Revision & Test Session

EVENING COACHING

10TH NOTES PHYSICS

Student Name :_____

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School :_____

Adress

(SIMPLE HARMONIC MOTION & WAVE)

FEDERAL BOARD BOOK

Exercises Solved

Q.1 Give an example of vibratory motion, which is not simple harmonic motion. Give a reason of your selection.

Ans: When a ball is dropped from an altitude on a perfectly elastic surface then the motion is vibratory motion as well as oscillatory but not simple harmonic because the restoring force F is equal to mg which is a constant and not F ∝ x, Which is an essential condition for S.H.M where in an oscillation the acceleration is proportional to the displacement.

Q.2 At extreme position, velocity is zero but acceleration is maximum in simple harmonic motion. Haw can you theoretically explain it?

Ans: Velocity is zero: In Simple Harmonic Motion when object moves towards extreme position then its velocity decreases and becomes zero at extreme position. The object is at rest for instant so the velocity is zero at extreme position. Acceleration is maximum: According to Hooke's law F = -kx

Its means restoring force is maximum at extreme position. Newton's second of motion tells us that acceleration is directly proportional to the force. So at extreme position when restoring force is maximum then acceleration is maximum.

Q.3 what will happen to acceleration of mass spring system if its mass is doubled?

Ans: According to Newton's second law of motion, the acceleration of the body is given by

F=ma

Its mean $a \propto \frac{F}{m}$

This shows that when the mass of mass spring system is doubles then its acceleration becomes half.

Q.4 A simple pendulum has time period 'T'. What will happens to its time period if its thread length is shorten to half?

Ans: Time period of simple pendulum is given by

If the thread length is shorten to half then the time period will be 0.707 time the original time period

Q.5 A simple pendulum has time period of 4 second. Will its time period remain same or change, if its steel bob is replaced by wood bob of same size?

Ans: Time period of simple pendulum is given by

This shows that time period of simple pendulum does not depends upon mass. So whatever the mass of the bob is, the time period will remain same. Its mean the time period will remain same if its steel bob of simple pendulum is replaced by wood bob of same size.

Q.6 Same masses are attached to different springs, one is vibrating faster why?

Ans: Frequency of mass spring system is given by

This equation shows that frequency depends upon the mass and spring constant. Same masses are attached, which means mass is constant then spring constant will be different for both springs. As spring constant k is directly proportional to the frequency of mass spring system. So, the spring system which has greater mass comparatively, must have greater frequency. Hence mass spring system which have greater mass is vibrating faster.

Q.7 A simple pendulum has time period "T" in Murree. In Karachi, it has different time period. What would you do to make its time period same as it was in Murree?

Ans: Time period of the simple pendulum is given by

It shows that time period of simple pendulum depends upon length of string and gravitational acceleration. Both places have different time periods due to variation in the value of g. We cannot change the value of gravitational acceleration. So to make the time period same on both places, we have to change the length of string of simple pendulum.

Q.8 What will happen to the frequency of waves in a ripple tank if time period of electrical vibrator is decreased? What will happen to the wave speed?

Ans: We know that time period is the reciprocal of the frequency of the wave.

This shows that if the time period of electrical vibrator is decreased then the frequency will increase. Now, we know that

This shows that time period is inversely proportional to the speed of the wave. So, if time period of electrical vibrator is deceased then the speed of the wave will increase.

Q.9 Why do water waves refract at the boundary of shallow water and deep water in ripple tank experiment?

Ans: The speed of water waves depends on the depth of water. Its speed is reduced when it enters shallow water. Their wavelength changes (decrease) but the frequency remains constant. The deeper the water, the faster the waves travel and so waves will refract (change direction) when they enter deeper or shallower water at an angle.

Q.10 Under what conditions are the waves diffracted the most?

Ans: The diffraction of waves depends upon the opening of the obstacles.

A Waves are diffracted most strongly when the size of the opening of obstacle is less than or equal to the size of the wavelength of generated waves.

Punjab Book

1. What is meant by oscillation?

Ans: When a body moves back and forth or to and fro about its mean position. This is called vibration or oscillation. Example: Motion of simple pendulum.

2. Define simple harmonic motion?

The acceleration of a body executing SHM is directly proportional to the displacement of the body from the mean position and is always directed towards the mean position.

Mathematically $a \propto -x$

3. Define Hooke,s law?

Ans: According to Hooke"s law the exerted force is directly proportional to the displacement .

$F \propto x \Rightarrow$ $\boxed{F = -kx}$

4. How does stiffness of the spring affect the value of k?

Ans: The value of k is a measure of the stiffness of the spring.

5. What is the function of restoring force during oscillatory motion?

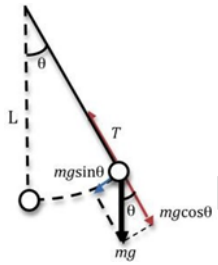
Ans:A restoring force always pushes or pulls the object performing oscillatory motion

$\boxed{F_r = -kx}$

towards the mean position.

6. Which type of forces are acting on a displaced pendulum?

Ans: The restoring force that causes the pendulum to undergo simple harmonic motion is the component of gravitational force $mg \sin\theta$



tangent to the path of motion.

7. Define time period and write down formulas of time period for mass attached to a spring and for simple pendulum?

Ans: Time Period (T): Time required to complete one vibration is called time period. It is denoted by "T". The time period T of the SHM of mass m attached to a spring is given by following equation: $T = 2\pi\sqrt{\frac{m}{k}}$

Formula for the time period of simple pendulum $T = 2\pi\sqrt{\frac{l}{g}}$

8. Define following terms which characterize SHM?

(i)Vibration (ii) Time period (iii) Frequency (iv) Amplitude (v) Displacement

Ans: (i) **Vibration:**- One complete round trip of a vibrating body about its mean position is called o vibration.

Time period (T): The time taken by a vibrating body to complete one vibration is called time period.

Frequency (f): The number of vibrations per cycle of vibrating body in one second is called its frequency. It is reciprocal of time period $f = \frac{1}{T}$

Amplitude (A): The displacement of a vibrating body on either side from its mean position to extreme position is called its amplitude.

Displacement (D) :- Distance covered by the vibrating body at any instant during the vibration from mean position.

9. Write down important features of Simple Harmonic Motion?

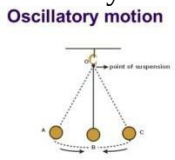
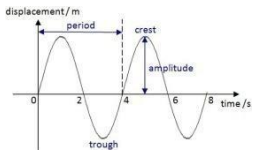
A body executing SHM always vibrates about a fixed position.

Its acceleration is always directed towards the mean position.

The magnitude of acceleration is always directly proportional to its displacement from mean position i.e. acceleration will be zero at the mean position while it will be maximum at the extreme positions.

Its velocity is maximum at the mean position and zero on the extreme positions.

10. Define time period and frequency in case of vibratory motion?

Case	Time Period	Frequency
Vibratory Motion 	The time required to complete one vibration is known as time period.	The number of vibrations completed in one second is known as frequency.
Waves 	The time required to pass one wave from a certain point is called time period.	The number of waves passing through a certain point in one second is known as frequency.

11. Differentiate between mechanical waves and electromagnetic waves?

Mechanical waves	Electromagnetic waves
The waves which require medium for their propagation are known as mechanical waves. Examples • Sound waves • Waves produced on a rope • Water waves	The waves which do not require medium for their propagation are known as electromagnetic waves. Examples • X-rays • Radio waves • Heat and light waves

12. Differentiate between transverse waves and compressional waves or longitudinal waves?

Transverse waves	Longitudinal waves.

The waves in which the direction of vibratory motion of particles of medium is perpendicular to the direction of propagation of waves are called transverse waves. Examples • Waves produced in a rope • Water waves • **Ripples on the surface of water.** • **Vibrations in a guitar string.** • **Electromagnetic waves – e.g. light waves, microwaves, radio waves.** • **Seismic S-waves.**	The waves in which the direction of vibratory motion of particles of medium is parallel to the direction of propagation of waves are called longitudinal waves. Examples • Sound waves • **Speaking on the mic** • **Earthquake (Seismic-P wave)**

13. Write down the relationship between frequency and time period ?

Ans: Frequency is a reciprocal of time period. $f = \frac{1}{T}$

14. Find the time period and frequency of a simple pendulum 1.0m long at a location where g = 9.8ms^{-2} ?

Ans: the given data L = 1.0m g = 9.8ms^{-2}

Putting the given value in time period of simple pendulum $T = 2\pi\sqrt{\frac{l}{g}}$

15. When the ball is at the centre of the bowl what will be the net force ?

Ans: When the ball is at the centre of the bowl the net force acting on the ball is zero because at this position weight of the ball acts downward and is equal to the upward normal force of the surface of the bowl.

16. What is the displacement of an object in a simple harmonic motion when kinetic energy and potential energy are equal?

Ans: Kinetic energy and potential energy are equal when the body is at the middle of mean and extreme position.

17. If we replace iron bob of simple pendulum with the wooden bob what will be affect of time period of simple pendulum?

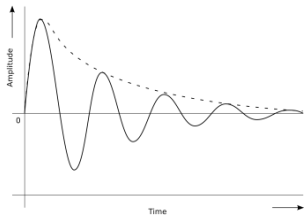
Ans: The time period of simple pendulum would remain same because period of a pendulum is independent of mass and amplitude.

Formula $T = 2\pi\sqrt{\frac{l}{g}}$

18. What is meant by damped oscillation?

Ans: The oscillations of a system in the presence of some resistive of force are damped oscillations.

19. How does the mechanical energy of system reduce?

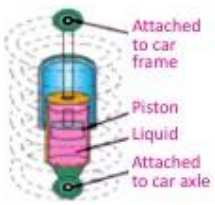


Ans:The friction reduces the mechanical energy of the system as time passes and the motion is said to be damped, this damping progressively reduces the amplitude of motion.

