Important physical and mathematical bases

1 Conversions of some units

1	mm = 10^{-3} m	7	g = 10^{-3} kg
2	mm^2 = 10^{-6} m^2		
3	mm^3 = 10^{-9} m^3	8	Angstrom = 10^{-10} m
4	cm = 10^{-2} m		
5	cm^2 = 10^{-4} m^2	9	Liter = 10^{-3} m^3
6	cm^3 = 10^{-6} m^3		

****

2 Complications and fractures

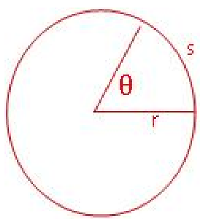
SI Prefixes	Abbreviation	Multiple (10^{n})
Femto	f	10^{-15}
Pico	P	10^{-12}
Angstrom	A	10^{-10}
Nano	n	10^{-9}
Micro	µ	10^{-6}
Milli	m	10^{-3}
Centi	c	10^{-2}
Deci	d	10^{-1}
Kilo	k	10^{3}
Mega	M	10^{6}
Giga	G	10^{9}
Tera	T	10^{12}

****

3 Trigonometry

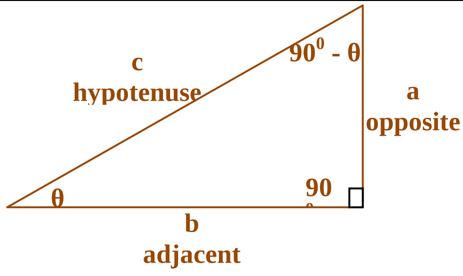
a Ring Measurement

The arc length (S) is proportional to radius (r) when (θ) is constant where :



$$- = \frac{s}{r} \quad \Leftrightarrow \quad - = sr$$

b Trigonometric functions

	$\sin\theta = \frac{a}{c}$	$\cos\theta = \frac{b}{c}$	$\tan\theta = \frac{\sin}{\cos} = \frac{a}{b}$
	$\sin\theta = \cos(90^0 - 0)$	$\cos\theta = \sin(90^0 - 0)$	$\cot\theta = \tan(90^0 - 0)$
	$\sin(-\theta) = -\sin\theta$	$\cos(-\theta) = -\cos\theta$	$\tan(-\theta) = -\tan\theta$
	$\sin^2\theta + \cos^2\theta = 1$		

****

3 Circumferences, areas and volumes of some geometric shapes

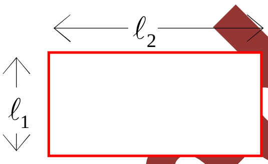
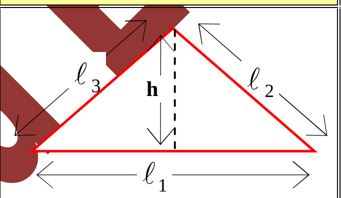
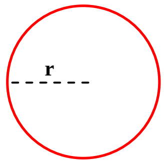
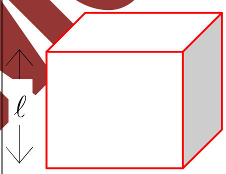
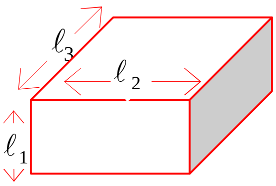
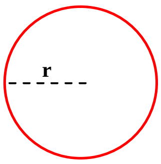
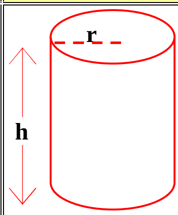
Figure	Square	Rectangle	Triangle	Circle
Geometrical shape				
Circumference (C)	4ℓ	$2(\ell_1 + \ell_2)$	$\ell_1 + \ell_2 + \ell_3$	2®r
Area (A)	ℓ^2	$\ell_1 \times \ell_2$	$\frac{1}{2}\ell_1 \times h$	®r^2

Figure	Cube	Cuboid	Sphere	Cylinder
Geometrical shape				
Area (A)	$6\ell^2$	$2(\ell_1\ell_2 + \ell_2\ell_3 + \ell_1\ell_3)$	4®r^2	®rh
Volume (V_{ol})	ℓ^3	$\ell_1 \times \ell_2 \times \ell_3$	$\frac{4}{3}$®r^3	®$r^2 \times h$

****

4 Graphical relations between (two variables)

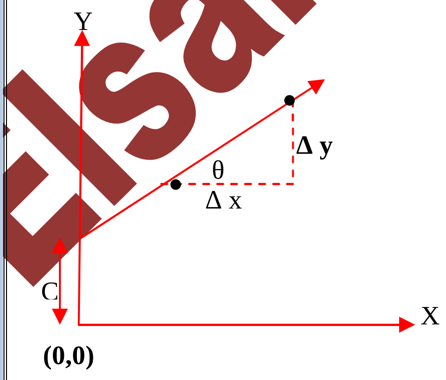
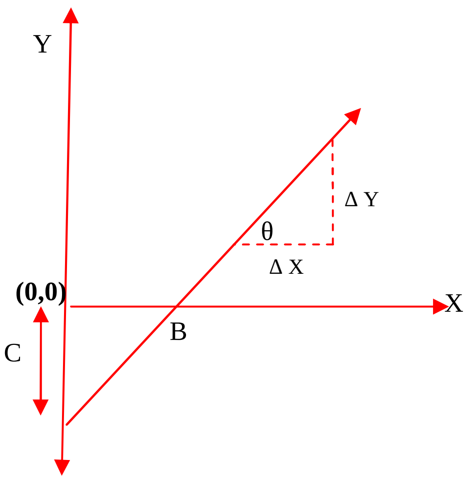
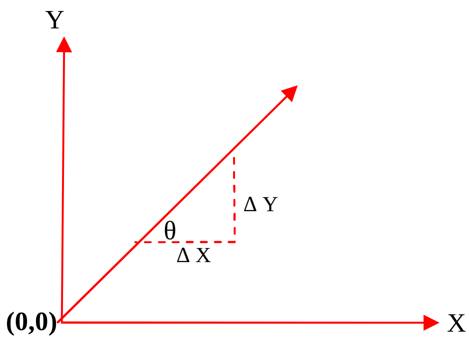
The proportional relation between two quantities on (X) and (Y) axes is :

a- Directly relation

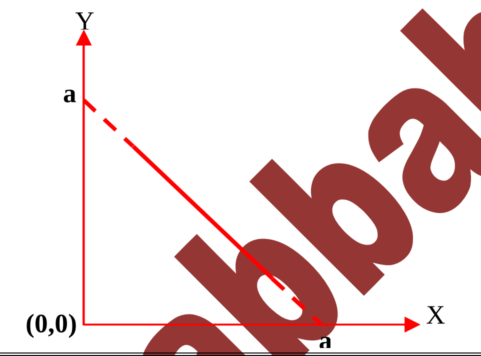
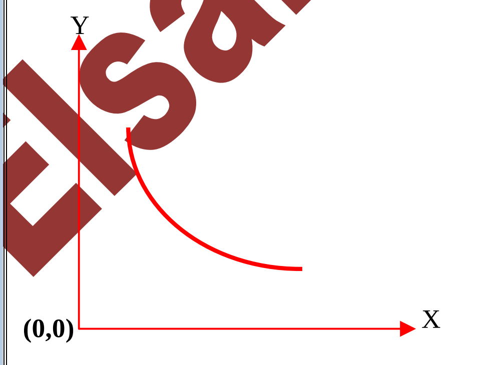
b- Inversely relation

c- Sine wave relation

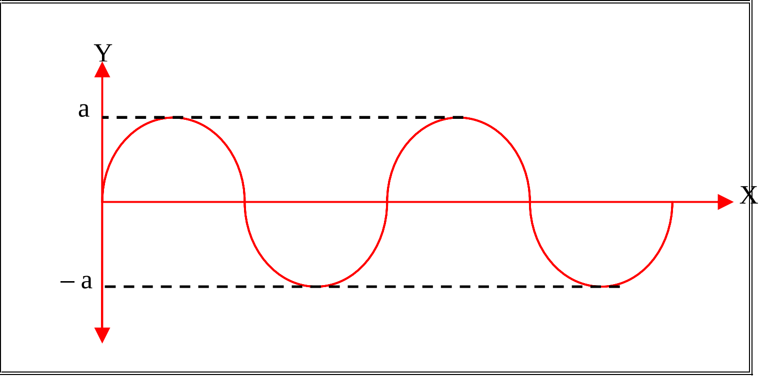
a Directly relation cases

Case	Graph
The general equation for straight line is y = m x + c **where :** • y : the variable represented on y-axis • x : the variable represented on x-axis • c : the intersected length from positive y-axis • m : slope of straight line . $m = \tan^{-} = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$ • θ : is the angle between straight line and x-axis	
The same : The equation for straight line is y = m x – c **but :** • c : is the intersected length from negative y-axis • m : is the slope of straight line . $m = \tan^{-} = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$ **note :** at point B : ⇨ y = zero so 0 = m x – c ⇨ $m = \frac{c}{x}$ ⇨ m x = c	
y = m x • At x = zero ⇨ y = zero • The straight line passes by the original point (0 , 0) • $slope = \tan^{-} = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$	

b Inversely relation cases

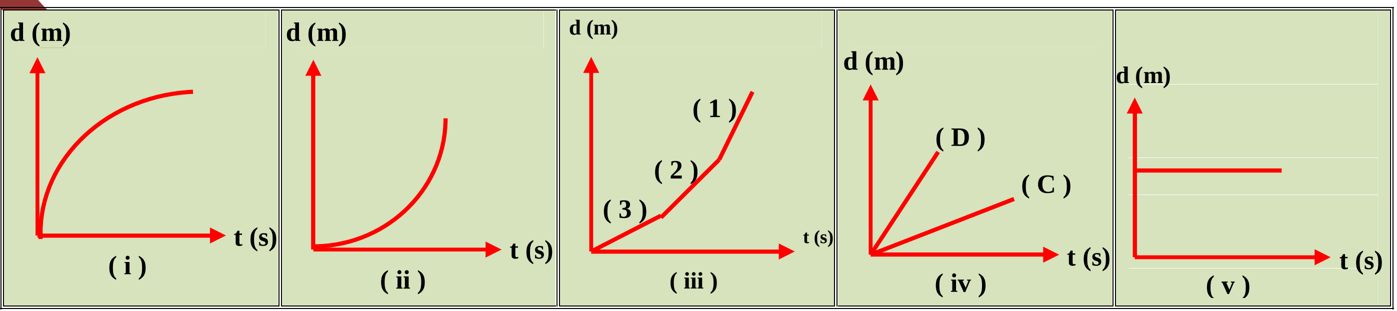
Case	Graph
$y = m - x$ The sum of the two quantities x , y at any point = constant value (m) • At x = zero ⇨ y = constant value (a) • At y = zero ⇨ x = constant value (a)	
$y = \frac{m}{x}$ The product of two quantities x , y at any point equal constant value (m)	

c Sine wave relation

Case	Graph
$y = a \sin x$ The value of (y) ranges from (a , – a) regularly .	

