RATU NAVULA COLLEGE
Y12 PHYSICS SUPPLEMENTARY NOTES 4

LESSON 72-73 Experiment 8: Critical angles

S/S 4.2 WAVES

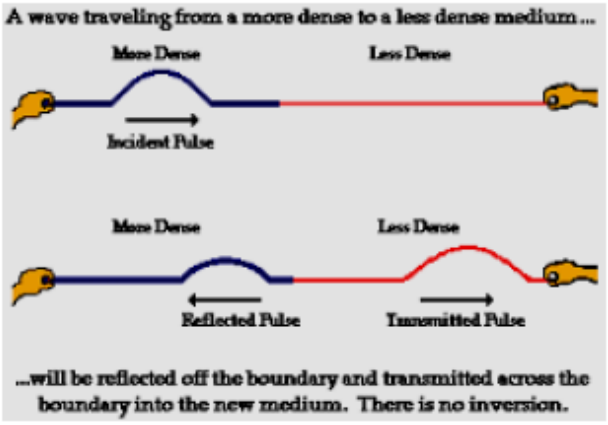
LESSON 74 LO: explain wave phenomena and solve related problems.

Wave is a disturbance, which can transfer energy without the particles of the wave having to move from one place to another.

REFLECTIONS AND TRANSMISSION OF WAVES:

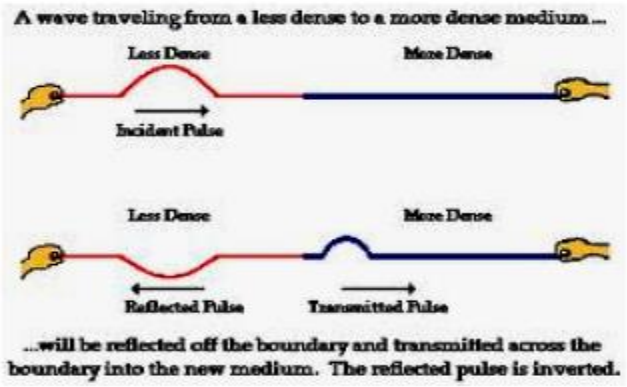
(a) Heavy to Light String:

A pulse (or wave) on a heavy string moves towards a lighter string. The pulse moves slower along the heavy string and faster along the lighter string. Small reflected pulse the same way up as the original pulse moves back along the heavy string.



(b) Light to Heavy String:

A pulse on a light string moves towards a heavy string. A small reflected pulse upside down original pulse moves back along the light string.

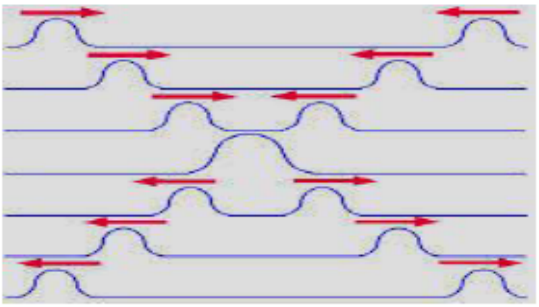


Amplitude of the reflected and transmitted waves are less, showing loss of energy. The pulse in the lighter string is further from the boundary, as they are travelling faster.

(c) Velocity of wave on a string does not depend on the **amplitude** of the waves. It depends on the tension in the string.
Similarly the velocity of light does not depend on the intensity of the light and intensity is related to amplitude in waves.

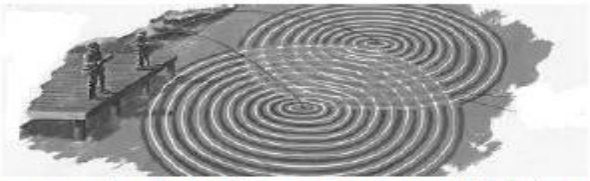
(d) Superposition:

Superposition is the ability of waves to add their displacements and their energy at each position with respect to time.
Constructive superposition refers to two waves of same amplitude meet then we get a resultant displacement of twice the amplitude where waves overlap.



4.2.11 INTERFERENCE

Interference pattern happens when two waves of equal amplitude and velocity moving in opposite direction overlap each other.