20. Explain the function of shock absorber (application of shock absorber).

Ans : Shock absorbers are one practical application of damped oscillation. A shock absorber consists of a piston moving through a liquid such as oil. The upper part of the shock absorber is

firmly attached to the body of car travels over a bump on the road, the car may vibrate violently. The shock absorbers damp these vibrations and convert their energy into heat energy of the oil.



21. How a wave can be defined? In which categories are these divided?

22. Ans: A wave is a disturbance in the medium which causes the particles of the medium to undergo vibratory motion about their mean position in equal interval of time. There are two types of waves. (i) Mechanical waves (ii) Electromagnetic waves

23. Define electromagnetic waves and give its examples?

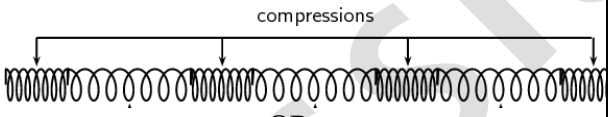
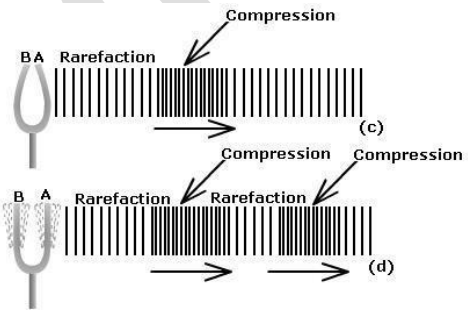
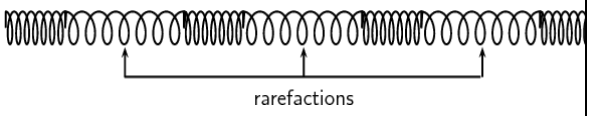
Ans: Waves which do not require a medium for their propagation are called electromagnetic waves.

Radio wave , *Heat waves , X rays*

24. Why mechanical waves do not pass through space?

Ans: No, mechanical waves do not pass through the space because they require medium for their propagation.

25. Differentiate between compression and rarefaction?

Compression	Rarefaction
The region of a wave where loops of spring are close together is called compression.  OR The region of a wave where particles of medium are closed to each other is called compression of wave. 	The region of a wave where the loops of spring are space apart is called rarefaction.  R The region of a wave where particles of medium are closed to each other is called compression of wave.

26. A wave moves on a slink with frequency of 4 Hz and wavelength of 0.4m.what is the speed of wave?

Ans: Given Data f = 4hz $\lambda = 0.4m$

Solve by using the formula v = fλ

$V = (4)(0.4)$, $V = 1.6ms^{-1}$

27. **If the length of a simple pendulum is doubled, what will be the change in its time period ?**

Ans:- If the length of pendulum is doubled then time period will be increase by $\sqrt{2}$ times.

Because the formula of time period = Formula $T = 2\pi\sqrt{\frac{l}{g}}$

If length is doubled L = 2L

$$T = 2\pi\sqrt{\frac{2l}{g}}$$

$$T = \sqrt{2}\ (2\pi\sqrt{\frac{2l}{g}})$$

So Time Period is increase $\sqrt{2}$ times.

28. **A ball is dropped from a certain height onto the flour and keeps bouncing. Is the motion of the ball simple harmonic? Explain.**

Ans: **No,** the ball will not execute S.H.M because its motion does not fulfill the conditions of S.H.M like its acceleration is not directed towards mean position.

29. **A student performed two experiments with a simple pendulum. He / She used two bobs of different massed by keeping other parameters constant. To his / her astonishment the time period of the pendulum did not change! Why?**

Ans: The time period of pendulum is independent of mass of bob. It depends upon the length of string of pendulum and gravitational acceleration, According to formula.

$$T = 2\pi\sqrt{\frac{2l}{g}}$$

30. **Plane waves in the ripple tank undergo refraction when they move from deep to shallow water. What change occurs in the speed of the waves?**

Ans: Speed of waves is larger in deep water than in shallow water. Due to difference in speed of waves in different medium, when they move from deep water to shallow water, causes them to change their direction, this change is called refraction of wave.

KPK BOARD

CONCEPTUAL QUESTIONS

Q1. Is every oscillatory motion simple harmonic? Give example.

Ans: No, it is not necessary for every oscillatory motion to be simple harmonic motion. Since all restoring forces are not proportional to the displacement. While for SHM the following two conditions must be satisfied.

a) The acceleration of the vibrating body is directly proportional to the displacement and is directed towards the mean position.
b) The resorting force is proportional to the displacement and is directed towards the mean position.

Example:

Motion of simple pendulum and spring mass system are both oscillatory and simple harmonic motion.

Whereas, the Earth revolving around the Sun, a bouncing ball are examples of oscillatory motion but not simple harmonic motion.

Q2. For a particle with simple harmonic motion, at what point of the motion does the velocity attain maximum magnitude? Minimum magnitude?

Ans: For a particle executing SHM its total energy at any instant of time is constant. That is the sum of kinetic and potential energy remains the same at every point.

When the particle is at mean position,the K.E is maximum so at this position the velocity of the particle will be maximum.

At extreme position the particle come to rest and due to restoring force it moves backward. Therefore, at extreme position it K.E is zero. So, at this position the velocity of the particle will be minimum or zero.

Q3. Is the restoring force on a mass attached to spring in simple harmonic motion ever zero? If so, where?

Ans: Yes, the restoring force in SHM become zero at the mean position. According to Hook's law, we have

F=-kx---------(1)

In equation (1) 'x' represents the displacement of vibrating body from mean position.

Now at the mean position, we have

x=0

so, equation (1) becomes

F=-k(0)

F=0 ------ (2)

Equation (2) shows that the restoring force is zero at mean position.

Q4. If we shorten the string of the pendulum to half its original length, what is the effect on its time period and frequency?

Ans: i) we know that the time period of simple pendulum is given by

$$T = 2\pi\sqrt{\frac{\ell}{g}} \quad \text{---------- (1)}$$

Put $\ell=\frac{\ell}{2}$ in eq (1), as length of string decreased to half, so we get

$$T' = 2\pi\sqrt{\frac{\ell/2}{g}}$$

$$T' = 2\pi\sqrt{\frac{\ell}{2g}}$$

$$T' = 2\pi\,\frac{1}{\sqrt{2}}\sqrt{\frac{\ell}{g}}$$

$$T' = \frac{1}{\sqrt{2}}\left(2\pi\sqrt{\frac{\ell}{g}}\right)$$

$$T' = \frac{1}{\sqrt{2}}\mathrm{T}$$

$$T' = \frac{T}{\sqrt{2}} \quad \text{------- (2)}$$

Equation (2) shows that the time period will decreased by the factor $\frac{1}{\sqrt{2}}$ when the length of the string becomes half.

ii) The frequency of the simple pendulum is given by formula

$$f = \frac{1}{2\pi}\sqrt{\frac{g}{\ell}} \quad \text{---------- (3)}$$

Put $\ell=\frac{\ell}{2}$ in eq (3), as length of string decreased to half, so we get

$$f' = \frac{1}{2\pi}\sqrt{\frac{g}{\ell/2}}$$

$$f' = \frac{1}{2\pi}\sqrt{\frac{2g}{\ell}}$$

$$f' = \frac{1}{2\pi}\sqrt{2}\sqrt{\frac{g}{\ell}}$$

$$f' = \sqrt{2}\left(\frac{1}{2\pi}\sqrt{\frac{g}{\ell}}\right)$$

$$f' = \sqrt{2}f \quad \text{------ (4)}$$

Equation (4) shows that the frequency will increase by the factor $\sqrt{2}$ when the length of the string becomes half.

Q5. A thin rope hangs from dark high tower so that its upper end is not visible. How can the length of the rope be determined?

Ans: To determine the length of rope we attach a stone to its lower end of rope, so that the arrangement becomes like a simple pendulum.

Now time period of simple pendulum is

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

Squaring both sides

$$(T)^2 = (2\pi\sqrt{\frac{\ell}{g}})^2$$

$$\Longrightarrow T^2 = 4\pi^2\frac{\ell}{g}$$

$$\Longrightarrow \quad gT^2 = 4\pi^2\ell$$

$$\Longrightarrow \ell = \frac{gT^2}{4\pi^2} \text{ ------ (1)}$$

Now set pendulum into vibration and note the time period of pendulum for one vibration which gives the time period. Put values of "g", "T" and "π" in eq(1) the length of rope can be calculated.

Q6. Suppose you stand on a swing instead of sitting on it. Will your frequency of oscillation increase or decrease?

Ans: The swing may be considered as a simple pendulum. As we know that

$$f = \frac{1}{2\pi}\sqrt{\frac{g}{\ell}} - - - (1)$$

Where ℓ =length of the pendulum, which is equal to the distance from the point of suspension to the center of mass of the person on the swing.

Earlier, when a person is sitting on the swing, the Centre of mass was far from the point of suspension.

As person stand up on the swing the length between the centre of mass of a person and the point of suspension decreases.

It is clear from equation (1), that frequency of oscillation is inversely proportional to the square root of length of the pendulum. So frequency of oscillation increases as length decreases when the person stands up instead of sitting.

Q7. Explain the difference between the speed of transverse wave traveling along a cord and the speed of a tiny colored part of the cord?

Ans: Transverse waves are those in which particles of the medium vibrate at right angle to the direction of propagation of wave motion.

Consider a cord having a colored tiny part. It's one end is fixed and the other end is in our hand. If we move our hand up and down transverse waves are produced moving in forward direction. As these are transverse waves, so each part of the string moves up and down i.e. vibrating up and down, while the transverse waves move in the forward direction. Thus, transverse waves move in the forward direction while the colored tiny part of the string moves up and down executing SHM.

Q8. Why waves refract at the boundary of shallow and deep water?

Ans: Refraction of waves involves a change in the direction of waves as they pass from one medium to another. In refraction, both speed and wavelength of waves change. The speed of a wave depends upon the properties of a medium through which it travels. The speed of waves is not same in shallow and deep water. Wave travel faster in deep water as compared to shallow water. Refraction occurs as the speed of the wave changes.