Think and answer

Study there relationships ?



Chapter : one

Wave motion

Waves — Unit one

◈there are two types of motion :

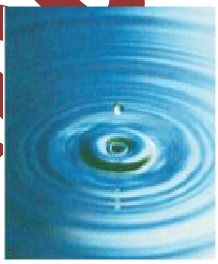
❶ Translation motion : it is motion that has starting point and end point.

❷ Periodic motion : it is the motion that repeats itself regularly in equal intervals time

◈periodic motion can be classified into:

• Wave motion . • Oscillatory motion.

Water wave



- The collision of the stone with water is a source of disturbance.
- This disturbance propagates on the surface of water in the form of uniform concentric circles, whose center is the position at which the stone falls.
- These circles transfer energy in the same direction of their propagation.
- These circles are called **water wave** and its propagation represents **wave motion.**

Wave

" it is the disturbance that propagates and transfer the energy in the direction of its propagation"

Give reason

► **the wave is disturbance that propagates and transfer the energy in the direction of its propagation.**

Because if the source was vibrated by specified way , the particles of surrounded medium will be vibrated by the same way. so the vibration transfer from the vibrating source to particles of touched medium which is forwarded and so on the disturbance is transferred as wave motion.

Types of waves

Waves can be classified into:

waves

1 **Mechanical waves**

2 **Electromagnetic waves**

First : Mechanical Waves

Source	Vibrating source that transmits the disturbance .
Propagation medium	They propagate through materialistic media only (solid – liquid – gas)
Definition	It is a disturbance that propagates in materialistic media.
Examples	Water waves , sound waves and vibrating string .
Conditions	❶ medium to transmit disturbance through it. ❷ source of vibration. ❸ disturbance that transfer from the source to the medium .

Conditions of Mechanical Waves

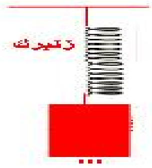
1 Medium to transmit disturbance through it

◈ The mechanical waves need a materialistic medium to travel through because the medium particles vibrate to transfer the wave mechanical energy, thus :

❶ we can't hear the voice of cosmic explosions that occur in the space.
❷ The astronauts used wireless devices to communicate with each other in space.

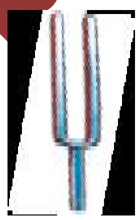
2 Source of vibration

Some forms of the vibrating sources :

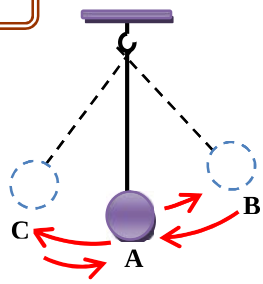

Plumb attached to a vibrating spring (yoyo)


Vibrating string


Simple pendulum (clock pendulum)


Vibrating tuning fork

3 Disturbance that transfer from the source to the medium



When the source vibrates, it produce disturbance.

◈ Simple pendulum as a source of vibration:

- It is static at point A (rest position)
- When it is pushed, it moves right and left around its rest position in equal intervals of time.
- This motion is called oscillatory motion.

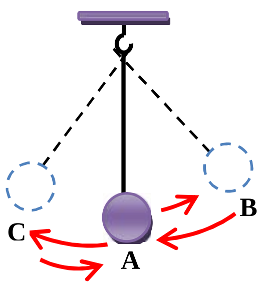
Oscillatory motion

" it is the object's motion at the two sides of its original position (rest position) and represented and repeated in equal intervals of time."

Concepts related to oscillatory motion

❶ **Complete oscillation**
❷ **Displacement**
❸ **Amplitude**
❹ **Frequency**
❺ **Periodic time**

1 Complete oscillation



when the pendulum moves from **A** to **B** then to **C** and returns back to **A**

(**A** ⟶ **B** ⟶ **A** ⟶ **C** ⟶ **A**) , it has passed by A two successive times in the same direction (in the same phase) . so, it make complete oscillation.

Phase

The position and the direction of the medium particles at a certain instant.

Complete oscillation

It is the motion of the oscillating body when it passes one point along the path of its motion twice successively in the same direction

2 Amplitude

- when the pendulum moves away from its rest position, it makes a displacement (d) is a vector quantity and measured in meter (m)
- The maximum displacement made by the pendulum (the distance **AB** or **AC**) is called amplitude.
- The amplitude represents quarter of a complete oscillation.
- the amplitude is a measurable quantity and measure in meter (m).

Displacement (d)

" it is the distance of the vibrating of the vibrating body at any instant from its rest position or its equilibrium origin"

Amplitude (A)

" it is the maximum displacement of the vibrating body away from its original position."

Or

It is the distance between two points along the path of the vibrating object, where the velocity at one point is maximum and zero at the other.

No	What is meant by?	That means that
1	**The amplitude of a vibrating body = 20 cm**	The maximum displacement of the vibrating body away from its original position = 20 cm
2	**The distance between two points along the path of vibrating object where the velocity at them = 10 cm**	The amplitude = 5 cm

Notes

❶ Complete oscillation = 4 × amplitude = 4 displacement .

❷ The total displacement that made by object during complete oscillation = zero .

	Frequency (υ)	Periodic time (T)
Definition	It is the number of complete oscillation made by a vibrating body in one second.	It is the number taken by a vibrating body to make one complete oscillation. **Or** It is the time taken by the vibrating body to pass by the same point along the path of its motion two successive times in the same direction.
The relation	$3 = \frac{n(number\ \ of\ \ oscillatio\ ns)}{t(Time)}$	$T = \frac{t(Time)}{n(number\ \ of\ \ oscillatio\ ns)}$ T = 4 × Time of amplitude
Measurement unit	Hertz (Hz) kHz – MHz – GHz ***equivalent to*** oscillation/sec **or** cycle/sec **or** second^{-1}	Second (s – ms – µs)

No	What is meant by?	That means that
1	**The frequency of a tuning fork = 50 Hz**	The fork makes 50 complete oscillations (vibrations) in one second.
2	**The periodic time of a vibration body = 2 s**	The vibrating body takes 2s to make one complete oscillation. Or this oscillating body = $\frac{1}{2}$ Hz
3	**Vibrating body made 300 complete oscillation in two minutes.**	The frequency of vibrating body = 2.5 Hz

No	When the ?	Solution
1	**Kinetic energy for a vibrating pendulum = 0**	At the maximum displacement for it.
2	**Periodic time of a vibrating body = 0.02s**	If the frequency is equal 50 Hz.
3	**Amplitude of a vibrating body = 0**	Before the beginning of vibration directly.
4	**vibrating body had complete vibration.**	During the period between the path of it with one point in two successive times in the same direction.

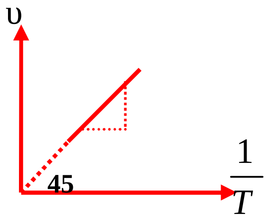
The relation between the frequency (υ) and the periodic time (T)

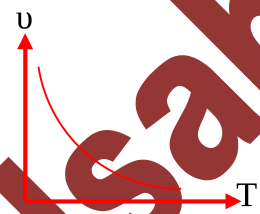
$\because \nu = \dfrac{n(\text{number of oscillations})}{t(\text{Time})}$, $\because T = \dfrac{t(\text{Time})}{n(\text{number of oscillations})}$

$$\therefore \nu = \frac{1}{T}$$

i.e. Frequency = Reciprocal of the periodic time.

So, the frequency is inversely proportional to the periodic time.





Slope = υ × T = 1

No	Give reason	Because
1	When the frequency increased, the periodic time decreased .	The Frequency is Reciprocal of the periodic time
2	When the periodic time to half, the frequency increased to double.	frequency is inversely proportional to the periodic time.
3	We can measure frequency by unit of s^{-1}	The Frequency is Reciprocal of the periodic time $\nu = \frac{1}{T}$ and the unit of periodic time is sec so the unit of Frequency is s^{-1}

What happen when ….?

► **The frequency of an oscillating motion is doubled relative to its periodic time.**

The periodic time will be halved because $\nu = \frac{1}{T}$

Solved examples

1) A string vibrates to make maximum displacement at period 0.002 s , calculate the frequency of this string.

answer

T = 4 × Time of amplitude

T = 4 × 0.002 = 0.008 s ⇨ $\nu = \frac{1}{T} = \frac{1}{0.008} = 125 HZ$

****

2)A tuning fork makes 1200 complete oscillations on 3 s, calculate the frequency of this tuning fork and it's periodical time.

answer

$$\upsilon = \frac{n(number\ of\ oscillations)}{t(Time)} = \frac{1200}{3} = 400HZ$$

$$T = \frac{t(Time)}{n(number\ of\ oscillations)} = \frac{3}{1200} = 0.025S$$

****

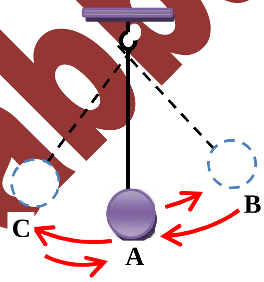
3)In the opposite figure : if the time taken by pendulum to move from A to C is 0.8 s, calculate :

(a) The periodic time.

(b) The frequency.

(c) The number of complete oscillation through 16 s.

(d) The time required to make 50 oscillation.



answer

$$T = \frac{t}{n} = \frac{0.8}{0.5} = 1.6s$$

$$3 = \frac{1}{T} = \frac{1}{1.6} = 0.625Hz$$

$$n = \frac{t}{T} = \frac{16}{1.6} = 10 \quad oscillations$$

$$t = nT = 50 \times 1.6 = 80s$$

****

4)A vibrating body makes $\frac{1}{4}$ complete oscillation in $\frac{1}{80}$ of sec, calculate

❶ periodic time. ❷ frequency.

answer

❶ ∵ T = 4 × Time of amplitude ⇨ y $T = 4 \times \frac{1}{80} = \frac{1}{20} = 0.05$ s

❷ $\neg = \frac{1}{T} = \frac{1}{0.05} = 20Hz$

****

5)A simple pendulum makes 1200 oscillation in one minute and at every complete oscillation it cut 20 cm a distance calculate

❶ amplitude. ❷ frequency. ❸ periodic time.

answer

❶ ∵ $A = \frac{1}{4}$ × complete oscillation ⇨ y $A = \frac{1}{4} \times 20 = 5$ cm

❷ $\neg Z \frac{n}{t} Z \frac{1200}{60} Z$ **20Hz** ,

❸ $T Z \frac{1}{3} Z \frac{1}{20} Z$ **0.05s**

Experience to illustrate simple harmonic motion

- The simple oscillatory motion (such as the motion of simple pendulum or spring coil) is called simple harmonic motion, which can be represented by a lateral curves as follows :

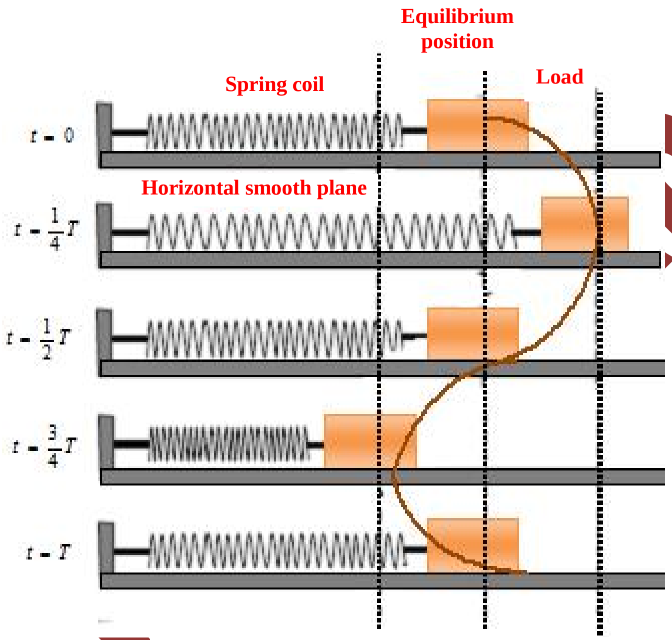
(a) Put a load on horizontal smooth plane and fix one end of spring coil to a side of the load and the other end to the wall.