When crest from one wave meets a trough from another wave, this is known as destructive interference.

Constructive Interference:

Constructive interference happens when crest from one wave meet a crest from another wa or trough meets a trough.

As the trough and crest move away from the source, the continuous series of points appear, forming undisturbed lines of points appear, forming undisturbed lines of water. These lines a called nodal lines. Antinodes line form from when a crest meets a crest or trough meets a tro from two waves form.

When two or more waves overlap, the resultant displacement at a point is equal to the sum of the individual displacements at that point. This is the principle of **superposition**.

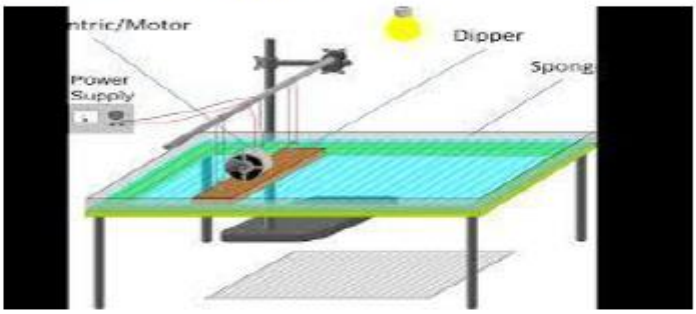
Displacement is a vector quantity, so the sign is important.
At the point of overlap:

- if both waves have the same sign displacement (i.e. both positive or both negative) **constructive interference** (**reinforcement**) will occur.
- At the point of overlap, if one wave has a positive displacement and the other has a negative displacement, **destructive interference** (**cancellation**) will occur.

Lesson 75 LO: Explain Interference using Ripple Tank Generator

RIPPLE TANK GENERATOR

In laboratory, a ripple tank is used to study waves.



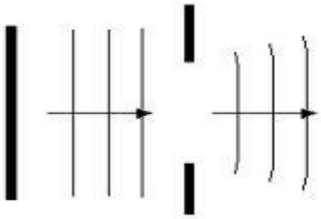
http://spmphysics.onlinetuition.com.my/2013/07/phenomena-of-waves.html

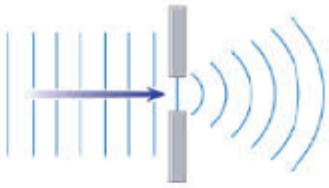
Experiments done in the ripple tank show that water waves behave like light waves.

DIFFRACTION:

Diffraction is the bending of a wave as it either passes through a barrier or passes through an opening.
When waves are diffracted, the frequency, wavelength and speed never change. Since the wavelength stays at one length, its length determines how much diffraction occurs. The longer the wavelength, the more diffraction occurs, and the shorter the wavelength, the less diffraction occurs. When the waves go through a smaller opening, the more diffraction or spreading out of the waves occurs. A larger opening leads to less diffraction.

When water waves passes through a narrow gap is equal or less than the wavelength of the incident wave. If the width of the gap is greater than the wavelength of the incident waves, the effect of the diffraction will be very small.





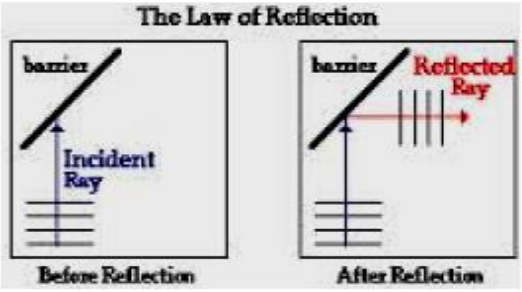
LESSON 76 LO: Explain Wave Phenomena of Reflection

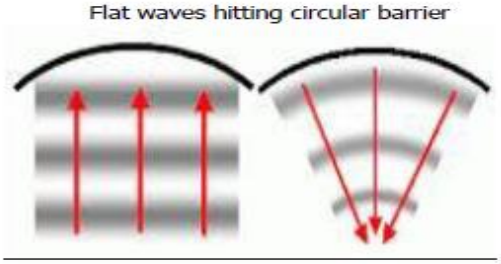
TWO DIMENSIONAL WAVES
REFLECTION OF WATER WAVES

1. Straight waves are moving towards a straight barrier.
2. Straight waves move at an angle to the barrier.
3. Straight waves are moving towards a concave barrier.
4. Straight waves are moving towards a convex barrier.
5. Circular waves are moving towards straight barrier.
6. Circular wave moving towards a concave barrier.
7. Circular wave moving towards convex barrier.