Thus, if water waves are passing from deep water into shallow water, they slow down. The speed of wave is proportional to the wavelength. So when waves are transmitted from deep water into shallow water, its speed and wavelength decreases and wave change its direction i.e. refracted.

Q9. What is the effect on diffraction if the opening is made small?

Ans: Diffraction is the bending of waves around corners of an obstacle. The amount of bending of a wave depends upon the relative size of the wavelength of the wave and size of the opening.

If the opening is much larger than the wavelength, then very less bending occurs which is un-noticeable. However, the separation is comparable to the size of the wavelength, and then a considerable bending occurs and can be seen easily with naked eye. Thus, the wave bends more and more if the opening is made small.

ASSIGNMENTS

10.1 When an object oscillates with a frequency of 0.5 Hz, what is its time period?

Given data:

Frequency=f=0.5 Hz

Required:

Time period=T=?

Solution:

Using formula

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

$=\frac{1}{0.5}$

$=\frac{10}{5}$

T=2 sec

10.2 Determine the restoring force of a spring displaced 1.5 m, with the spring constant of 30.0 N/m.

Given data:

Displaced=x= 1.5 m

Spring constant =k= 30.0 N/m

Required:

Restoring force= F_{res}=?

Solution:

We know that

F_{res}= -kx

= -(30.0)(1.5)

F_{res} = -45 N

10.3 A body of mass 0.2 kg is attached to a spring placed on a frictionless horizontal surface. The spring constant of spring is 4 N/m. Find the time period of oscillating mass spring system.

Given data:

Mass =m= 0.2 kg

Spring constant =k= 4 N/m

Required:

Time period=T=?

Solution:

We know that

$T = 2\pi\sqrt{\frac{m}{k}}$

Putting values

$$T = 2(3.14)\sqrt{\frac{0.2}{4}}$$

$$= 2(3.14)\sqrt{0.05}$$

$$= 6.28 \times 0.223$$

T = 1.4 sec

10.4 At what angle must a pendulum be displaced to create a restoring force of 4.00 N or a bob with a mass of 500.0g?

Given data:

Restoring force=F_{res}= 4.00N

Mass=m=500.0 g =0.5 kg

Required:

Angle=θ =?

Solution:

By using formula

F_{res}=mg $sin\theta$

$$\frac{F_{res}}{mg} = sin\theta$$

$$=> sin\theta = \frac{F_{res}}{mg}$$

$$\theta = \sin^{-1}\frac{F_{res}}{mg}$$

$$\theta = \sin^{-1}\frac{4.00}{(0.5)(9.8)}$$

$$\theta = \sin^{-1}\frac{4.00}{4.9}$$

$$\theta = \sin^{-1} 0.816$$

$$\theta = 54.6^{o}$$

10.5 What is the gravitational field strength at the top of the Mount Everest at an altitude of 8954.0m, if a pendulum with a length of 1.00m has a period of 2.01 sec?

Given data:

Length=ℓ=1.00m

Time period=T=2.01 sec

Required:

Gravitational field strength=g=?

Solution:

We know that

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

$$T^2 = \left(2\pi\sqrt{\frac{\ell}{g}}\right)^2$$

$$T^2 = 4\pi^2\frac{\ell}{g}$$

$$gT^2 = 4\pi^2\ell$$

$$g = \frac{4\pi^2\ell}{T^2}$$

$$g = \frac{4(3.14)^2 \times (1.00)}{(2.01)^2}$$

$$g = \frac{4 \times 9.8596 \times 1.00}{4.0401}$$

$$g = \frac{39.4384}{4.0401}$$

g=9.761 m/s^2

10.6 A sound wave of wavelength 1.7x10^{-2} m. Calculate the frequency of sound if its velocity is 343.4 m/s?

Given data:

Wavelength= λ =1.7x10^{-2} m

Speed of sound= v =343.4m/s

Required:

Frequency = f=?

Solution:

As we know that v=fλ

f=$\frac{v}{\lambda}$ → (1)

Putting values in equation (1) we get,

$f = \frac{343.4}{1.7 \times 10^{-2}}$

f= 202.0x10^{2}Hz

f= 2.20x10^{4}Hz

This is the required frequency of the wave.

NUMERICAL QUESTIONS

1. **A mass hang from a spring vibrates 15 times in 12sec. calculate (a) the frequency and (b) the period of the vibration.**

Given data:

No. of vibrations=N=15

Time for 15 vibrations=t=12sec

Required:

(a) Frequency=f=?

(b) Time period=t=?

Solution:

a. Frequency =f=$\frac{N}{t}$

Putting the values in eq, we get

f=$\frac{15}{12}$

f=1.25Hz

b. We know that

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

Putting values

=$\frac{1}{1.25}$

T=0.8 sec

2. A spring requires a force of 100.0N to compress it to a displacement of 4cm.what its spring constant?

Given data:

Force=F=100.0N

Displacement=x=4cm=4/100m=0.04m

Required:

Spring constant=k=?

Solution:

We know

F=kx

$k = \frac{F}{x}$

$= \frac{100}{0.04}$

=2500N/m

k=2.5×10^3N/m

3. A second pendulum is a pendulum with period of 2.0 sec. How long must a secoı pendulum be on earth (g=9.8m/s^2) and moon (where g=1.62 m/s^2)? What is t frequency of second pendulum at earth and on moon?

Given data:

Time period=T=2.0sec

Gravity on earth=g_e=9.8m/s^2

Gravity on earth=g_m=1.62m/s^2

Required:

i. Length of pendulum on earth=ℓ_e=?

ii. Length of pendulum on moon=ℓ_m=?

iii. Frequency of pendulum on earth=f_e=?

iv. Frequency of pendulum on moon=f_m=?

Solution:

i. We know that

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

$$T^2 = \left(2\pi\sqrt{\frac{\ell}{g}}\right)^2$$

$$T^2 = 4\pi^2\frac{\ell}{g}$$

$$T^2 g = 4\pi^2\ell$$

$$\frac{T^2 g}{4\pi^2} = \ell$$

$$=> l = \frac{T^2 g}{4\pi^2}$$

On earth

$$=> \ell_e = \frac{T^2 g_e}{4\pi^2} \quad \text{---------- (1)}$$

Putting values in eq (1) we get

$$\ell_e = \frac{(2.0)^2 \times (9.8)}{4(3.14)^2}$$

$$\ell_e = \frac{4 \times (9.8)}{4 \times 9.8596}$$

$$\ell_e = \frac{9.8}{9.8596}$$

$$\boxed{\ell_e = 0.99\text{m}}$$

ii. For moon, we replaced"ℓ_e" by"ℓ_m" and "g_e" by "g_m" in eq (1) ,we get

$$\ell_m = \frac{T^2 g_m}{4\pi^2}$$

Putting values

$$\ell_m = \frac{(2.0)^2 \times (1.62)}{4(3.14)^2}$$

$$\ell_m = \frac{4 \times (1.62)}{4 \times 9.8596}$$

$$\ell_m = \frac{1.62}{9.8596}$$

$\ell_m = 0.164m$

$\boxed{\ell_m = 0.16m}$

iii. The frequency of pendulum is given by

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

Frequency on Earth

$$f_e = \frac{1}{T}$$

Putting values

$$f_e = \frac{1}{2.0}$$

$\boxed{f_e = 0.5Hz}$

iv. Frequency on Moon

$$f_m = \frac{1}{T}$$

Putting values

$$f_m = \frac{1}{2.0}$$

$\boxed{f_m = 0.5Hz}$

4. Calculate the period and frequency of a propeller on a plane if it completes 250 cycles in 5.0 sec.

Given data:

No. of cycles=N=250

Time for 250 cycles=t=5.0sec

Required:

i. Time period=T=?

ii. Frequency=f=?

Solution:

i. We know that

$$T = \frac{t}{N}$$

Putting values

$$T = \frac{5.0}{250}$$

$T = 0.02\ sec$

ii. We know that

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

Putting values

$$f = \frac{1}{0.02}$$

$$f = 50Hz$$

5. Water waves with wavelength 2.8m, produced in a ripple tank, travel with a speed of 3.80m/s. What is the frequency of the straight vibrator that produced them?

Given data:

Wave length $=\lambda = 2.8m$

Speed of waves= $v = 3.80m/s$

Required:

Frequency=f=?

Solution:

We know that

$v = f\lambda$

$$f = \frac{v}{\lambda}$$

Putting values

$$f = \frac{3.80}{2.8}$$

$$f = 1.357Hz$$

$$f = 1.4Hz$$

6. The distance between successive crests in a series of water waves is 4.0m and the crests travels 9.0m in 4.5 sec. What is the frequency of the waves?

Given data:

Distance=s=9.0m

Wavelength= $\lambda = 4.0m$

Required:

Frequency=f=?

Solution:

We know that

$$v = \frac{s}{t}$$

Putting values

$$v = \frac{9.0}{4.5}$$

$$v = 2m/s \quad ------i)$$

As we know that

$v = f\lambda$

$f = \frac{v}{\lambda}$

Putting values

$f = \frac{2}{4.0}$

$f = 0.5Hz$

7. A station broadcasts an AM radio wave whose frequency is 1230×10^3Hz (1230kHz on the dial) and an FM radio waves whose frequency is 91.9×10^6Hz (91.9 MHz on the dial). Find the distance between adjacent crests in each wave.

Given data:

Frequency of AM radio=f_{AM}=1230×10^3Hz

Frequency of FM radio=f_{FM}=91.9×10^6Hz

Speed of radio waves= $v = c$ =3×10^8m/s

Required:

i. Wavelength of AM radio waves= λ_{AM}=?

ii. Wavelength of FM radio waves= λ_{FM}=?