(b) At pulling the load the spring elongates.

(c) When we leave the load it returns to the equilibrium position.

(d) Then it compresses.

(e) Finally it returns to the equilibrium position.



Sine wave for simple harmonic motion

Think and answer

1- Draw a lateral curve illustrate the relation between a way of body center weigh balance and time?
2- If the time of an amplitude is (t) so the time to arrive to center of it ……………

****

Types of mechanical waves

❶ **Transverse waves .** ❷ **Longitudinal waves.**

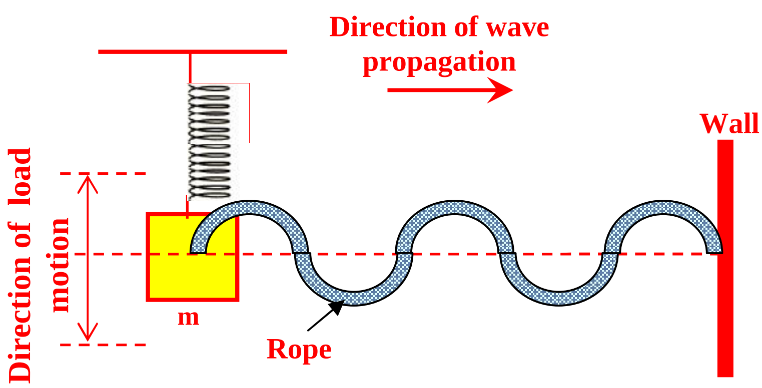
(1) transverse waves

To describe the nature of transverse waves we carry out the two following experiments:

Experiment

Steps :

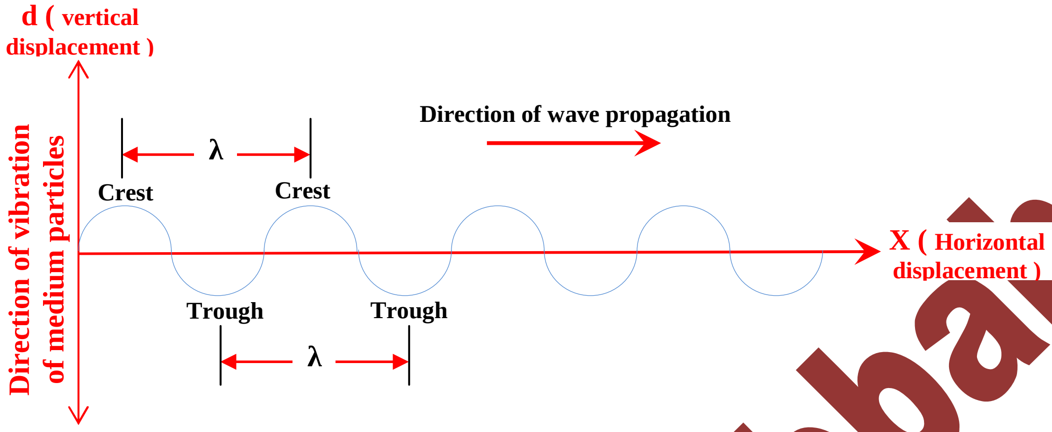
1- Bring a load (m) fixed to a vertical spring and a horizontal rope.
2- Fix the other end of the rope to the wall.
3- Pull the load downwards and leave it.



Observation :

1- The load makes a simple harmonic motion upwards and downwards.
2- The rope makes a similar motion.
3- The motion transfers along the rope in the form of a moving horizontal wave at a certain velocity while the parts of the rope move vertically by a simple harmonic motion.

Conclusion:



1- When the rope vibrates upwards and downwards, the wave transfer to the rope in the form of crests and troughs.
2- The direction of vibration of the rope is perpendicular to the direction of wave propagation and this wave is called **transverse wave.**

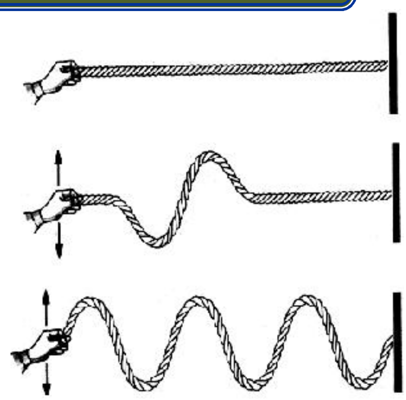
Crest
It is the position of the maximum displacement of medium particles in the positive direction .

Trough
It is the position of the maximum displacement of medium particles in the negative direction .

Transverse wave
It is the wave in which the vibration of the medium particles is perpendicular to the direction of the wave propagation and consists of crests and troughs.

Wavelength of transverse wave (λ)
It is the distance between two successive crests or two successive troughs .

Experiment to generate a train of travelling waves on a tensile rope



❶ fix one side of a rope to a wall and fix the other side by your hand.
❷ move your hand once vertically upwards to make one pulse, after that move your hand once vertically downwards to make another pulse.
❸ you will observe a wave propagates along the rope in form of a pulse upwards and a pulse downwards is called **travelling wave.**
❹ if you still move your hand upwards and downward, a continuous wave produced in the rope as a result of simple harmonic motion. is called **train of wave**.

trains of wave
A continuous wave produced in the rope as a result of simple harmonic motion.

Travelling wave
It is odd or even disturbance move from a point to other.
Or
It is a wave distributes as only pulse

Give reason

► **When we did a wave on the string, this mean that we made a work.**

Because the work done by the vibrating source (vibration generator or the hand) on the string transfer in the form of :
- Potential energy represented in pulling the string.
- Kinetic energy represented in the vibration of the string.

Graphical representation of transverse waves

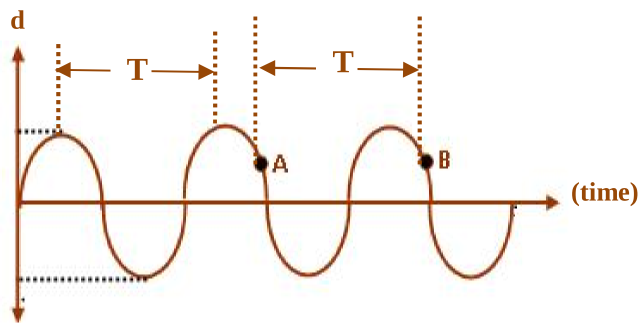


Fig (2)

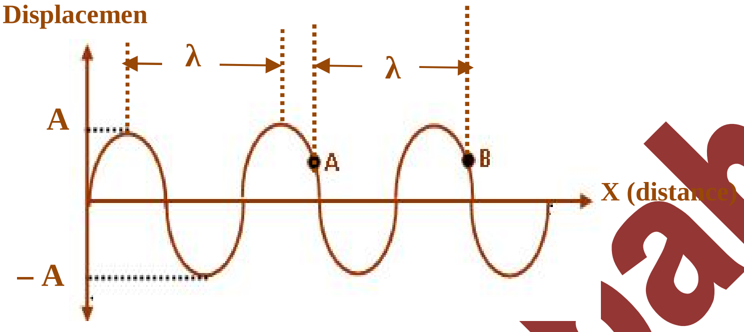


Fig (1)

◈ The relation between the displacement and the horizontal distance or between the displacement and time is represented by a curve in the form of sine wave.

◈ **From the two graphs :**

- Wave amplitude (A) = The maximum displacement of the medium particles from its rest position.
- The maximum displacement for a transverse wave will be in crest.
- Points **A** and **B** have the same phase (move in the same manner and in the same direction) and successive.

  ∴ In figure (1) : The distance between A and B = Wavelength.

  In figure (2) : The time between A and B = Periodic time.
- The horizontal distance between crest and trough = $\frac{\lambda}{2}$
- The vertical distance between crest and trough = 2 × Amplitude = 2 A
- The wavelength (λ) can be determined from the relation: $\lambda = \frac{X \ (Total \ distance)}{n \ (Number \ of \ waves)}$
- The frequency (υ) can be determined from the relation: $\nu = \frac{n \ (Number \ of \ waves)}{t \ (Time)}$
- We can calculate the numbers of transverse waves can be determined from the relation :

  n = the difference between two crests = the difference between two troughs.

Wavelength (λ)

It is the distance between any two successive points having the same phase (have the same displacement and direction)

Or

It is the distance covered by the wave during one period time.

Frequency (υ)

It is the number of waves that passes a certain point along the wave motion in a time of 1 s.

Or

It is the number of wavelengths covered by the propagated wave in a certain direction in 1 s.

No	What is meant by?	That means that
1	**The wavelength of a transverse wave = 20 cm**	The distance between two successive crests or two successive troughs for this wave = 20 cm
2	**The distance between center of successive crest and troughs for transverse wave = 0. 5 m**	The wavelength for this wave = 0. 25 m
3	**The distance between the first crest and third crest for transverse wave = 18 cm**	The wavelength for this wave = 9 cm

Solved examples

1) A transverse wave which the distance between the first crest and sixteenth crest = 105 m, and the time elapsed between the pass of the first crest and sixteenth crest = 0.37 s , find: ❶ wavelength. ❷ frequency . ❸ periodic time.