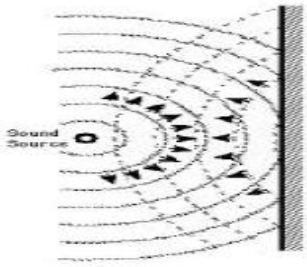
4.2.12 REFLECTIONS

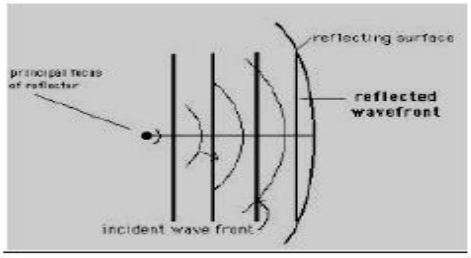
Waves are reflected off barriers, obeying the same laws of reflection as light. Note that the angle of incidence equals the angle of reflection.





Circular waves hitting flat and circular barriers





When water waves pass between deep to shallow region:

-they <u>obey law of refraction</u>.

-the velocity decreases. **($V_d > V_s$)**

-the wavelength decreases. **($\lambda_d > \lambda_s$)**

-frequency remains constant.

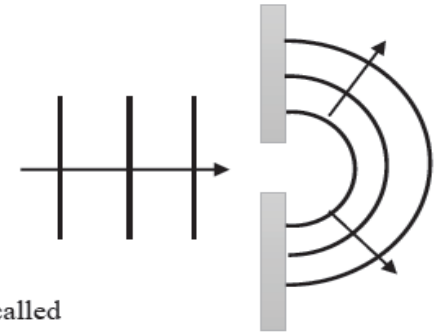
Waves obey Snells Law:

$$\frac{v_1}{v_2} = \frac{\sin\theta_1}{\sin\theta_2} = \frac{n_2}{n_1} = \frac{\lambda_1}{\lambda_2}$$

ACTIVITY ON WAVE PHENOMENA and PULSE

2019

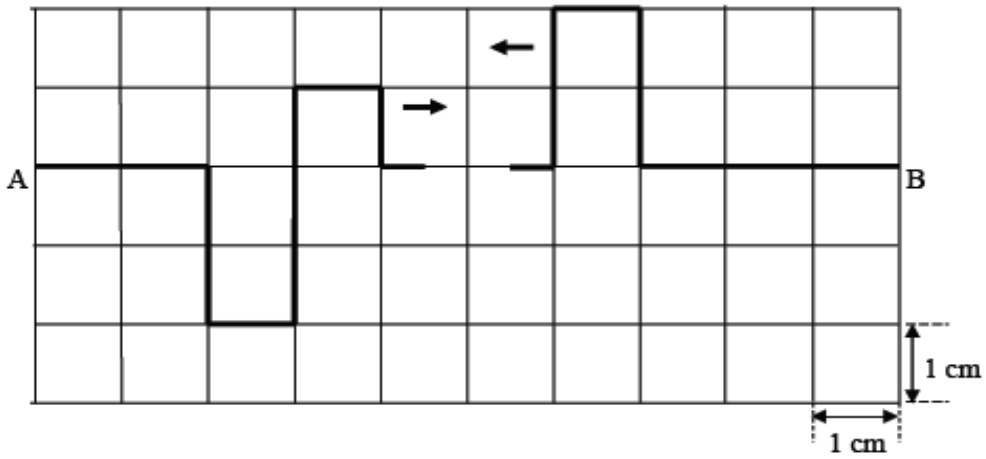
The diagram shows a wave passing through the gap in a barrier. The pattern produced by the wave after passing through the barrier as shown below.