Solution:

i. We know that

$v = f\lambda$

⇨ $c = f_{AM}\lambda_{AM}$

⇨ $\lambda_{AM} = \frac{c}{f_{AM}}$ -------1)

Putting values in eq (1), we get

$$\lambda_{AM} = \frac{3\times10^8}{1230\times10^3}$$

$$\lambda_{AM} = 2.44\times10^2 m$$

$\lambda_{AM} = 244.0m$

ii. For FM waves, eq (1) can be written as

$\lambda_{FM} = \frac{c}{f_{FM}}$ -------2)

Putting values in eq (2), we get

$$\lambda_{FM} = \frac{3\times10^8}{91.9\times10^6}$$

$$\lambda_{FM} = 0.0326\times10^2 m$$

$$\lambda_{FM} = 3.26m$$

FEDERAL BOARD BOOK

CH#11(SOUND)

Exercises Solved

Q.1 Why does sound travel faster in solids than liquids and gases?

Ans: Sound travels more quickly through solids than through liquids and gases because the molecules of a solid are closer together and, therefore, can transmit the vibrations (energy) faster. Sound travels slowly through liquid because the molecules of a liquid having space more than solid but less then gases. And sound travels most slowly through gases because the molecules of a gas are farthest apart.

Q.2 Why are we able to distinguish between two sounds having same loudness?

Ans: Sounds of same loudness will have same amplitude and sound of same pitch will have same frequency. So, quality helps to distinguish the sound waves having same loudness and same pitch. The quality of sound is that characteristic which enables us to distinguish one sound from another having the same pitch and loudness. The sound which is more pleasant is said to be of a rich quality.

Q.3 Vibrating mobile phone on wooden table sounds louder than held in hand. Why?

Ans: We know that loudness of the sound depends upon the surface are of the vibrating body. When the vibrating mobile phone is in contact with the table, the vibration of the mobile phone is being transmitted to the surface of table whose surface area is very large as compared to the surface area of hand. Hence vibrating mobile phone on wooden table sounds louder due to large surface area.

Q.4 During a match in cricket stadium, you see a batsman striking the ball but we hear stroke sound slightly later. Explain this time difference?

Ans: Speed of light in air is larger than the speed of sound.

During a match in cricket stadium, when the batsman strikes the ball then we can it see but we hear the stroke slightly later. This is because the speed of sound is less than the speed of light in air. That's why the stroke seems first but we hear it slightly later.

Q.5 How much intensity level increases when intensity of louder sound is double the intensity of faintest audible sound?

Ans: As we know that

Thus the sound level increase by 3dB.

Q.6 Two singers are singing together simultaneously with intensity level 60dB of each in a hall.

a. Is intensity of sound in the hall is doubled? b. Is the intensity level of sound is doubled?

Ans: (a) Sound level is defined on a non-linear scale. If two singers are singing together and each creates an intensity level of 60dB (corresponding intensity = 1x 10-wm-2, then total intensity level at that point is 120dB.

(b) As we know that $\Delta\beta = 10\log I$ dB

Here I is the combined intensity of the two sounds, while lo is the reference intensity and is taken as the intensity of the single sound.

$\Delta\beta = 3$dB Thus intensity of sound will increase three times.

Q.7 If pitch of sound is increased then that is its effect on:

a) Frequency of sound b) Speed of sound C) Intensity of sound d) Loudness of sound e) Wavelength

a) **Frequency of sound**: Pitch of sound is directly proportional to frequency, so when pitch increases then frequency also increases.

b)**Speed of sound:** Speed of sound remains same because speed of sound depends on the medium and not on pitch.

c)**Intensity of sound:** Intensity of sound remains same because intensity of sound depends on the medium and not on pitch.

d)**Loudness of sound:** Loudness of sound remains same because loudness of sound depends on the medium and not on pitch.

e)**Wavelength:** Wavelength will decrease with increase in pitch of sound. As m

Q.8 Vibrating bodies produce sound. When a pendulum vibrates, we do not hear its sound. Why?

Ans: A sound is heard only if the body vibrates at a frequency more than 20 Hz and less than 20,000 Hz. The pendulum oscillates at a frequency less than 20 Hz. Hence, no sound is heard.

Q.9 Two students are talking in the corridor of your school, you can hear them in your class room but you cannot see them. Why?

Ans: It happens due to diffraction. Diffraction is a phenomenon of bending of a wave on corners, having size of the order of wavelength of the wave. Sound waves can bend at the corners but light waves cannot. So when two students talk in the corridor of school, sound is diffracted by corner and we able to hear it but cannot see them.

Q.10 How do curtains help to reduce loudness of sound?

Ans: Curtains can absorb sound from coming into home, or even control the sound within a room to reduce echoes and reverberation. However, not all curtains will work towards absorbing sound, so there are factors to consider in order to get the best results:

- Sound absorbing vs soundproofing
- Material
- Density
- Coverage

Q.11 What steps would you take to stop echoing in a large room?

Ans: We can take following steps to stop echoing in a large room.

Cover the Floor. Carpets and rugs do more than provide soft padding for your feet.

Cover the Walls and Windows. Wall and window coverings reduce the amount of sound reflecting off window glass and hard wall surfaces.

Fill Rooms with Furnishings.

Install Acoustic Panels.

PUNJAB BOARD

1. What is necessary condition for the production of sound?

Ans: *Sound is produced by vibrating bodies*. Due to vibration of bodies the air around them also vibrates and the air vibration produces sensation of sound in air.

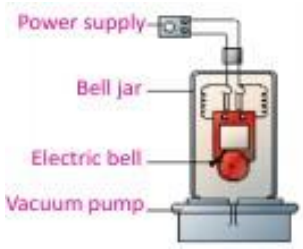
2. What is the effect of the medium on the speed of sound ? In which medium sound travels more faster; air, solid or liquid? Justify your answer.

Ans: Every medium has distinct density. Speed of sound increases with the increase in density. So, the speed of sound is maximum in solids due to their high density. Speed of sound in solids is about fifteen times than that in gases and speed of sound in liquid is five times than gases.

3. How can you prove the mechanical nature of sound by a simple experiment?

Ans: Sound waves require material medium for their propagation, therefore, they are mechanical waves.

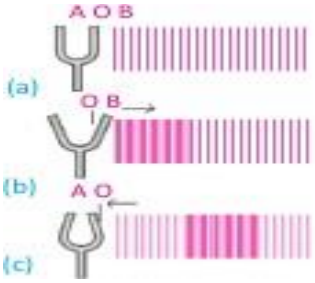
Experiment: Suspend an electric bell in bell jar with help of two wires connected to a power supply. When we switch ON the power supply, electric bell will begin to ring. Now pump out air from jar by vacuum pump. Again switch ON, no sound is heard in absence of air as a medium. Now start pumping out air from jars, the sound of bell starts becoming more and more feeble and eventually dies out. *It is concluded that sound waves can only propagate in presence of air (medium).*



4. What do you understand by the longitudinal wave? Describe the longitudinal nature of sound waves.

Ans: **Longitudinal waves: "***In longitudinal wave the particles of the medium move back and forth along the direction of propagation of wave*.**"**

Explanation: Propagation of sound waves produced by vibrating tuning fork can be understood by a vibrating tuning fork as shown in fig. before the vibration of tuning for, density of air molecules on the right side is uniform (Fig a). When the right prong of tuning fork moves from mean position O to B (Fig b), it exerts some pressure on the adjacent layer of air molecules and produces a compression and after some time rarefaction is also produced thus this sound wave show the longitudinal nature.



5.Sound is aform of wave. List at least three reasons to support the idea that sound is a wave.

Ans:**Reasons:** Sound is a form of wave as:

- Sound shows reflection like waves.
- Sound shows refraction like waves.
- Sound shows diffraction like waves.

6.What is the difference between the loudness and intensity of sound? Derive the relationship between the two.

Ans:Loudness of sound:"It is the characteristics of sound by which loud and faint sound can be distinguished."

Intensity of sound:"Sound energy passing per second through a unit area held perpendicular to the direction of propagation of sound waves is called intensity of sound."

Relationship between loudness and intensity of sound: Loudness (L) is directly proportional to the logarithm of

Where K is constant of proportionality.

7.On what factors does the loudness of sound depend?

Ans:Factors: Loudness of sound depends upon number of actors. Some of them are given below:

- Amplitude of vibrating body
- Area of vibrating body
- Distance from vibrating body

8. What do you mean by the term intensity level of the sound? Name and define the unit of intensity level of sound.

Ans: Intensity level of the sound:"The difference between loudness L of unknown sound and loudness Lo is called intensity level of sound."

Unit:The unit of intensity level of sound is bel. Bel is bigger unit while decibel is a smaller unit.

1bel = 10dB

9.What are the units of loudness? Why do we use logarithmic scale to describe the range of the sound intensities we hear?

Ans:Unit of Loudness: Loudness depends upon the physical condition of the listener. It has no specific units. It is measured in terms of intensity level whose unit is (bel).

The use of logarithmic scale is due to the following law i.e. Loudness is directly proportional to logarithm of intensity. So, we use logarithmic scale.

10.What is Difference between frequency and pitch?

Ans:Frequency:"Number of waves passing through a point in unit time is called frequency." Pitch:"It is the characteristics of sound by which we distinguish between a shrill and an grave sound." Relation between frequency and pitch: Frequency is directly proportion to pitch.

11.Describe the effect of change in amplitude on loudness and the effect of change in frequency on pitch of sound.

Ans:If the amplitude of vibrating body increases then loudness also increases, and vice versa. Similarly if frequency increases pitch also increases and vice versa.

12.If the pitch of sound is increased, what are the changes in the following?
(a)Frequency (b) wave length(c) wave speed (d) Amplitude

Ans:
(a) If the pitch of sound is increased, frequency also increases.
(b) Wavelength decreases when pitch of sound increases.
(c) Wave velocity remains same.
(d) Amplitude doesn‟t change.

13.If we clap or speak in front of a building while standing at a particular distance, we rehear our sound after sometime. Can you explain how does it happen?