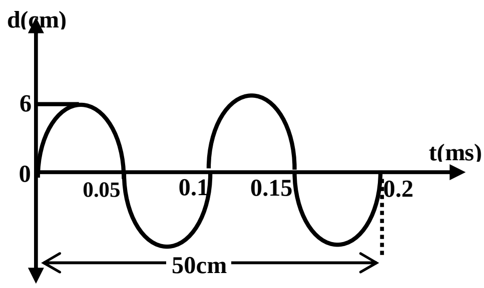
Answer

Numbers of waves = 16 – 1 = 15 wave

❶ $\lambda = \frac{X}{n} = \frac{105}{15} = 7m$, ❷ $\nu = \frac{n}{t} = \frac{15}{0.375} = 40Hz$, ❸ $T = \frac{1}{\nu} = \frac{1}{40} = 0.025s$

****

2) From the opposite figure, calculate ❶ wave amplitude. ❷ the frequency. ❸ the periodic time. ❹ the wavelength.



Answer

❶ A = 6 cm

❷ $\nu = \frac{n}{t} = \frac{2}{0.2\times10^{-3}} = 10^{4}\,Hz$

❸ $T = \frac{1}{\nu} = \frac{1}{10^{4}} = 10^{-4}\,s$

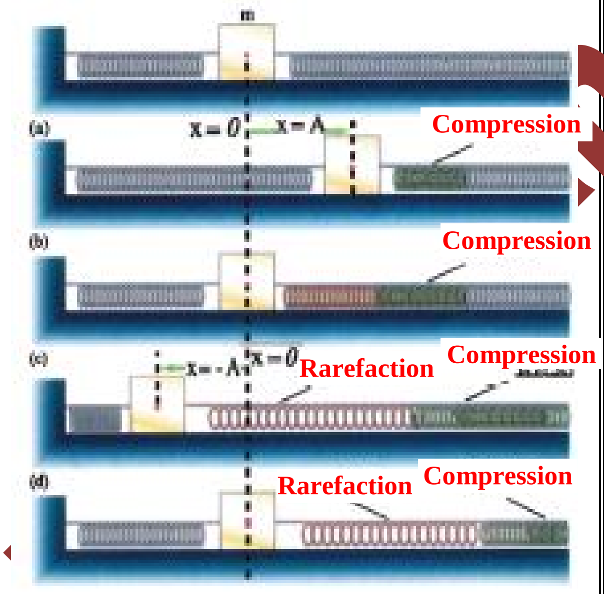
❹ $\lambda = \frac{X}{n} = \frac{5\times10^{-2}}{2} = 0.25m$

****

(2) longitudinal waves

To describe the nature of longitudinal waves we carry out the following experiment:

Experiment



Steps :

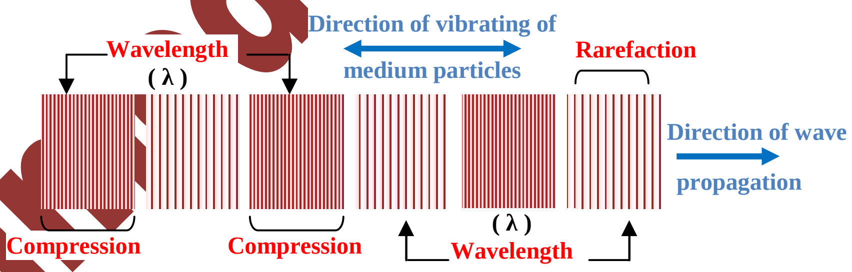
1- put a load (m) on a smooth horizontal plane.
2- Fix one end of the load to a spring and the other end to another spring attached to a wall.(fig. a)
3- Pull the load distance (x) to the right side then leave it to return to the equilibrium position (fig. b)
4- Pull the load distance (x) to the left side then leave it to return to the equilibrium position (fig. c)

Observation :

❶ The distance between the turns of the spring increase making a rarefaction , which transfers consecutively through the spring.

❷ The distance between the turns of the spring decrease making a compression , which transfers consecutively through the spring.

Conclusion :



1- During the vibration of the spring, a group of compressions and rarefactions transfers along the spring.
2- The group of the compressions and the rarefactions represents a wave propagates in the same direction of the vibration of the medium particles which is called **longitudinal wave.**

Compression

It is the area in which the medium particles are close to each other.

Rarefaction

It is the area in which the medium particles are far from each other .

Longitudinal wave

It is the wave in which the medium particles vibrate along the direction of the wave propagation around their equilibrium position and consists of compressions and rarefactions.

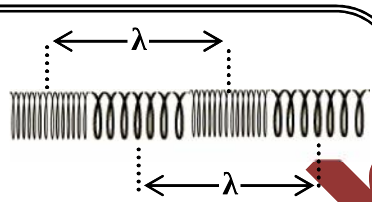
Wavelength of longitudinal wave

It is the distance between the centers of two successive compressions or the centers of two successive rarefactions.

Or

It is the sum of successive compression and rarefaction.

Notes



The one longitudinal wave consists of successive compression and rarefaction.

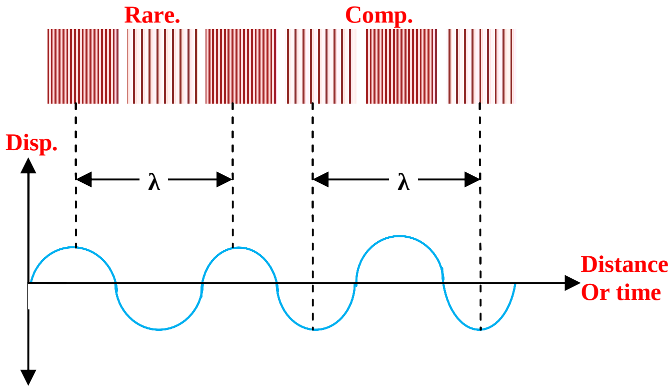
y the distance of one compression or one rarefaction = $\frac{1}{2}$ a

Number of waves = the difference between number of two compressions = the difference between two rarefactions

No	What is meant by?	That means that
1	**The wavelength of a longitudinal wave = 20 cm**	The distance between the centers of two successive compressions or the centers of two successive rarefactions for this wave = 20 cm
2	**The distance between center of compression and successive rarefaction for longitudinal wave = 1.2 m**	The wavelength for this wave = 0. 6 m
3	**The distance between center of the first compression and fourth compression for longitudinal wave = 15 cm**	The wavelength for this wave = 5 cm

Graphical representation of transverse waves

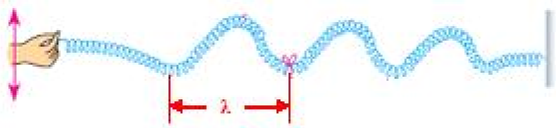
◈the relation between the displacement and the distance or between the displacement and the time is represented by a curve in form of sine wave. So, all the concepts and laws of the transverse wave are the same for this curve.



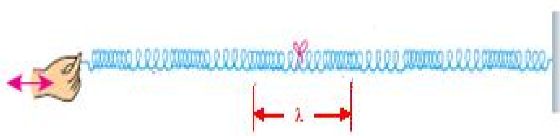
Graphical representation of transverse waves

Using a spring coil as follows:

1- Moving the coil upwards and downwards while fixing the other end, a transverse wave is formed.

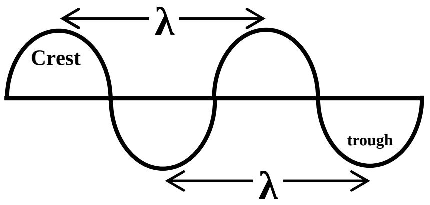
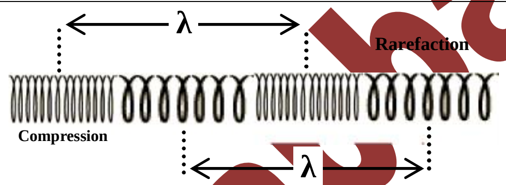


2- Moving the coil inwards and outwards while fixing the other end, a longitudinal wave is formed.

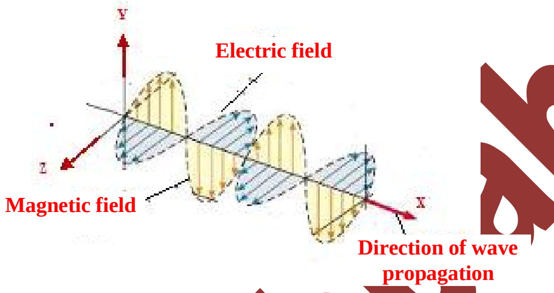


Give reason ► **Sound propagates in gases in the form of longitudinal waves.**

Because when sound is produced, the particles of the gas (medium) vibrate in the same direction of wave propagation in the form of compression and rarefactions due to its weak intermolecular forces.

Points of comparison	Transverse wave	Longitudinal wave
Wave form		
Direction of vibration of medium particles	Perpendicular to the direction of wave propagation.	Along the direction of wave propagation.
Composition	Crests and troughs.	Compressions and rarefactions.
Wavelength	The distance between two successive crests or two successive troughs.	The distance between the centers of two successive compressions or the centers of two successive rarefactions.
Examples	• Waves on water surface. • Propagating waves in strings.	• Sound waves in gases. • Waves inside water

Second : Electromagnetic Waves



Source	Originated from the vibration of two fields; one of them is electric field and the other is magnetic field, where both are perpendicular to each other and to the direction of wave propagation.
Propagation medium	They propagate through materialistic media and non-materialistic media (space or volume)
Electromagnetic waves definition	They are waves originated from vibrating electric and magnetic fields having the same phase with frequency (υ), perpendicular to each other and to the direction of wave propagation and can spread in materialistic media and in space.
Examples	❶ light waves. ❷ X-ray waves. ❸ Gamma rays. ❹ wireless waves (radio, TV and cell phones), where: - Sound or image are converted into waves received by the antenna. - These waves are converted into electric signals then to sound or image.
Types of electromagnetic waves	Transverse waves only.

Points of comparison	Mechanical waves	Electromagnetic waves
Source	Originated from the vibration of medium particles either perpendicular to the direction of wave propagation or in the same direction of wave propagation.	Originated from the vibration of two perpendicular fields one of them is electric field and the other is magnetic and both are perpendicular to the direction of wave propagation.
Propagation medium	Need medium to propagate.	Propagate in materialistic or non-materialistic media (space)
Types	Transverse and longitudinal waves	Transverse waves only
Vision	We can see some of them.	We can't see them but we fell their effect.
Examples	❶water waves. ❷sound waves. ❸ waves propagate in string.	❶light waves. ❷X-ray waves. ❸ Radio rays.