This property of waves is called

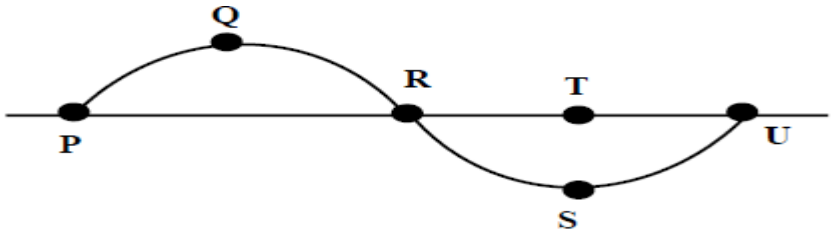
A. diffusion.
B. dispersion.
C. refraction.
D. diffraction.

Two wave pulses are traveling towards each other at 1 cms^{-1} as shown below.



Draw the shape of the resultant wave after 2 seconds.

2017



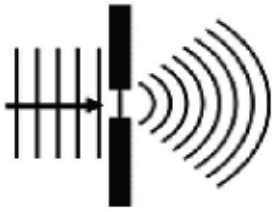
The **amplitude** of the wave can be measured between the points

A. **S** and **T**.
B. **P** and **U**.
C. **R** and **U**.
D. **Q** and **S**.

2016

The diagram shows straight wave fronts passing through an opening in a barrier. This wave phenomenon is known as

A. reflection.
B. refraction.
C. diffraction.
D. interference.



2015

Light bends around objects as a result of

A. interference.
B. diffraction.
C. dispersion.
D. reflection.

When waves meet in phase, they will form

A. nodes.
B. antinodes.
C. more waves.
D. smaller waves.

2014

A group of students standing about 100 m from their school building, clapped a pair of wooden boards and heard an 'echo'. An '**echo**' is an example of

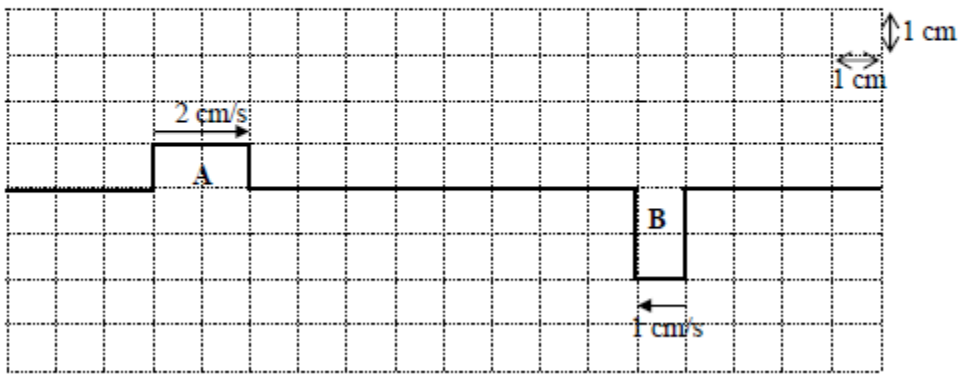
A. refraction of sound waves.
B. reflection of sound waves.
C. diffraction of sound waves.
D. interference of sound waves.

On hot sunny days, the blurred shimmering effect over a tar sealed roads stretching into the distance, which appears like a pool of water, is called **mirage**.

Which physics principle/concept is used to explain formation of mirage?

_____

The figure below shows two waves **A** and **B** travelling along a string towards each other.



(grid not drawn to scale)

(i) What is the amplitude of wave **B**?

(ii) On the diagram in the **Answer Book**, sketch the resultant wave pattern after 3 seconds.

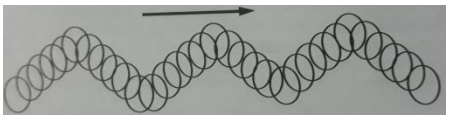
2013

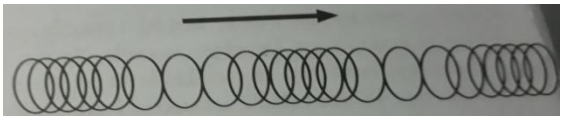
During a school assembly, while walking in front of a pair of loudspeakers, faint and loud sounds were heard. The most probable cause of this is

A. an echo.
B. diffraction.
C. interference.
D. superposition.

1. Fig. A and B shows two different types of waves travelling along a 'slinky'.

A B



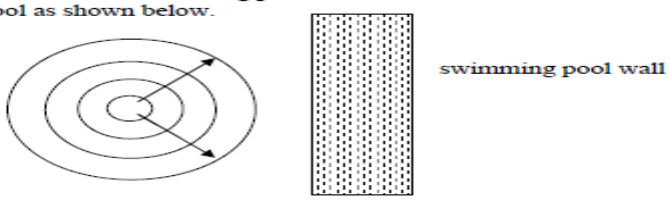


Which choice best describes the wave motion?