Ans: This sound which we hear is called an echo and is a result of reflection of sound from the surface. When sound is incident on the surface of a medium it bounces back into the first medium. This phenomenon is called echo or reflection of sound.

14. What is the audible frequency range for human ear? Does this range vary with the age of people? Explain.

Ans: Audible frequency range is from 20Hz to 20,000H and it varies with the age of people.

15.Explain that noise is a nuisance.

Ans: Noise is a nuisance: Some sounds produce unpleasant effects on our ears such as sound of machinery, the slamming of a door, and sound of traffic in big cities. Sound which as jarring and unpleasant effect on

our ears is called noise. Noise corresponds to irregular and sudden vibrations produced by some sounds. Noise has negative effects on human health as it can cause conditions such as hearing loss, sleep disturbances, aggression, hypertension, high stress levels. Noise can also cause accidents by interfering with communication and warning signals.

16.Describe the importance of a acoustic protection.

Ans: Importance of Acoustics protection:

- Reflection of sound is less prominent if the surface is soft and irregular, but it is more prominent on rigid and smooth surface.
- Soft porous material such as draperies and rugs absorb large amount of sound energy and thus quit echoes and softening noises.
- By using soft and sound insulating materials and double glazed windows we can reduce the level of noise pollution.

If surface of the class rooms and public halls are too absorbent, then sound level is low for audience.

17.What are the uses of ultrasound in medicine?

Ans: Uses of Ultrasound:

- In medical field, ultrasonic waves are used to diagnose and treat different ailments.
- Powerful ultrasound is now being used to remove blood clots formed in the arteries.
- Ultrasound can also be used to get the pictures of thyroid gland for diagnosis purposes.

Conceptual Questions

1.Why two tin cans with a string stretched between them could be better way to communicate than merely shouting through the air?

Ans: Reasons:

- It is due to the fact that speed of sound is 15 times higher in solids than air. So, it is easy to communicate through tin cans.
- The other reason is that, it avoids spreading of sound waves in air.

2.We can recognize persons speaking with the same loudness from their voice. How is this possible?

Ans: We can recognize persons due to difference in the quality of their sounds because every person has unique quality of sound.

3.You can listen to your friend round a corner, but you cannot see him / her. Why?

Ans: Diffraction of sound is more prominent than diffraction of light as light waves have smaller wavelength than sound waves. So, you can‟t see your friend at a round corner but listen him / her.

4.Why must the volume of a stereo in a room with wall-two-wall carpet be tuned higher than in a room with a wooden floor?

Ans: The reflection of sound waves in wooden floor is maximum so, the sound will be higher. On the other hand, in a carpeted room reflection of sound waves is minimum so, the sound will be lower.

5.A student says that the two terms speed and frequency of the wave refer to the same thing. What is your response?

Ans: Speed is the distance covered by waves in unit time while frequency is number of waves passing from a point in unit time so, they are two different quantities. But the time factor is similar in both quantities.

6.Two people are listening to the same music at the same distance. They disagree on its loudness. Explain how this could happen?

Ans: Loudness depends upon the physical conditions of listener so, the sound appears louder to a person with a sensitive ear than a person with defective ears.

7.Is there any difference between echo and reflection of sound? Explain.

Ans: There is no difference between echo and reflection of sound because when sound falls on the surface of medium then, it bounces back to first medium this is called reflection of sound or echo of sound.

8.**Will two separate 50dB sounds together constitute a 100dB sound? Explain.**

Ans: No, since decibel scale is not a linear scale but a logarithmic scale, therefore, they cannot be added simply. Hence, two separate 50 dB . Sounds together would 100dB sound.

9.Why ultrasound is useful in medical field?

Ans: **Uses of Ultrasound:**

i. In medical field, ultrasonic waves are used to diagnose and treat different ailments.

ii. Powerful ultrasound is now being used to remove blood clots formed in the arteries.

iii. Ultrasound can also be used to get the pictures of thyroid gland for diagnostic pure Poses

Kpk board

Conceptual Questions

Give a brief response to the following questions.

Q1. Why sound produced by a simple pendulum is not heard?

Ans: The waves produced by a simple pendulum not heard because the frequency of these waves is less than 20Hz and the membrane of human ear can only detect those sound whose frequency is greater than 20Hz and below than 20,000Hz. The frequency of waves produced by a simple pendulum is less than 20Hz that is why we cannot hear such sounds of low frequencies.

Q2. If a ringing bicycle bell is held tightly by hand, it shops producing sound. Why?

Ans: When a body vibrates sound is produced due to vibrations. Thus if a ringing bicycle bell is held tightly by hand, it stops producing sound because its vibrations die out and as a result bell will produce no sound.

Q3. Why is the intensity of an echo less than that of original sound?

Ans: The intensity of an echo less than that of original sound becauseintensity decreases with distance and the sound has traveled from the source to a reflecting surface and back.

When the sound strikes with wall, it imparts some of its energy to the wall. Thus the reflected waves possess less energy and become less intens e. Therefore, the intensity of an echo is less intense than the original sound waves.

Q4. In which medium air or water, an echo heard sooner. Why?

Ans: An echo is heard sooner in water as compared to air because the speed of sound depends on the elasticity of the medium. The more elastic a medium the greater will be the speed of sound and vice versa. So water is more elastic than air. The sound will travel faster in water that is why, we heard on echo sooner in water as compare to air.

Q5. Why sound cannot be heard on moon?

Ans: Sound waves are longitudinal waves which needs a material medium for their propagation. In moon atmosphere there is no material medium that is why sound cannot be heard on moon.

Q6. If a person places his ear on rails of railroad for determination of coming train. Why is this done, and how does it work?

Ans: The person places his ear on rails of railroad in order to indicate the coming train earlier because sound travels faster in solids (steel) as compared to air.

In steel the speed of sound is about 4500 m/s while in air it is just 343 m/s (at temperature of 20°C). Due to high speed of sound in steel, when ear is placed on the rail, a person may easily hear the sound due to vibration of railroad which indicates the coming train before he see it.

Q7. When you watch a thunderstorm, you see the lightning first, and you hear the thunder afterward. Why is the thunder delayed?

Ans: The thunder light is seen earlier than thunder sound is heard because light travels much faster than sound in air.

Speed of light in air is 3×10^8 m/s whereas the speed of sound in air is 343 m/s. Thus, because of this reason we see the light of thunder much earlier than we hear its sound.

Q8. If the speed of sound is dependent on frequency, would music from marching band be enjoyed?

Ans: No, if the speed of sound is dependent on frequency, then it will not be possible for us to enjoy the music from marching band.

The universal relation for the speed of sound wave is given by

$$v = f\lambda ----(1)$$

Eq (1) shows that, the speed of sound is not dependent on the frequency of sound.

If the speed depends upon the frequency of sound, then sound of different instruments (having different frequencies) will be heard at different speeds. This will produce an unpleasant effect on our ear and we get disturbed.

Q9. Why does your voice sound fuller in the shower?

Ans: Mostly our bathroom is made up of tiles or others hard non absorbent surfaces. Sound reflects better from these types of surfaces. The multiple reflections from these walls enrich the sound and making voice louder and more powerful.

Reverberation also makes the sound richer and fuller. It occurs when our ear picks many echo's in a very short interval of time.

There occurs resonance as well, as a result of which we hear loud sound. It occurs when the frequency of the sound wave produced matches the frequency of the shower.

Due to these effects the sound in a shower is fuller and richer.

Q10. Why is it so quiet after a snowfall?

Ans: Snow is porous and is a good sound absorber. When snow accumulates on the ground, it acts as a sound absorber, damping sound waves like other sound absorbing materials. Snow wraps everything in a thick blanket, which acts as a sound barrier. A very little sound energy is reflected when sound waves hit the snow surface. Due to its porous nature, sound waves enter into its

surface and make multiple reflections, due to which considerable amount of energy is absorbed. Thus there is so quite after a snowfall.

ASSIGNMENTS:

11.1 Suppose that when a certain sound intensity level (dB) triples, the sound intensity (in W/m2) also triples. Determine this sound intensity level.

Given data:

Intensity of sound =I=$3I_o$

Required:

Intensity level=β=?

Solution:

We know that

$$\beta = 10log\frac{I}{I_o} - - - -(1)$$

Putting values in eq (1)

$$\beta = 10log\frac{3I_o}{I_o}$$

$$\beta = 10log3$$

$$\beta = 10 \times (0.477)$$

$$\beta = 4.77d\text{B}$$

11.2 If the time between seeing lightning and hearing the thunder is 5.0s. The speed of sound is 343m/s, how far away is the lightning?

Given data:

Time=t=5.0sec

Speed of sound =v=343m/s

Required:

Distance of lighting =S=?

Solution:

As we know that

$$S = vt - - - -(1)$$

Putting values in eq (1), we get

$$S = 343 \times 5.0$$

$$S = 1715m$$

Or

$$S = \frac{1715}{1000}km$$

$$S = 1.715km$$

Or

$$S = 1.7km$$

11.3 What is the frequency of sound with wavelength 0.25m in air with temperature of 32° C?

Given data:

Wavelength =λ= 0.25m

Temperature =T=32°C

Required:

Frequency=f =?

Solution:

We know that speed of sound in terms of temperature is

$$v = 331 + 0.6T ----(1)$$

Putting T =32°C in eq (1), we get

$v = (331 + 0.6 \times 32)m/s$

$v = (331 + 19.2)m/s$

$v = 350.2m/s$

$v = 350m/s$

Now for finding the frequency, we have

$v = f\lambda$

$f = \frac{v}{\lambda} ----(1)$

Putting the values in eq (1), we get

$f = \frac{350}{0.25}$

$f = 1400Hz$

11.4 A man stands in between two parallelcliffs and fires a gun; he hears two successive echoes after 3s and 5s. What is the distance between cliffs?

Given data:

Time for first echo =T_1=3s

Time for second echo =T_2=5s

Speed of sound=v=330m/s

Required:

Distance between two cliffs=S=?