	Give reason	Answer
1	**Mechanical waves need materialistic to propagate and can't propagate in the space.**	Because it Originated from the vibration of medium particles but in space there isn't a materialistic.
2	**Electromagnetic waves Propagate in space and materialistic media**	Because it consist of two fields electric and magnetic perpendicular to each other where both of them don't need medium to propagate through.
3	**Mechanical waves can be Transverse or longitudinal waves**	Because when the medium particles are vibrates in the same direction of wave propagation; a longitudinal wave will originates. And when the medium particles are vibrates perpendicular to the direction of wave propagation; a transverse wave will originates .
4	**All electromagnetic waves are transverse waves only.**	Because both of electric and magnetic fields are perpendicular to each other and the direction of wave propagation.
5	**We can't hear the voices of cosmic explosions that occur in the space.**	Because light is an electromagnetic wave that can propagate through the space while the sound is a mechanical wave need a medium to propagate and can't propagate through space.
6	**The astronauts used wireless devices to communicate with each other in space.**	Because sound is a mechanical wave need a materialistic medium to travel through and the space don't contain air , but wireless waves is an electromagnetic waves can be propagates in space

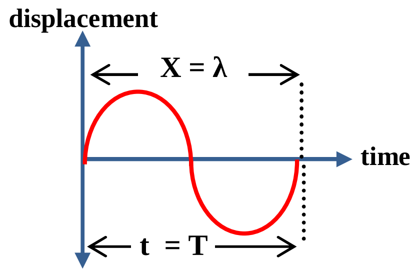
Deduction of the velocity of propagation of the waves

The relation between wavelength, frequency and the velocity of propagation of the waves

◈ If a wave transfers at velocity (v) from a place to another at distance (λ), the wave takes time equals the periodic time (T).

$\because V = \frac{X}{t}$ when X = λ , t = T $\therefore V = \frac{a}{T}$

$\because 3 = \frac{1}{T}$ $\therefore$ $V = 3a$



Wave velocity (V)

" it is the distance covered by the wave in one second in a certain direction"

What is meant by

► **The wave velocity = 20 m/s**

This means that the covered distance by the wave in one second = 20m

Complete

► **If the light waves propagates in air, the air particles ………….**

(vibrates longitudinal – vibrates transverse – vibrate longitudinal and transverse – don't vibrate)

Notes

◈ This relation is applied to all types of waves (longitudinal and transverse) .

- When two waves propagate (for example two sound waves) in the same medium, with different frequencies and their velocities are the same.

$$V_1 = V_2$$

$$\lambda_1 \upsilon_1 = \lambda_2 \upsilon_2$$

- Where λ_1 and υ_1 are the wavelength and the frequency for the first wave, λ_2 and υ_2 are the wavelength and the frequency for the second wave.

$$\therefore \frac{a_1}{a_2} = \frac{3_2}{3_1}$$

- When a wave (sound or light) transfers from one medium to another medium, its velocity and wavelength changes while its frequency remains constant because it depends on the source.

$$\upsilon_1 = \upsilon_2$$

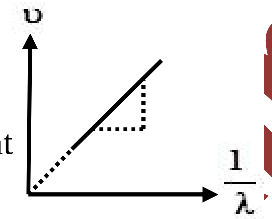
$$\frac{v_1}{a_1} = \frac{v_2}{a_2}$$

- Where λ_1 and v_1 are the wavelength and the velocity for the first medium, λ_2 and v_2 are the wavelength and the velocity for the second medium.

$$\therefore \frac{V_1}{V_2} = \frac{a_1}{a_2}$$

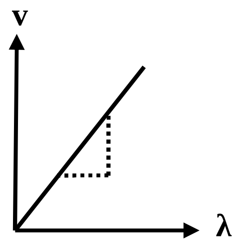
i . e .

- The wave length is inversely proportional to the frequency at constant wave velocity, which can be represented graphically .



$$slope = a\,3 = V$$

- The wave velocity is directly proportional to the wavelength at constant frequency, which can be represented graphically .



$$slope = \frac{V}{a} = 3$$

Give Reason

► **As the frequency of a wave in medium increase ,its wavelength decrease.**

Because the wave velocity is constant in the same medium.so, the frequency is inversely proportional to the wavelength ($3 \sim \frac{1}{a}$) .

	What is happen if .....?	Answer
1	**The velocity of a wave increases in a medium relative to another medium concerning its wavelength.**	The wavelength increases because at constant the frequency of a wave, the wave velocity is directly proportional to its wavelength.
2	**The frequency of a wave propagating in a medium increases to the double.**	The wavelength will decrease to the half because the frequency is inversely proportional to the wavelength at constant wave velocity ($3 \sim \frac{1}{a}$)

3	**The wavelength of a wave propagation in a medium increases to the double concerning the velocity of propagation.**	The wave velocity will not change because the wave velocity is constant for a certain medium.
4	**Increasing the frequency of a wave propagates in a medium concerning the velocity of propagation.**	

Solved Examples

1) A student was counted the number of waves passing by a certain point in water sea and he found them were 15 waves during 3 second and the wavelength is 0.7 m . calculate the speed of propagation.

Answer

$$\nu = \frac{n}{t} = \frac{15}{3} = 5\text{Hz}, \quad V = \nu \times \lambda = 0.7 \times 5 = 3.5\text{m/s}$$

****

2) Light wave propagate in space at speed 300000 km/s (3×10^8 m/s) and the wavelength of light is 6000 Å. what is the frequency of this light? (given that 1 Angstrom (Å) = 10^{-10}m

Answer

$$\nu = \frac{V}{\lambda} = \frac{3\times10^8}{6\times10^3\times10^{-10}} = 0.5\times10^{15}\text{Hz}$$

****

3) Two tones, their frequencies 425 Hz and 680 Hz if the wavelength of one of them is greater than the other by 30 cm, calculate the velocity of sound in air.

Answer

∵ the two waves in the same medium so the velocity is constant.

∴ the frequency is inversely proportional to the wavelength ($\nu \sim \frac{1}{\lambda}$) .

So the wave has greater frequency will has shorter wavelength. and

$$\because \frac{\nu_1}{\nu_2} = \frac{\lambda_2}{\lambda_1} \Rightarrow \frac{680}{425} = \frac{\lambda_1 + 0.3}{\lambda_1} \Rightarrow 680\lambda_1 = 425\lambda_1 + 127.5 \Rightarrow \lambda_1 = 0.5\text{m}$$

$$\because V = \nu \times \lambda = 680 \times 0.5 = 340\text{m/s}$$

****

4) A tuning fork of frequency 480 Hz was knocked, then was approached to a tube opened from both sides of length 12 m . so, the beginning of the first wave reached the end of the tube when the tuning almost sending the wave number thirteen , calculate the sound velocity in air.

Answer

Number of waves in the tube = 12 waves

$$\lambda = \frac{X}{n} = \frac{12}{12} = 1\text{m}, \quad V = \nu \times \lambda = 1 \times 480 = 480\text{m/s}$$

****

5) A student was threw a stone in a lake. So, 30 waves were formed after 3 seconds from the colliding of the stone with the water, where the radius of the outer circle is 2 m . find:
❶ The Wavelength. ❷ The Frequency. ❸ The wave velocity. ❹ The Periodic time.

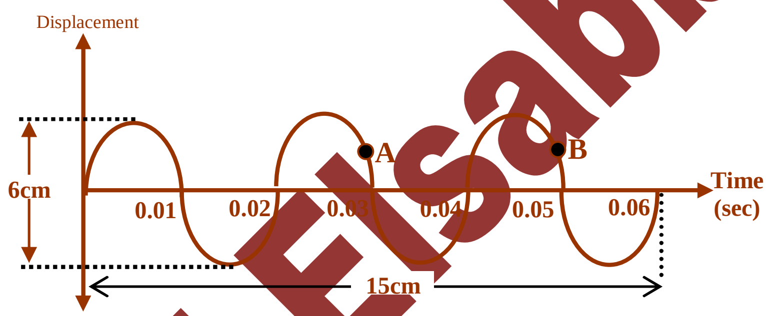
Answer

❶ $\lambda = \frac{X}{n} = \frac{2.1}{30} = 0.07\text{m}$ ❷ $\nu = \frac{n}{t} = \frac{30}{3} = 10\text{Hz}$

❸ $T = \frac{1}{\nu} = \frac{1}{10} = 0.1\text{s}$ ❹ $V = \nu \times \lambda = 10 \times 0.07 = 0.7\text{m/s}$

****

6) from the opposite figure
Calculate :
❶ Wavelength. ❷ Amplitude.
❸ Periodic time. ❹ Frequency.
❺ wave velocity.
❻what is the distance AB ?
❼ The wavelength if the frequency is doubled.



Answer

❶ $\lambda = \frac{X}{n} = \frac{15 \times 10^{-2}}{3} = 5 \times 10^{-2} = 0.05\text{m}$

❷ Amplitude = Maximum displacement = $\frac{6 \times 10^{-2}}{2}$ =0.03m

❸ $T = \frac{t}{n} = \frac{0.06}{3} = 0.02\text{s}$,

❹ $\nu = \frac{1}{T} = \frac{1}{0.02} = 50\text{Hz}$

❺ The distance AB = Wavelength .

❻ $\frac{\lambda_1}{\lambda_2} = \frac{\nu_2}{\nu_1} \Rightarrow \frac{0.05}{\lambda_2} = \frac{2\nu_1}{\nu_1} \Rightarrow \lambda_2 = 0.025\ m$

****

7) A sound source produces a sound wave its frequency was 170 Hz propagate in air with velocity 340 m/s, calculate the wavelength of this wave. And if you know that when the temperature was increased by a ratio of 10% , calculate the sound velocity in air .

Answer

$\because V = \nu \times \lambda \therefore 340 = 170\lambda \therefore \lambda = \frac{340}{170} = 2\text{m}$

$\because$ The increase in wavelength = $2 \times \frac{10}{100} = 0.2$ m

$\therefore \lambda_2 = 2 + 0.2 = 2.2\text{m}$,

$\therefore V_2 = \nu \times \lambda_2 = 170 \times 2.2 = 374\text{m/s}$

****

8) Two waves, their frequencies 512 Hz and 256 Hz were propagated in certain medium by the same velocity, calculate the ratio between the wavelengths of them.