	A	**B**
A	mechanical	Electromagnetic
B	Electromagnetic	Mechanical
C	Longitudinal	Transverse
D	transverse	longitudinal

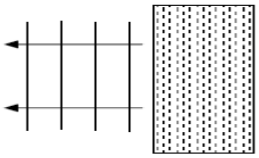
2012

Kiran throws a small stone into a swimming pool and watched the waves reflect off the straight wall of the pool as shown below.

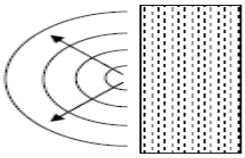


The waves reflected off the swimming pool wall that she sees will **most likely** be

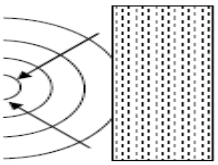
A.



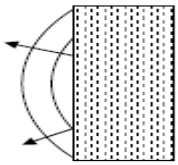
B.



C.

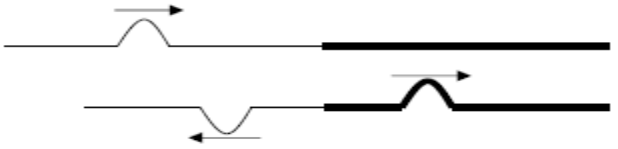


D.

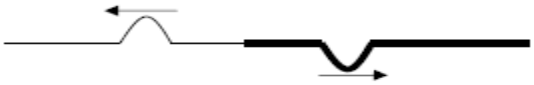


Which of the following diagrams best represents transmission and reflection of a pulse travelling from a thin string into a thick string?

A.

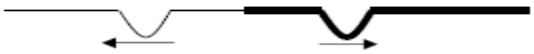


B.



C.

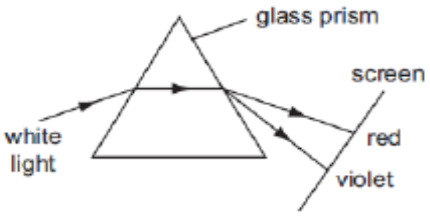
D.



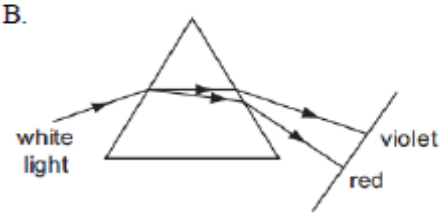
2010

Which of the following diagrams correctly shows the dispersion of white light by a glass prism?

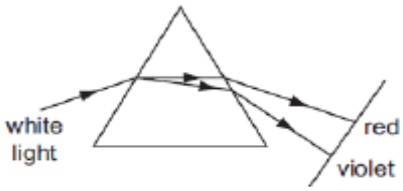
A.



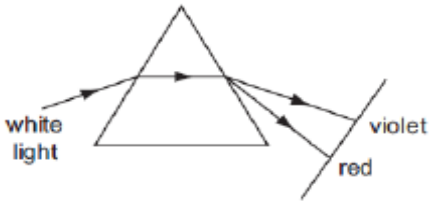
B.



C.

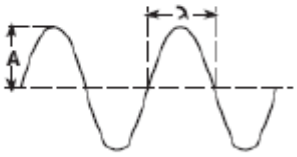


D.

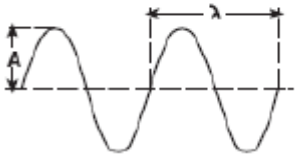


Which of the following wave diagrams has both wavelength (λ) and amplitude (A) labelled correctly?

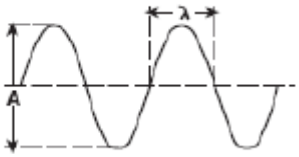
A.