Solution:

I. First we find the distance between the 1st cliff and man=S_1=?

Time taken by sound waves to reach the 1st cliff = $t_1=\frac{T_1}{2}$

$$= \frac{3}{2} sec$$

$$= 1.5sec$$

Distance of man from 1st cliff =S_1=?

As we know that

$$S = vt$$

$$\Rightarrow S_1 = vt_1$$

$$\Rightarrow S_1 = 330 \times 1.5$$
$$\Rightarrow S_1 = 495m$$

II. Now, we find the distance between the 2nd cliff and man=S_2=?

Time taken by sound waves to reach the 2nd cliff = $t_2=\frac{T_2}{2}$

$$= \frac{5}{2} sec$$
$$= 2.5sec$$

Distance of man from 2nd cliff =S_2=?

As we know that

$$S = vt$$
$$\Rightarrow S_2 = vt_2$$
$$\Rightarrow S_2 = 330 \times 2.5$$
$$\Rightarrow S_2 = 825m$$

Now the distance between two cliffs is given by

$$S = S_1 + S_2$$

Putting values

$$S = (495 + 825)m$$
$$S = 1320m$$

NUMERICAL QUESTIONS

1. **The sound intensity 3m from a jackhammer is 8.20×10^{-2} W/m^2. What is the sound intensity in decibels? (use the usual reference level of $I_o = 1.00\times10^{-12}$W/m^2)**

Given data:

Intensity of sound=I=8.20×10^{-2} W/m^2

Usual reference level= $I_o = 1.00\times10^{-12}$W/m^2

Required:

Intensity level=β =?

Solution:

We know that

$$\beta = 10log\frac{I}{I_o}$$

Putting values

$$\beta = 10log\left(\frac{8.20 \times 10^{-2}}{1.00 \times 10^{-12}}\right)$$
$$\beta = 10log(8.20 \times 10^{10})$$
$$\beta = 10 \times 10.91381385\ dB$$
$$\beta = 109.138\ dB$$
$$\beta = 109.14\ dB$$

Hence, intensity level = $\beta = 109.14\ dB$

2. **A ship is anchored where the depth of water is 120m. An ultra-sonic signal sends to the bottom of the lake returns in 0.16s. What is the speed of sound in water?**

Given data:

Depth of water =S=120m

Total time=T=0.16s

Time taken by the sound to reached the bottom of water=t=T/2

$$t = \frac{0.16}{2}\ sec$$

$$t = 0.08\ sec$$

Required:

Speed of sound=v=?

Solution:

We know that

$$S = vt$$

$$\Rightarrow v = \frac{S}{t} - - - (1)$$

Putting values in eq (!1), we get

$$v = \frac{120}{0.08}$$

$$v = 1500 m/sec$$

3. **A gunshot from a .22 rim fire rifle has an intensity of about I= (2.5×10^{13}) Io. Do we need to wear ear protection? (Considering that prolonged exposure to sounds above 85 decibels can cause hearing damage or loss).**

Given data:

Intensity=I=2.5×10^{13} I_o

Intensity level limit =85dB

Required:

(a) Intensity level =β =?

(b) Ear protection=?

Solution:

(a) We know that

$$\beta = 10log\frac{I}{I_o}$$

Putting values

$$\beta = 10log\left(\frac{2.5\times10^{13}I_o}{I_o}\right)$$

$$\beta = 10log(2.5\times10^{13})$$

$$\beta = 10\times13.39$$

$$\beta = 133.9\ dB$$

$$\beta = 134\ dB$$

(b) As we have given that safe intensity level limit is 85dB, so 134dB is to greater than 85dB. So we need to wear ear protection.

4. **What sound intensity level in dB is produced by earphones that create an intensity of 4.00×10^{-2} W/m^2? (Use the usual reference level of $I_o = 1.00 \times 10^{-12}$W/m^2).**

Given data:

Intensity of sound =I=4.00×10^{-2} W/m^2

Usual reference level = $I_o = 1.00 \times 10^{-12}$W/m^2

Required:

Intensity level= β =?

Solution:

We know that

$$\beta = 10log\frac{I}{I_o}$$

Putting values

$$\beta = 10log\left(\frac{4.00 \times 10^{-2}}{1.00 \times 10^{-12}}\right)$$

$$\beta = 10log(4 \times 10^{10})$$
$$\beta = 10 \times 10.60205999$$
$$\beta = 106.02dB$$

5. **What is the speed of sound in air at -20°C?**

Given data:

Temperature=T= -20°C

Required:

Speed of sound =v=?

Solution:

We know that

$$v = 331 + 0.6T - - - -(1)$$

Putting T =-20°C in eq (1), we get

$$v = [331 + 0.6 \times (-20)]m/s$$
$$v = [331 - 12]m/s$$
$$v = 319\ m/s$$

Hence, the speed of sound at -20°C is 319 m/s.

6. **Army man wear binoculars see the flash from enemy tank fire 5 sec before the fire is heard, he records 26°C temperature on his personal thermometer. What is the distance of the tank from him?**

Given data:

Time =t=5 sec

Temperature=T=26°C

Required:

Distance of tank =S=?

Solution:

We know that

$$S = vt - - - -(1)$$

Also

$$v = 331 + 0.6T - - - -(2)$$

Putting eq (2) in eq (1), we get

$$S = (331 + 0.6T)t - - - - - (3)$$

Putting values in eq (3), we get

$$S = (331 + 0.6 \times 26) \times 5$$
$$S = (331 + 15.6) \times 5$$
$$S = (346.6) \times 5$$
$$S = 1733m$$
$$S = 1.733 \times 10^3 m$$
$$S = 1.733\ km$$
$$S = 1.7\ km$$

So the distance of tank is 1.7 km.

7. **Calculate the wavelengths of sounds at the extremes of the audible range, 20Hz and 20,000Hz, at normal temperature of 20°C?**

Given data:

Frequency of 1st sound = f_1=20Hz

Frequency of 2nd sound = f_2=20,000Hz

Temperature=T=20°C

Required:

i. Wavelength of 1st sound = λ_1=?

ii. Wavelength of 2nd sound = λ_2=?

Solution:

i. We know that

$$v = f\lambda$$
$$\Rightarrow \lambda = \frac{v}{f}$$
$$\Rightarrow \lambda_1 = \frac{v}{f_1} - - - -(1)$$

Also

$$v = 331 + 0.6T - - - -(2)$$

Putting eq (2) in eq (1), we get

$$\lambda_1 = \frac{331 + 0.6T}{f_1} - - - -(3)$$

Putting values in eq (3), we get

$$\lambda_1 = \frac{331 + 0.6 \times 20}{20}$$

$$\lambda_1 = \frac{331 + 12}{20}$$

$$\lambda_1 = \frac{343}{20}$$

$$\lambda_1 = 17.15m$$

Or

$$\lambda_1 = 17\ m$$

ii. For λ_2 eq (3) becomes

$$\lambda_2 = \frac{331 + 0.6T}{f_2} - - - -(4)$$

Putting values in eq (4), we get

$$\lambda_1 = \frac{331 + 0.6 \times 20}{20000}$$

$$\lambda_1 = \frac{331 + 12}{20000}$$

$$\lambda_1 = \frac{343}{20000}$$

$$\lambda_1 = 0.017\ m$$

Or

$$\lambda_1 = 0.017 \times 100\ \ cm$$

$$\lambda_1 = 1.7\ cm$$

8. Ishfaq stands between two high rise buildings A and B, such that he is at 33m distance from building A. When he blows the whistle, he hears first echo after 0.2s and second echo after 0.8s. Calculate (a) the Speed of sound and (b) distance of building B from him?

Given Data:

Distance of Ishfaq from building "A" =S_1= 33m

Time for 1st echo=T_1=0.2sec

Time for 2nd echo=T_2 = 0.8sec

Required:

i. Speed of sound =v=?

ii. Distance of building "B" from Ishfaq =S_2=?

Solution:

i. Speed of sound =v=?

Time for 1st echo=T_1=0.2 sec

Time for echo to reach building "A" =t_1=?

$t_1 = \frac{T_l}{2}$

$t_1 = \frac{0.2}{2}$

= 0.1sec

So

$t_1 = 0.1$ sec

Now the speed of sound is given by

$S_1 = vt_1 \longrightarrow (1)$

$\Longrightarrow v = \frac{S_1}{t_1} \longrightarrow (2)$

Put $S_1 = 33$m and $t_1 = 0.1$ sec in eq (2) we get,

$\Longrightarrow v = \frac{33}{0.1}$

$\Longrightarrow v = 330$m/sec

ii. Distance of building "B" from Ishfaq $= S_2 = ?$

Time for 2nd echo $= T_2 = 0.8$ sec

Time to reach building "B" $= t_2 = ?$

$t_2 = \frac{T_2}{2}$

$t_2 = \frac{0.8}{2}$

$= 0.4$sec

So

$t_2 = 0.4$ sec

Now to find the distance of building "B" from Ishfaq is given by

$S_2 = vt_2 \longrightarrow (3)$

Put given values in eq (3), we get

$S_2 = 330 \times 0.4$

$\Longrightarrow S_2 = 132$m

So the distance of Ishfaq from building "B" is 132 m.

FEDERAL BOARD CHAPTER 12
SOLVED EXERCISE

CONCEPTUAL QUESTION

Q1. When you look at the front side of polished spoon, your image is inverted and from back of spoon, your image is erect. Explain why?

Ans: A shiny spoon has both concave and convex surfaces. The inner surface is like a concave mirror and the outer surface is like a convex mirror. When you look at the inner surface keeping it very close, you will see an enlarged erect image of yourself. As you move the spoon away from you the image becomes inverted. When you look into the outer surface, you will see a diminished, erect image of yourself.

Explanation:

- The inner surface of a spoon acts like a concave mirror, while its outer surface acts as a convex mirror
- When you look at the back of a spoon you see an upright image of yourself, this is because the reflective curved surface of the metal acts as a diverging.