Answer

$$\frac{\lambda_1}{\lambda_2} = \frac{\upsilon_2}{\upsilon_1} = \frac{256}{512} = \frac{1}{2} = 0.5$$

****

٩)the following table shows the relation between the wavelength (λ) and the frequency (υ) for a wave propagates in a medium

λ (m)	1	2	4	5	8	10
υ (Hz)	500	250	X	100	62.5	50

(a) draw the graph between (υ) on the vertical axis and ($\frac{1}{\lambda}$) on the horizontal axis

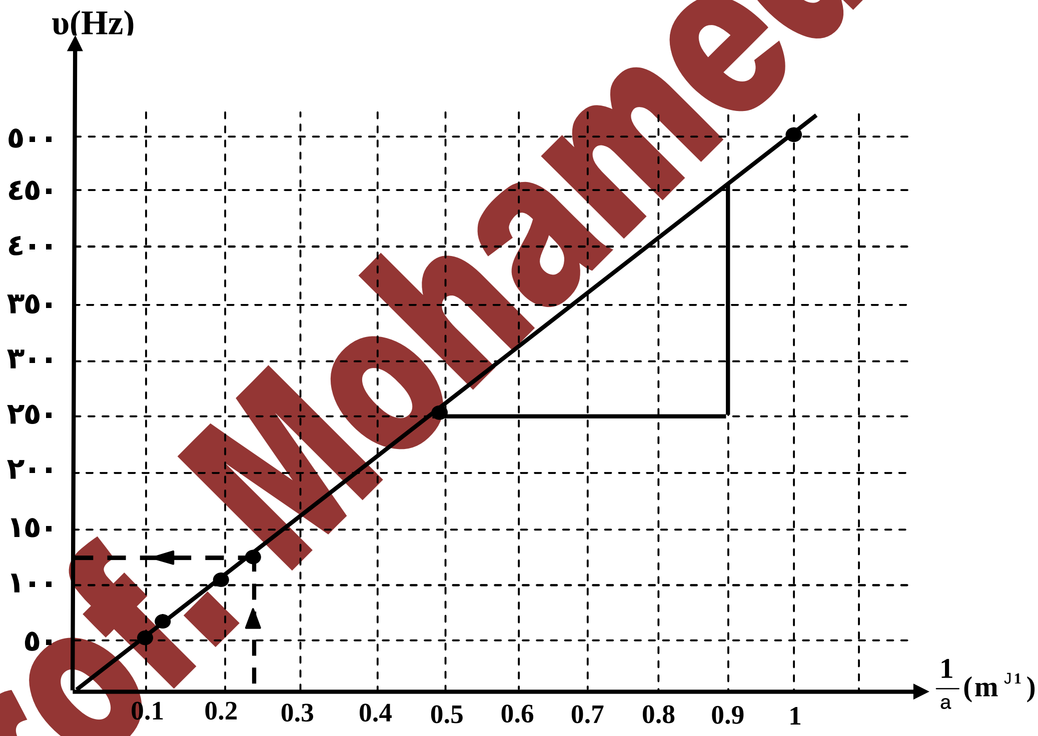
(b) from the graph find:

❶ the value of x.

❷ the wave velocity through the medium.

Answer

$\frac{1}{\lambda}$ (m^{-1})	1	0.5	0.25	0.2	0.125	0.1
υ(Hz)	500	250	X	100	62.5	50



❶ X= 125Hz

❷ $slope = \frac{\Delta \upsilon}{\Delta(\frac{1}{\lambda})} = \frac{450-250}{0.9-0.5} = 500\, m/s$

****

QUESTION ON Chapter 1 Wave Motion

Questions signed by:
(🕮) have been taken from the school book.
(✍) have been taken from the previous exams .
(🗐) have been taken from student assessment guide.
****

1 write down the specific term for each statement of the following :

1) Disturbance that propagate and transfers the energy in the same direction of the propagation.
2) Disturbance propagate in a materialistic only.
3) Waves originated from vibrating electric and magnetic fields having the same phase with frequency (υ), perpendicular to each other and to the direction of wave propagation and can spread in materialistic media and space.
4) Object's motion at the two sides of its original position and repeated in equal intervals of time.
5) The motion of the oscillating body when it passes one point along the path of its motion twice successively in the same direction.
6) The distance of the vibrating body at any instant from its rest position or equilibrium position and it is a vector quantity.
7) • The maximum displacement of the vibrating body away from its original position.
   • ✍ The distance between two points along the path of the vibrating object, where the velocity at one point is maximum and zero at the other.
8) Two points on the wave have the same position and direction at a certain instant.
9) • ✍ The number of complete oscillations done by the vibrating body in one second.
   • The number of waves which pass by the same point along the path of the wave motion in one second.
   • The number of wavelengths covered by the propagated wave in a certain direction in one second.
10) • The time taken by the vibrating body to make one complete oscillation.
   • The time taken by the wave to cover a distance of one wavelength.
11) Wave in which the vibration of the medium particles is perpendicular to the direction of wave propagation.
12) Wave in which the vibration of the medium particles is around their equilibrium position along the direction of wave propagation.
13) The area in which the medium particles are far from each other.
14) The area in which the medium particles are close from each other.
15) The position of the maximum displacement in the positive direction.
16) The position of the maximum displacement in the negative direction.
17) The distance between two successive crests or two successive troughs.
18) • The distance between the centers of two successive compressions or the centers of two successive rarefactions.
   • The sum of successive compression and rarefaction.
19) ✍ The distance between any two successive points having the same phase (have the same displacement and direction)

- The distance covered by the wave during one periodic time.

20) The distance covered by the wave in one second in a certain direction

- The product of the frequency and the wavelength.

****

2 Choose the correct answer of the given answer:

1) Waves transfer the ………… (matter – particles – energy – water)

2) Waves that need medium to propagate through are ………..
(electromagnetic waves – radio waves – mechanical waves – all the pervious)

3) All the following waves propagate in space except ……..
(light waves – x-ray waves – sound waves – wireless waves)

4) Which of the following waves are longitudinal waves ?.................
(infrared waves – sound waves in air – light waves – radio waves in space)

5) Transverse waves are waves consisting of ……………….
a) Compression and rarefactions.
b) Crests and troughs.
c) Crests and troughs where the particles of the medium move short distances about their equilibrium position in a direction perpendicular to the direction of propagation.
d) Compression and rarefactions where the particles of the medium move short distances about their equilibrium position along the direction of propagation of the wave.

6) The electromagnetic waves differ from the mechanical waves that they can propagate in ……
(air – glass – vacuum – water)

7) The sound waves is ………….. waves
(electromagnetic – longitudinal – transverse – circular)

8) Half the vertical distance between the crest and trough of a transverse wave is called ………..
(frequency – wavelength – amplitude – displacement)

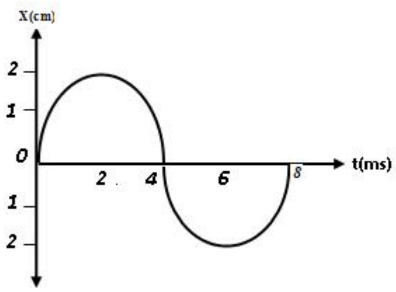
9) The time taken for vibrating body to arrive the maximum displacement equal to …………..
(periodic time – half periodic time – quarter periodic time)

10) The distance of a wave transfers during periodic time T second equal to …………
(wavelength – half wavelength – double wavelength)

11) **in the opposite figure** :

(i) The amplitude of this wave is ……………..
(2 cm – 3 cm – 4 cm – 6 cm)

(ii) The frequency of the wave is …………. Hz
(100 – 125 – 250 – 500)

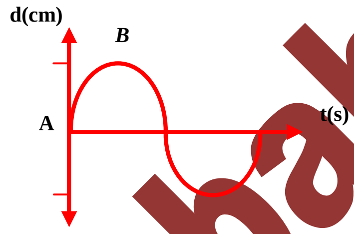


12) The ratio between the time of the amplitude and the time of the complete oscillation is ……..

($\frac{2}{1}$ – $\frac{1}{2}$ – $\frac{4}{1}$ – $\frac{1}{4}$)

13) **in the opposite figure** :

A wave of frequency 50 Hz, the time interval between the two points (A) and (B) is ……………….



($\frac{2}{25}$ – $\frac{1}{50}$ – $\frac{1}{200}$ – $\frac{1}{25}$)

14) The number of waves that pass a certain point in the direction of wave propagation in one second is ……………

(the frequency – the wavelength – the amplitude – wave velocity)

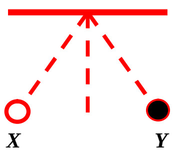
15) If the time interval between the first crest and the tenth crest in a wave motion is 0.2 s, then the frequency is ………… (55 Hz – 50 Hz – 45 Hz – 40 Hz)

16) ✍ If the time taken by the oscillating body to make a complete oscillation is 0.1 s, then the number of the oscillations done by the oscillating body in 100 s is ………… Oscillation.

(10 – 100 – 1000 – 10000)

17) **in the opposite figure** :

the pendulum moves freely. If the time taken to move between (X) and (Y) is 1 s, then the frequency of the vibrational motion 0f the pendulum is ………



(0.5 Hz – 5 Hz – 10 Hz – 50 Hz)

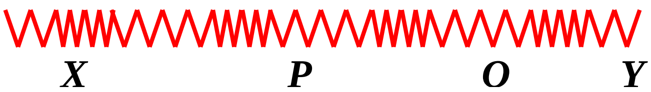
18) 📄 A floating body on the water surface of a lake; if the lake waves cause the vibration of the body up and down 90 times in a minute, then the frequency of these waves equals ………

(90 Hz – 60 Hz – 1.5 Hz – 0.6 Hz)

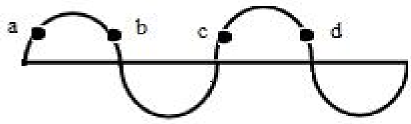
19) In the longitudinal wave, the direction of the medium particles is ………… The direction of wave propagation . (along – perpendicular to – inclined to – opposite to)

20) **In the opposite figure** :

a longitudinal wave propagate in a spring coil from (X) to (Y) the wavelength of this wave is the distance ………………



(PQ – 2 PQ – XY – $\frac{XY}{2}$)



21) **In the opposite figure** :

Points …………. Have the same phase.

[(a,b,c) – (a,b) – (b,c) – (b,d)]

22) The wavelength is the distance between two successive points have the same …………

(direction – velocity – phase – amplitude)

23) If the distance between two successive points in phase for a wave equals 50 cm, then the wavelength for this wave equals …………

(12.5 cm – 25 cm – 50 cm – 100 cm)

24) 📖 The relation between the velocity of propagation of the waves " v " in a medium , the frequency and the wavelength is ………… (**V** Z ᵃ ³ / **V** Z $\frac{a}{3}$ / **V** Z $\frac{3}{a}$ / **V** Z $\frac{\mathbf{1}}{a\ 3}$)

25) 📖 If the velocity of sound in air is 340 m/s for a sound of frequency (tone) 255 Hz, the wavelength (m) is …………….. ($\frac{3}{2}$ – 20 – $\frac{3}{4}$ – $\frac{4}{3}$)

26) The velocity of wave propagation equals ………… ($\frac{a}{3}$ – $\frac{a}{T}$ – $\frac{3}{a}$ – a T)

27) 📖 Light of wavelength 6000 Å (1 Å = 10^{-10} m) propagate in space at velocity 300 × 10^3 km/s, its frequency is …………… (4×10^{10} Hz – 4×10^{14} Hz – 5×10^{14} Hz – 5×10^{12} Hz)

28) When the frequency of wave motion in a medium decreases, ………………
a) Its wavelength increases.
b) Its wavelength decreases.
c) Its velocity increases
d) Its velocity increases and its wavelength decrease

29) When frequency of wave motion decrease in a certain medium then …….
(wavelength increase – wavelength decrease – velocity of wave decrease – velocity of wave increase – wavelength decrease and velocity of wave increase)

30) The result of multiplying frequency × periodic time equal ……….
(1 – 2 – 3 – inconstant number)