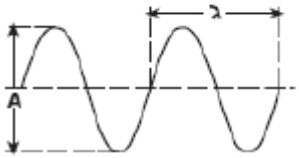
B.



C.



D.

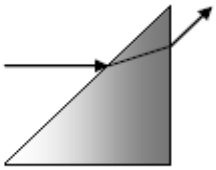


2009

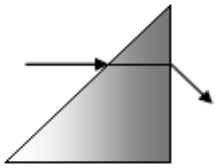
Which of the following does not change when light passes from air to water? (Speed/ frequency/ wavelength/ angle of incidence)

Which one of the diagrams below **best** shows the correct path of a ray of light travelling through a glass prism ?

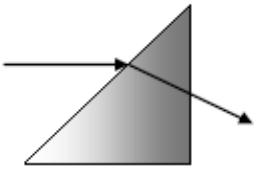
A.



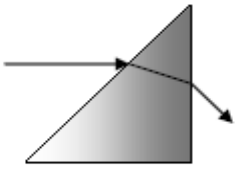
B.



C.



D.

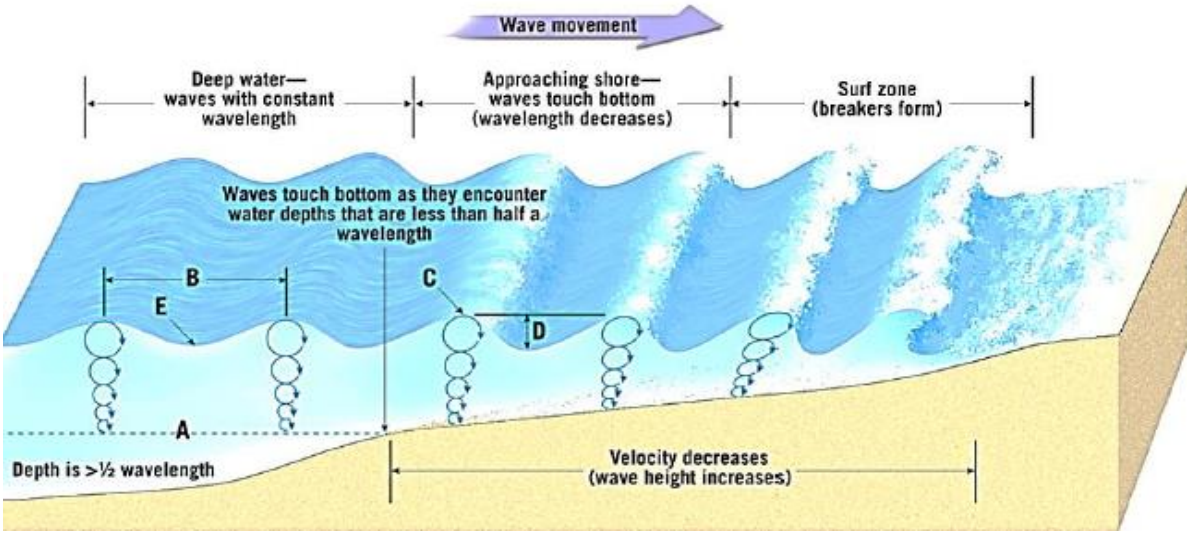


2007

When light travels through triangular prism, blue light bends more than red light. This is an example of property of _____. (diffusion/dispersion/diffraction/interefernce)

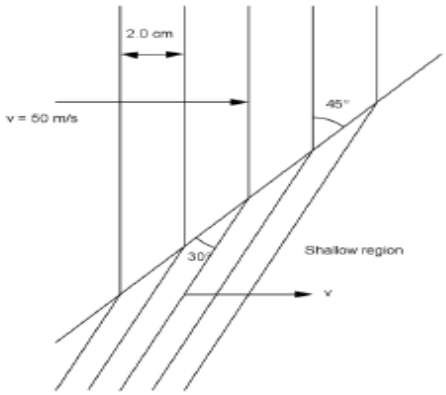
LESSON 77 LO: REFRACTION IN WATER WAVES

Features of deep-water and shallow-water waves.