Q2. Which mirror is used by girls for makeup and why?

Ans: People use a concave mirror for shaving or make up because when a person stands between the principal focus and pole of a concave mirror, person sees an enlarged, erect and virtual image of his face. This is the reason why a concave mirror of large focal length is used for shaving or make up.

Q3. Why are large convex mirrors fixed at blind turns of mountains?

Ans: Convex mirrors give wide angle view of the other side of the blind turns Convex mirrors of small focal lengths are used in this case which give diminished. Erect image of the automobiles coming from the other side of the blind turns. In hilly areas they are used to avoid accidents at dangerous turns as they provide a view of the other side of the turn

Q4. Which mirrors are used for rear view of vehicles and why?

Ans: The rear view mirrors used in automobiles are convex mirrors. A convex mirror gives a virtual and diminished image of an object. Convex mirror is used as rear view mirror to have a smaller image of a larger view of the road and traffic coming behind the vehicle,

Q5. If a person is walking in pool, why do his legs appear shorter in water?

Ans: It is due to refraction of light this phenomenon happens. When the rays passing through the denser medium (water) to rarer medium (air) then the reflected ray bent away from the normal. We know that, the refractive index of water is greater than that of air. So, a person legs appear to be short while standing in the tank due to refraction.

Q6. Why do diamonds sparkle brightly?

Ans: Diamond has a very high refractive Index. It is because of this property that diamond sparkles. When light enters the diamond crystal, it suffers multiple total internal reflections and due to this, it sparkles.

Q7. When white light passes through a prism, it disperses into its seven colours. Why does dispersion take place in prism?

Ans: The phenomenon of splitting up of white light into its seven constituent colours while passing through a prism is called dispersion. This is because each of the colours has different frequency and wave length and deviates through different angles. Deviation of violet colour is maximum as its frequency is more while the deviation of red colour is minimum as its frequency is less. The frequency of a photon of violet light is greater than red light hence violet light is more energetic than the red light.

Q8. Magnifying glass can burn the paper. How is it possible?

Ans: When a magnifying glass is held over a piece of paper at a distance equal to its focal length, the sun's rays falling on the lens converge at a point that lies somewhere on the paper. Thus, solar energy spread over the lens surface area gets concentrated at one point. That's when the paper starts burning.

Q9. Your grandfather uses spectacles to read newspaper. You see through the spectacles and you observe that objects behind it were inverted. Why was it so observed?

Ans: The two possible causes of hypermetropia are

1. The focal length of the eye lens is too long.

2. Decrease in the length of the eyeball.

A convex lens is used in the spectacles to read newspaper. Therefore, the image formed by it is inverted,Normally old people suffer from an eye condition called long sightedness in which they can see far away objects clearly but the near objects seem blur to them To correct this defect, they use spectacles in which convex lenses are installed.

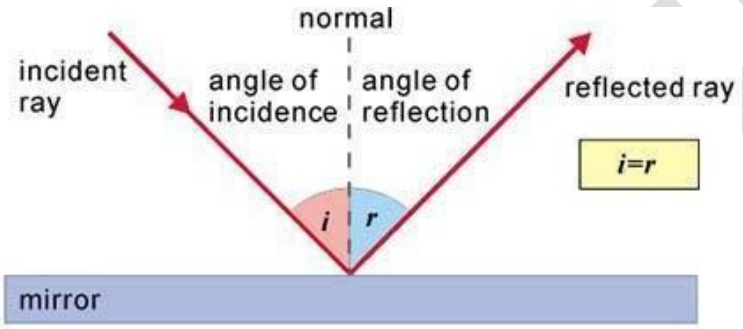
Q10. Under what condition, is a convex lens nearly acts as diverging lens?

Ans: A convex lens can behave as a diverging lens when it is placed in a medium whose refractive index is greater than the refractive index of the material of the lens. when the convex lens is held in a transparent medium of refractive Index grater than the refractive index of lens material, it would behave as a concave lens Diverging lens.

Punjab Book

1,What do you understand by reflection of light? Draw a diagram of a reflection at a plane surface?

Ans: Reflection of light:"When light travelling in a certain medium falls on the surface of another medium, a part of it bounces back in the same medium this is called reflection of light."



2.Describe the following terms used in Reflection?

(i) Normal (ii) Angle of incidence (iii) Angle of rejection

Normal: The perpendicular to a reflecting or refracting surface at the point of incidence of the ray concerned is called normal.

Angle of incidence: The angle between the incident ray and the normal ls called angle of incidence.

Angle of reflection: The angle between the normal and the reflected fray is called angle of reflection.

Laws of Reflection :

The law of reflection states that

1) incident ray, the reflected ray, and the normal to the surface of the mirror all lie in the same plane.
2) the angle of reflection is equal to the angle of incidence.

3.Define the following terms used in refraction: (i) Angle of incident (ii) Angle of refraction.

Angle of incidence: The angle made by the incident ray with the normal is called angle of incidence.

Angle of refraction: The angle made by the refracted ray with the normal is called angle of refraction.

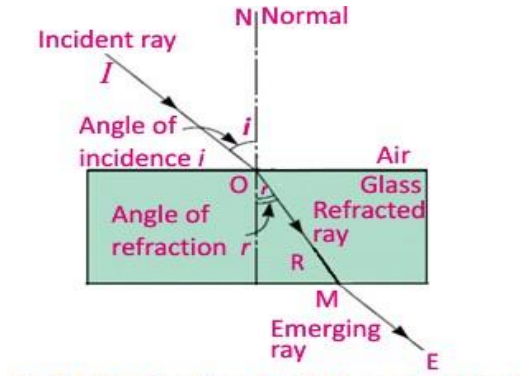
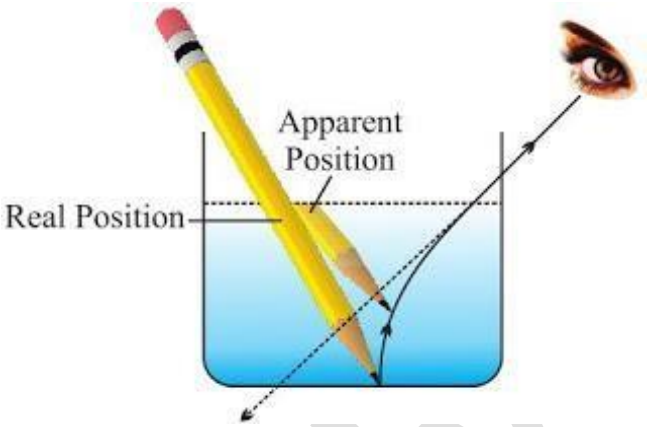


Fig. 12.8: Refraction of light by a glass block



6.What is meant by refractive index of a material? How would you determine the refractive index of a rectangular glass slab?

Ans:Refractive index:"The refractive index 'n' of a medium is the ratio of the speed of light „c" in air to the speed of light in the medium„v"

7.State the laws of refraction of light and show that how they may be verified using rectangular glass slab and pins?

Ans: Laws of refraction of light:

i. The incident ray, the refracted ray and the normal at the point of incidence all lie in the same plane.

ii. The ratio of the sine of the angle of incidence „i"and the sine of angle of reftaction „r"is always equal to a constant i.e.

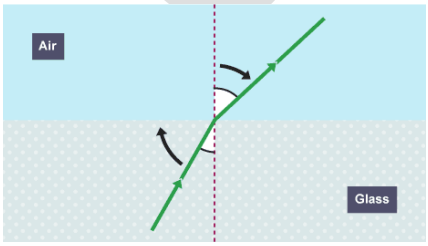
8.What is meant by the term total internal reflection?

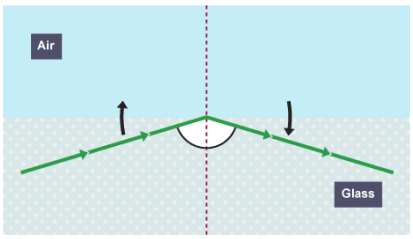
Ans:Total internal reflection:"When angle of incidence is greater than critical angle then no refraction occurs but light reflects back into denser medium. This phenomenon is called total internal reflection."

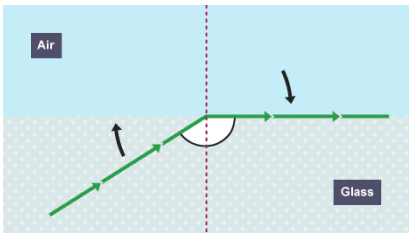
9.State the conditions for total internal reflection.

Ans: Conditions for T.I.R:

- The angle of incidence should be greater than c ritical angle.
- The light should enter from a denser medium to a rarer medium.