31) A dolphin made a sound with frequency 150 kHz , and the velocity of sound in water is 1500 m/s then the wavelength for this sound is …………
(10 m - 1 m - 0.1 m - 0.01 m - 0.001 m)

32) When a frequency of a vibrating body increase to double in the same medium then the periodic time ……… (increase to double – decrease to half – remain constant)

33) When the amplitude of a body is 10 cm then the displacement at any moment may be equal …………..cm (12 – 20 – 5 – 15)

34) Two sound waves whose frequencies 512 Hz and 256 Hz propagate in a certain medium, then
a) 📖 The ratio between their wavelengths respectively is ………. ($\frac{2}{1}$ – $\frac{1}{2}$ – $\frac{3}{1}$ – $\frac{1}{3}$)
b) The ratio between their velocities respectively is ………. ($\frac{2}{1}$ – $\frac{1}{2}$ – $\frac{1}{1}$ – $\frac{1}{3}$)

35) 📖 If the wavelength of a sound wave produced by an audio (sound producing) source is 0.5 m, the frequency is 666 Hz, then the velocity of propagation of sound in air is …………
(338 m/s – 333 m/s – 330 m/s – 346 m/s)

36) 📄 a girl stood on the beach to watch the waves. She observed that every two seconds, four waves pass in front of her and each wave its length is 0.5 m. so, the wave velocity is ………
(0.2 m/s – 0.25 m/s – 0.5 m/s – 1 m/s)

37) Wave of frequency υ_1, wavelength λ_1 and its velocity in a medium v_1 if this wave transfers from the medium to another medium where in it becomes $\frac{2}{3}$ v_1, then …………

a) The frequency υ_1 and wavelength λ_1 remain constant.
b) The wavelength λ_1 remain constant and frequency becomes $\frac{2}{3}$ υ_1
c) The wavelength λ_1 remain constant and frequency becomes $\frac{3}{2}$ υ_1
d) The frequency υ_1 remain constant and wavelength becomes $\frac{2}{3}$ λ_1

****

3 What is meant by ………?

1- ✍ The maximum displacement for an oscillating body = 5 cm
2- 🗐 The amplitude of an oscillating body = 2 cm
3- ✍ Number of oscillations for body in one second = 256 oscillations
4- The frequency of a tuning fork = 50 Hz
5- 🗐 An oscillating body makes 1200 complete oscillations in one minute.
6- 🗐 The periodic time of an oscillating body = 2 s
7- 🗐 ✍ The wavelength of a longitudinal wave = 30 cm
🗐 A sound wave of wavelength = 30 cm
8- 🗐 The wavelength of a transverse wave = 20 cm
🗐 The wavelength of sea waves = 20 cm
9- The distance between the centers of a compression and the rarefaction = 5 m
10- 🗐 ✍ The distance between the first crest and third crest of a transverse wave = 0.25 cm
11- ✍🗐 The distance between successive crest and tough in a wave = 15 cm
12- 🗐 wave velocity = 20 m/s .

****

4 Give reasons for :

1- We see the light produced from the cosmic explosions and we don't hear the sound produced from them.
2- Astronauts use wirless devices on the Moon surface.
3- The electromagnetic waves propagate in space.
4- ✍As the frequency of a wave in a medium increase, its wavelength decreases.
5- The sound propagates in gases in the form of longitudinal waves.
6- ✍ The sound propagate in solid material faster than the gases.
7- Water wave is a transverse waves.
8- The sound need materialistic media but light don't need materialistic media

****

5 Define :

1) 🕮 Wave.
2) Oscillatory motion.
3) 🗐 Electromagenetic waves.
4) 🕮 Displacement

5) 📖 Amplitude of oscillation
6) ✍📄📖 Complete oscillation.
7) 📖 Frequency.
8) 📖 Periodic time.
9) Phase
10) 📖 Longitudinal wave.
11) 📖 Transverse wave.
12) Crest of transverse wave.
13) Ttough of a transvere wave.
14) Compression of longitudinal wave
15) Rarefaction of a longitudinal wave.
16) The wave length of a longitudinal wave.
17) The wavelength of a transverse wave.
18) Wave velocity .
19) 📖 Wavelength
20) Mechanical waves.

****

6 Compare between:

1- ✍ The mechanical waves and electomagnetic waves .
(in terms of : the medium of propagation – type – examples)
2- ✍ Transverse waves and logitudinal waves .
(in terms of : the wave form – direction of particles vibration – composition – wavelength – examples)

****

7 What happen when ..... ? Mention the reason

1- The frequency of an oscillatory motion is doubled concerning its periodic time.
2- The frequency of a propagation wave in a medium increases concerning its wavelength.
3- The wavelength of a propagation wave in amedium is doubled concerning the velocity of propagation.
4- The wave velocity for a medium increases more than its velocity in another medium concerning the wavelength.

****

8 Miscellaneous questions

1- Mention the conditions of occurrence of mechanical wave.

****

2- A stretched string connected from one end with a vibrated tuning fork. Illustrate by drawing ❶ propagate of pulse (crest) ❷ propagate of pulse (tought) ❸ propagate of a transverse wave
(the direction of wave propagation indicating the wavelength and ampliyude)

****

3- Mention the physical quantity that is measured by the unit (cycle/second) and write the equivalent unit for it.

****

4- Mention the unit of measurment of each of the following :
❶ periodic time. ❷ Amplitude.
❸ Wavelength. ❹ Wave velocity.

****

5- 📖 Deduce the relation between frequency, wavelength and velocity of wave propagation.

****

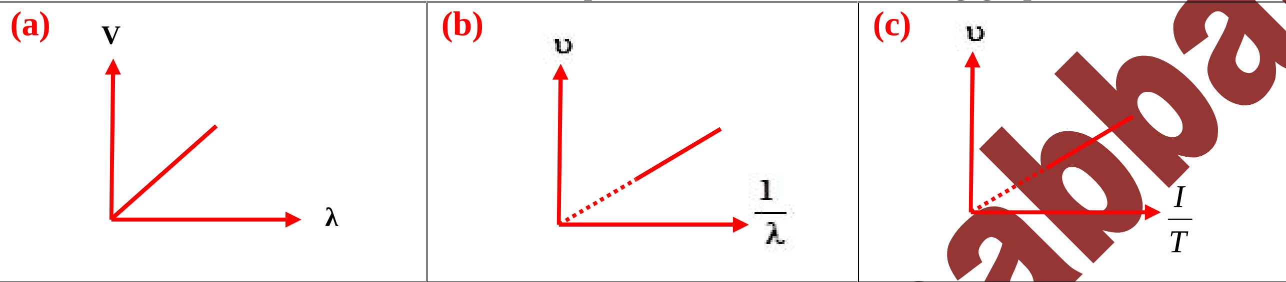
6- Draw a longitudinal wave and transverse wave of the same frequency and the wavelength.

7- Represent the following relations graphically, mentioning the mathematical relation:

❶ The frequency and the periodic time.
❷ The wavelength and the frequency for waves propagate in the same medium.
❸ The wavelength and the periodic time for waves propagate in the same medium.
❹ The wavelength and the wave velocity for a wave propagates in the different media.

****

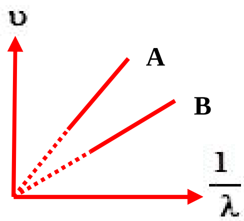
8- Write the mathematic relation and the slope for each of the following graphs:



Where : (v) is the wave velocity. (υ) frequency , (λ) wavelength , (T) periodic time.

****

9- The opposite figure illustratws the change of frequency with the reciprocal of the wavelength for a propagated wave in two different media (A) and (B) . in which medium the wave is faster ? why ?



****

9 Problems :

1- A vibrating string takes 0.01 s to make its maximum displacement. What is its frequency ?

(25 Hz)

****

2- 🗐 Wave generator produces 16 pulses in 4 s , **calculate :**

❶ the frequency. ❷ the perodic time. **(4 Hz , 0.25 s)**

****

3- 🗐 A vibrating source, its frequency 100 Hz. **Calculate** the time taken from passing of the 1^{st} crest to the 20^{st} crest by a point in the path of wave motion .

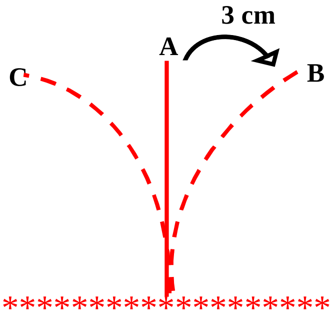
****

4- In the opposite figure :

An oscillating body takes 0.01 s to move from (A) to (B) .

Calculate :

(a) The periodic time.
(b) The frequency.
(c) The amplitude .



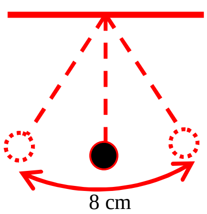
(0.04 s, 25 Hz , 3 cm)

****

5- In the opposite figure :

A vibrated simple pendulum made 120 oscillations in 6s **calculate :**

(a) The periodic time.
(b) The frequency.
(c) The amplitude .



(20Hz , 0.05s , 4cm)

6- The time between passing of the first crest and the fifth one by a certain point is 0.8 sec, **calculate** the number of waves which pass by this point through quarter sn hour.**(4500 waves)**

****

7- An oscillating body produce 1200 complete oscillations in one minute, where each oscillation cover a distance 20 m . **calculate** : ❶ the amplitude. ❷ the frequency. ❸ the periodic time. **(5 cm , 20 Hz , 0.05 s)**

****

8- A wave was generated in a string, where its frequency was 10Hz and its wavelength was 0.5 m **calculate**: ❶ The wave velocity through the string.
❷ The wavelength if its frequency is increased to 30 Hz. **(5 cm , 20 Hz , 0.05 s)**

****

9- A sound wave its frequency is 1.1 kHz , if you know that the velocity of sound in air is 340 m/s calculate the wavelength of this wave in air. **(0.3 m)**

****

10- If the average of wavelength for visable light is approximitly 5000Å and the velocity of sound in air is 3×10^8 m/s calculate the average frequency of visiable light. **(6×10^{14} Hz)**

****

11- The human ear can hear frequencies between 20 Hz and 20000 Hz. **Calculate** the least and the highest wavelength can be heared by the human ear. **(0.017 m , 17 m)**

****

12- If the sound wave length which The human ear can identify between 10 m and 1.6 m **Calculate** the least and the highest frequencies. (knowing that the velocity of sound in air is 340 m/s). **(32 : 20000 Hz)**

****

13- A wave of frequency 640 Hz propagates at velocity 320 m/s . **calculate**
❶ The periodic time. ❷ The wavelength. **(1.56×10^{-3} s , 0.5 m)**

****

14- Transverse waves propagate through thin thread at velocity 300 m/s. if the distance between two successive crests is 3 m . **calculate** : the frequency of the wave. **(100 Hz)**

****

15- ✍ calculate the velocity of a propagated transverse wave its frequency is 15 Hz along thread, if the distance between every successive crest and tough is 1.5 m . **(45 m/s)**