Example:

Water waves travelling at 5.0 cm/s and with a wavelength of 2.0cm are incident from deep water to shallow water as shown in the diagram.



A). Determine the relative refractive index.

$$n_{12} = \frac{\sin\theta_1}{\sin\theta_2}$$

$$= \frac{\sin 45}{\sin 30}$$

$$= 1.41\text{cm}$$

b). Determine the speed of the waves in the shallow water.

$$\frac{\sin\theta_1}{\sin\theta_2}=\frac{v_1}{v_2}$$

$$\frac{\sin 45}{\sin 30}=\frac{5}{v_2}$$

$$\therefore$$

$$v_2=\frac{5.0\sin 30}{\sin 45}$$

$$v_2=3.54\text{cm/s}$$

c). Determine the frequency of the wave. (in water, the frequency of the wave always be constant. It will have same frequency in deep and shallow region).

Velocity = frequency x wavelength

5 = frequency x 2

$\text{Frequency} = \frac{5}{2}$

f = 2.5Hz

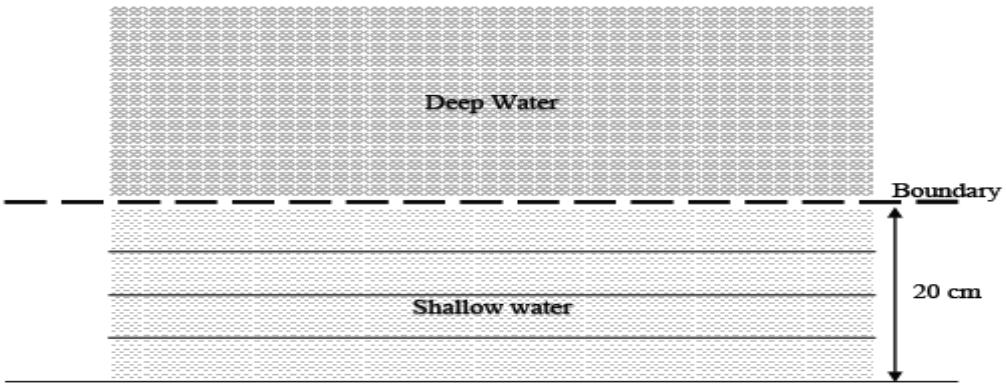
Partial Reflection and Refraction:

When waves travel from deep region to shallow region at the boundary, partial reflection and refraction happens to the incident rays.

Activity

2019

Water waves of frequency 10 Hz approach at right angles to a boundary between shallow and deep water as shown in the diagram below.

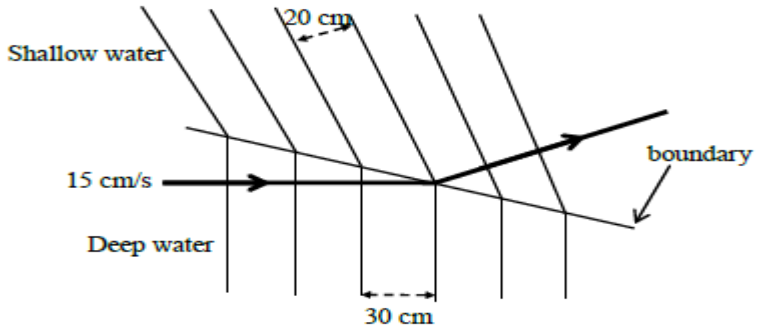


(i) **Calculate the wavelength of the waves in shallow water.** **(1 mark)**

(ii) **The wave now passes into deeper water where its speed is 60 cms^{-1}. Calculate wavelength of the waves in deep water.** **(1 mark)**

2015

Wave-fronts are seen to cross a boundary from deep to shallow water as shown below. The arrow shows the direction of the waves as they move from deep water to shallow water.



Use the information in the diagram above to answer the questions that follow.

(i) Calculate the frequency of the waves in deep water.

