3\,m}$
   g. Positive x direction
2. a. 1 m
   b. 0.17 Hz
   c. $\frac{\pi}{3s}$
   d. 5.9 s
   e. 0.17 m/s

Assessment:

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

B.
a. 0.25m
b. 0.97m
c. 4.3 s
d. 0.23 m/s

Additional Activities:

A.
k=15.7 rad/m

T=0.125s

ω=50.3 rad/s

v=3.2 m/s

B. .
y(x, t) =0.150Cos(15.7x-50.3t)

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