****

16- A transverse wave propagate through thread at velocity 12 m/s. and its frequency is 4 Hz, **calculate** the distance between every successive crests and tough and the distance between the first crest and eight crest **(21 m , 1.5 m)**

****

17- A tank full of water and at the bottom of the tank there is a vibrateing source its frequency is 500 Hz , if the number of waves which reaches the surface of the tank is 10 waves and the velocity of the sound in water is 1400 m/s ,**find** the deepth of the tank. **(28 m)**

****

18- If the number of waves which pass by a certain point is 50 waves in 5 sec and the distance between the first and fourth ctest is 120 cm . **calculate** the velocity of wave propagation. **(4 m/s)**

****

19- If the number of waves which pass by a certain point is 32 waves in 40 sec and the distance between the beging of first wave and the end of seventh wave is 63 cm . **calculate**
❶ the wavelength ❷ the periodic time ❸ the frequency. **(9m , 1.25 s , 0.8 Hz)**

20- ✍ if the velocity of water waves that pass by a certain point is 1.5 m/s and there are 30 waves pass by this point in 1 s , calculate the number of waves in a distance 60 m. **(1200 waves)**

****

21- If the distance between the second crest and the seventh one of a transverse wave is 20 m and the time between passing of the first crest and the fifth one by a certain point in the path of wave motion is 0.1 s . **calculate** : ❶ The wavelength of the wave motion.
❷ The frequency of the source of the disturbance.
❸ The wave velocity. **(4 m , 40 Hz , 160 m/s)**

****

22- 🗐 If 15 waves pass by a man standing at the end of a rock in the sea in 1 minuit and he observed that every 10 waves occupy 9 m . **find** : ❶ The perodic time.
❷ The frequency. ❸ The wavelength. ❹The wave velocity.
(4 s , 0.25 Hz , 0.9 m , 0.225 m/s)

****

23- 📖 A stone was thrown in a lake. So, 50 waves were formed after 5 seconds from the colliding of the stone with the water, where the radius of the outer circle is 2 m . **find** :
❶ The perodic time. ❷ The frequency. ❸ The wavelength. ❹The wave velocity.
(0.04 m , 10 Hz , 0.4 m/s , 0.1 s)

****

24- 🗐 An oscillating body produce 960 oscillations in one second. What is the number of the produced waves by this body until the sound reaches a person at a distance 100 m from the oscillating body? (knowing that : the speed of sound in air = 320 m/s) **(300 osc.)**

****

25- ✍ Calculate the number of complete waves which happen by a tuning fork from the beging lf its vibration until the sound reach to a person at a distance 5 m if the frequency of tuning fork is 512 Hz and the speed of sound in air = 320 m/s **(8 waves)**

****

26- 🗐 A train stands in a station and produce a beep of frequency 300 Hz. If there was a man standing at distance 0.99 km from the train and heared the sound after 3 s from its production. Find the wavelength of the sound in meters. **(1.1 m)**

****

27- ✍ A ship at distance 3.6 km from the beach and produce a beep of frequency 300 Hz if there was a man at the beach hered the sound after 12 sec from its production find the wavelength of the sound which produce from the beep. **(1 m)**

****

28- A perodic time of a vibrating source is $\frac{1}{140}$ **s** , If there was a person standing at distance 1.96 km from the source and heared the sound after 7 s from its production. **Find**:
❶ the wavelength of the waves which produce by the source.
❷ the distance which occupried by every compression or rarefaction for this wave.
❸ the distance between the first compression and the tenth compression. **(2 m , 1 m , 18 m)**

****

29- An oscillating body produces a complete oscillation every 0.02 s. so, the sound reaches a person at distance 170 m from the body after 0.5 s. calculate the distance between the first compression and the second rarefaction. **(10.2 m)**

****

30- A tuning fork of frequency 200 Hz was knocked, then was approched to a tube opened from both sides of length 8 m. so, the beging of the first wave reached the end of the tube when the sixth wave was entering the tube. Calculate the sound velocity in air. **(320 m/s)**

****

31- A tuning fork of frequency 412 Hz was knocked, then was approched to a tube opened from both sides of length 14 m. so, the beging of the first wave reached the end of the tube when the 21^{th} wave was entering the tube. Calculate the sound velocity in air. **(288.4 m/s)**

****

32- ✍ A spring coil its length 6 cm was fixed vertically by a load and was tensile by a force until its length reached 9 cm after that let the spring vibrated then he made 100 compelet oscillations in 20 sec , find the length of this wave and the velocity of propagated.

(12 cm , 0.6 m/s)

****

33- Two waves of frequencies 128 Hz and 320Hz propagate in air at velocity 320 m/s. calculate the difference in wavelength for them. **(1.5 m)**

****

34- Two tones have frequencies 680 Hz and 425 Hz. If the wavelength of one of them exceeds the wavelength of the other wave by 30 cm, calculate the velocity of sound in air. **(340 m/s)**

****

35- ✍ A wave motion propagate with constant frequency in different two medium, if the wavelength of it in the first medium is 6 cm, and 4 cm in the other medium, calclulate the ratio of velocity of propagate in each medium. **(3 : 2)**

****

36- A sound wave of frequency 900 Hz, its wavelength in air is 0.4m and its wavelength in water is 1.6 m. calculate :

(a) The ratio between the velocity of sound in the air to the velocity of sound in the water.

(b) The sound velocity in each medium. **($\frac{1}{4}$, 360 m/s , 1440 m/s)**

****

37- A wireless transmission station sends waves to a satellite at velocity 3×10^{8} m/s and after 0.03 s the waves are received by the same rader. Calculate the distance between the Earth and the satellite. **(4.5×10^{3} km)**

****

38- Earthquake produce two kinds of waves, the velocity of the first wave is 6000 m/s and the velocity of the second wave is 5000 m/s. what is the distance between the center of earthquake and a monitoring station was recorded the two waves which the period time between them is one minuit. **(18×10^{5} m)**

****

39- In the opposite figure find:

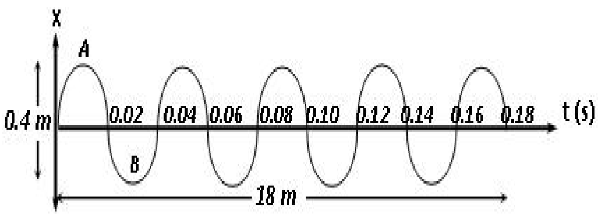
❶ The amplitude. ❷ The perodic time.

❸ The frequency. ❹ The wavelength

❺ The wave velocity.(in two different ways).

❻ The number of waves.

❼ The distance AB and what is represent?

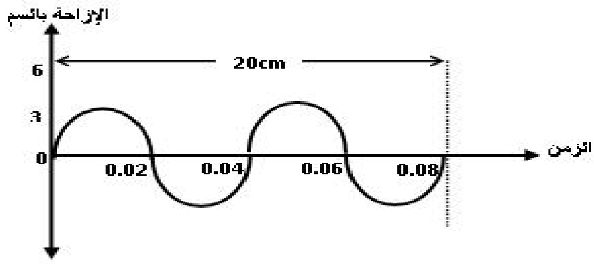


[0.4 m , 4 m , 25 Hz , 0.04 s , 4.5 waves , 100 m/s , 0.02 sec, half periodic time]

****

40- ✍ **In the opposite figure find:**

❶ The amplitude.
❷ The frequency.
❸ The wavelength
❹ The wave velocity.

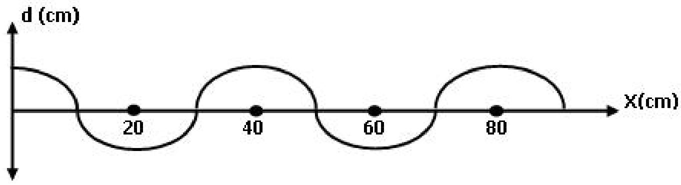


(25 cm , 25 Hz , 3 cm , 62.5 m/s)

****

41- **In the opposite figure find:**

❶ The amplitude.
❷ The wavelength
❸ The wave velocity if the frequency is 8 Hz

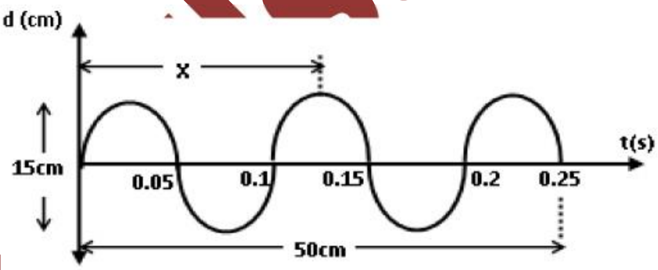


[4 cm , 40 cm , 3.2 m/s]

****

42- **In the opposite figure find:**

❶ The wavelength ❷ The perodic time.
❸ The frequency. ❹ The amplitude.
❺ The distance X represent ……………
❻ The distance between crest and succesive tough.

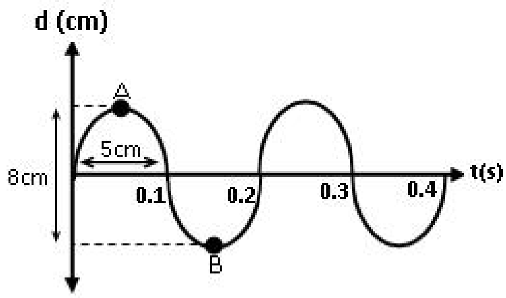


[20 cm , 0.1 s , 7.5 cm , $\frac{5}{4}$ a , 10 cm]

****

43- **the opposite figure find:**

❶ The points A, B represent ………. , ………..
❷ The horizontal distance between A,B = …….cm
❸ The perodic time = ………. s
❹ The amplitude = ………… cm
❺ wave velocity = …. × ….. = …… m/s



[crest , tough, half of wavelength = 10 cm , 0.2 sec ، 4cm ، 25 m/s)

****

44- The following table shows the relation between the wavelength (λ) and the frequency (υ) for a wave propagate in a medium:

λ (m)	1	٢	4	5	10
υ(Hz)	500	250	X	100	50

a) Draw the graph between (υ) on the vertical axis and ($\frac{1}{a}$) on the horizontal axis.

b) From the graph find :

❶ The value of X.

❷ The wave velocity through the medium. **(125 Hz , 500 m/s)**

45- The following table shows the relation between the wavelength (d) and the frequency (t) for a wave propagate in a medium:

d (m)	0	3	4	0	– 4	b	0
$t\times10^{-2}$(s)	0	a	10	20	30	35	40

a) Draw the graph between (d) on the vertical axis and (t) on the horizontal axis.

b) From the graph find :

❶ The value of a , b . **(0.05 s , – 4 s)**

❷ The amplitude of a wave. **(4 m)**

❸ The perodic time. **(0.4 s)**

❹ Frequency. **(2.5 Hz)**

****