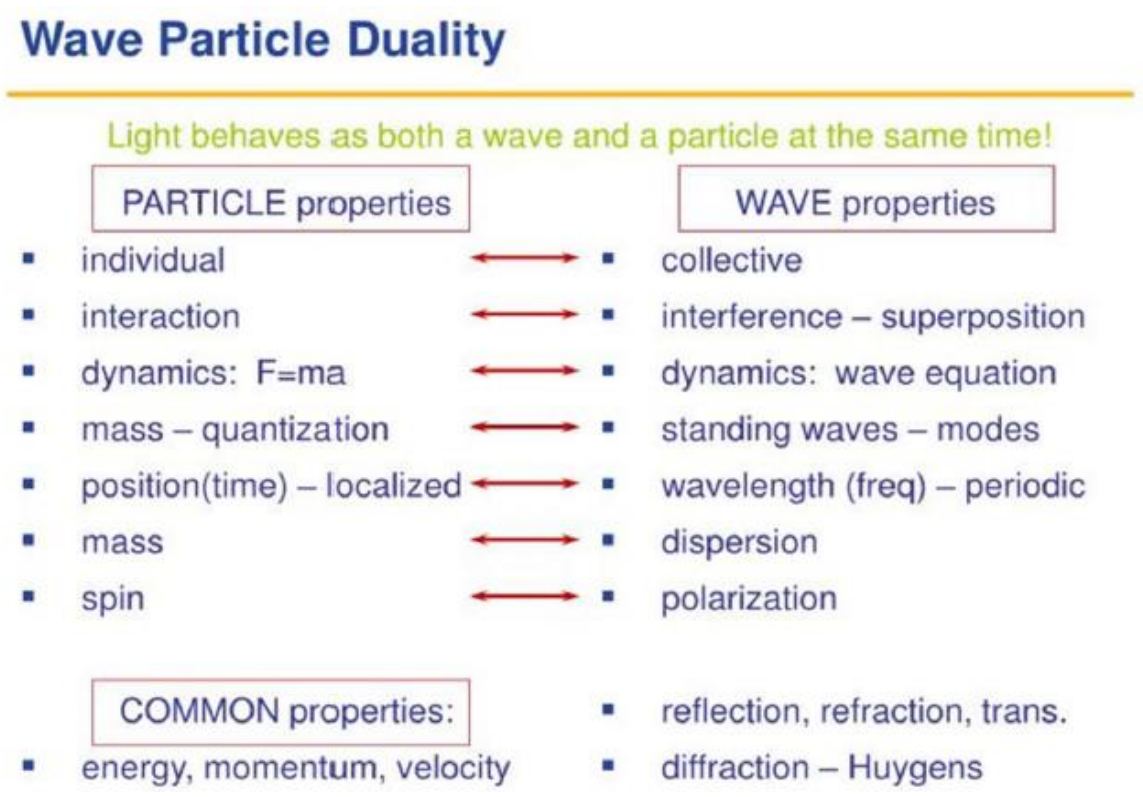
(ii) Find the velocity of the waves in shallow water.

LESSON 78 LO: study light as wave phenomena.

Wave Model of Light

-describes light as consisting of waves with a **very small wavelength** and travelling in straight lines forms source with a **very large speed**.

Can explain:	Cannot explain
• **Laws of reflection, partial refraction and reflection** • **Laws of refraction** • **Diffraction** • **Dispersion** • **Interference** • **Polarization** • **Speed of light decreases when travelling from less dense to high dense medium.**	- **Photo-electric effect.** - **gravitational effect of light passing close to a larger mass.** - **Pressure of light.** - **Crompton Effect**-collision between electrons or protons.



We can conclude that **Light appears to be Dualistic in nature.** (it is both particle and a wave)

Dual nature of light means that light holds the properties of both wave and particle. Sometimes light behaves like a particle (called a photon) and sometimes it behaves like a wave.

Sample 2020

Identify **a** phenomenon that supports:

(i) particle nature of light.

(ii) wave nature of light.

2019

Explain the term dual nature of light.

2017

State the wave model of light.

2010

The **dual nature of light** means that light

A. is both a particle and a wave.
B. can be reflected and refracted.
C. has both a frequency and a wavelength.
D. is both a transverse and a longitudinal wave.

2012

Fill in the blanks by choosing the most appropriate word given in the brackets.

The wave model of light describes light as consisting of waves with a very small _____1_____ (frequency/wavelength) and travelling in a straight line with a very large _____2_____. (speed/wavelength)