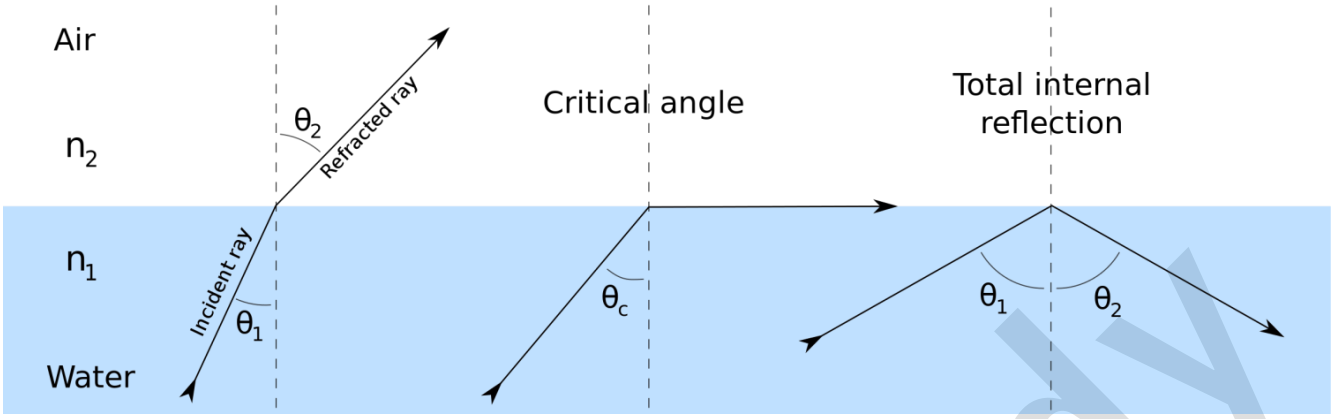






10. **What is critical angle? Derive a relationship between the critical angle and the refractive index of a substance.**

Ans: **Critical angle:**"*The angle of incidence that causes the refracted ray in rarer medium to bend through 90^o called critical angle.*"

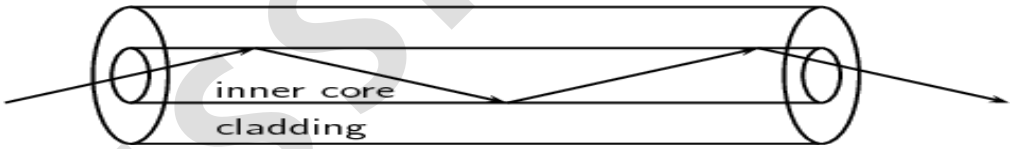


Relationship between critical angle and refractive index: The relationship for rays from denser to rare medium is.

11.What are optical fibres? Describe how total internal reflection is used in light propagating through optical fibres?

Ans: **Optical fibres:** A thin like glass rod through which light propagates by total internal reflection is called optical fiber.

In figure shows that light through optical fiber passes by T.I.R due to high refractive index of core.



Core: The inner light-carrying member with a high index of refraction.The refractive index of core is n =1.53

Cladding: The middle layer, which serves to confine the light to the core. It has a lower index of refraction. The refractive index of cladding is n =1.39

12.Define the following terms applied to a lens.

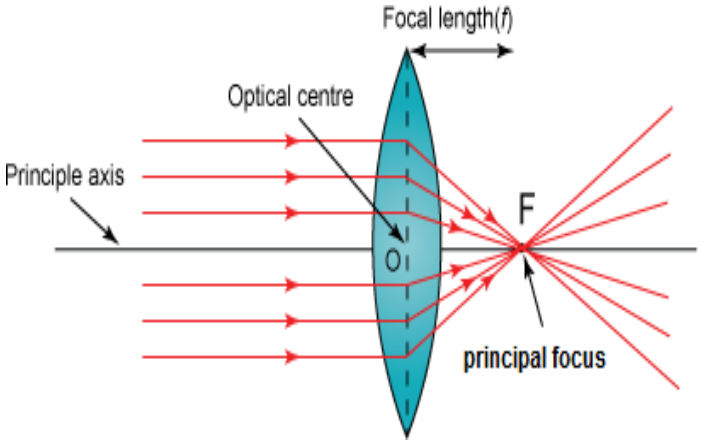
(a) Principal axis (b)Optical centre (c) Focal length

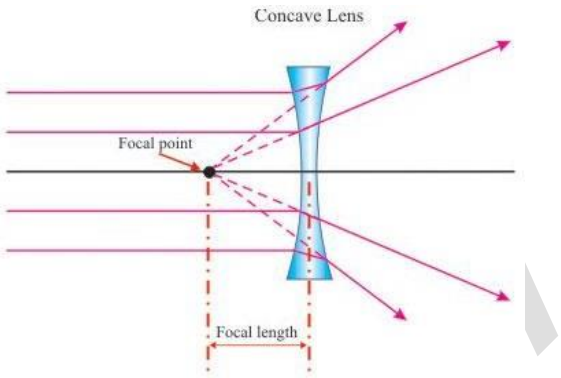
Ans:Principal axis: Each of the two surfaces of a spherical lens is a section of a sphere. The line passing through the two centres of curvatures of the lens is called principal axis.

Optical centre:"A point (C) on the principal axis at the centre of lens is called optical centre." Focal length, f:"This is the distance between the optical centre and the principal focus."

13.What is meant by the principal focus of a (a) convex lens (b) a concave lens? Illustrate your answer with ray diagrams.

Ans: **Principal focus of convex lens**: The light rays travelling parallel to the principal axis of a convex lens after refraction meet at a point on the principal axis, called principal focus or focal point F. Hence, convex lens is also called converging lens.





Principal focus of a concave lens: For a concave lens, the parallel rays appear to come from a point behind the lens called principal focus F. Hence concave lens is also called diverging lens.

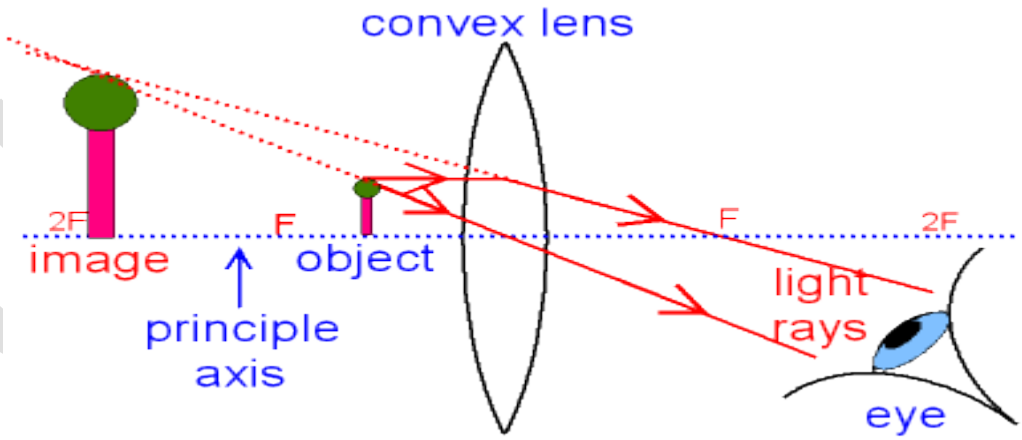
14.How light is refracted through convex lens?

Ans: Refraction through convex lens:

- When parallel light rays passes through the center of lens, they pass through focal point after refraction.
- When they pass through optical center they does not refract.
- The rays passing through principal focus become parallel to principal axis after refraction.

15.With the help of a ray diagram, how you can show the use of thin converging lens as a magnifying glass.

Ans: Magnifying glass is a convex lens which magnifies images of small objects.



16.A coin is placed at a focal point of a converging lens. Is an image formed? What is its nature?

Ans:No, image is formed because light rays move parallel to each other after refraction.

17.What are the difference between real and virtual images?

Virtual image	Real image
1 Virtual image can't be obtained on screen	**1.** Real image can be obtained on the screen
2. This image is larger than object.	**2.** This image is smaller than object.
3. Convex mirror forms *virtual image*.	**3.** Concave mirror forms *real image*.
4 For virtual image, q is taken as Negative	**4.** For real image, p and q are taken as *Positive*
5. Virtual image is *upright, erect.*	**5.** Real image is *inverted*.

18.How does a converging lens form a virtual image of a real object? How does a diverging lens can form a real image of a real object?

Ans: Virtual image of real object through converging lens: The real object is placed between optical center and focus point of converging lens. If the object is on left side the virtual image is formed behind the object on the left side of lens.

Real image of real object formed by diverging lens: No, real image is formed of real object by diverging lens. Instead, it forms virtual image.

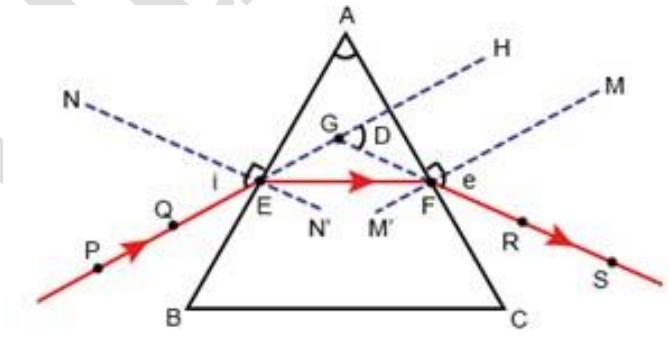
19.Define power of a lens and its units.

Ans:Power of lens:"The power of lens is the reciprocal of focal length."

Formula:

20.Describe the passage of light through a glass prism and measure the angle of deviation.

Ans:Refraction through prism: Prism is a transparent object (made of optical glass) with at least two polished plane faces inclined towards each other from which light is refracted. In case of triangular prism, the emergent ray is not parallel to the incident ray. It is deviated by the prism from its original path. the incident ray PE makes an angle of incidence „i" at point E and is refracted towards the normal N as EF. The refracted ray EF makes an angle „r" inside the prism and travels to the other face of the prism. This ray emerges out from prism at point F making and angle „e". Hence the emerging ray FS is not parallel to the incident ray PE but is deviated by an angle D which is called angle of deviation.



PE - Incident ray
EF - Refracted ray
FS - Emergent ray
A - Angle of the prism

∠i - Angle of incidence
∠r - Angle of refraction
∠e - Angle of emergence
∠D - Angle of deviation

21.Define the terms resolving power and magnifying power.

Ans:Resolving power:"The resolving power of an instrument is its ability to distinguish between two closely placed objects or point source."

Magnifying power:"The ratio of angles subtended by image as seen through optical device to that subtended by object at unaided eye is called magnifying power."

M =

22.Draw the ray diagrams of:

(a) Simple microscope (b) Compound microscope (c) Refracting telescope

Ans: (a)Simple microscope

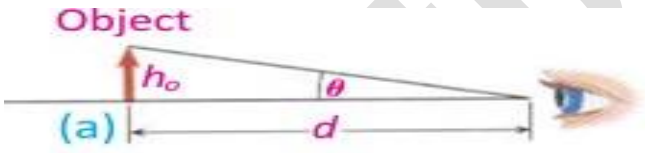
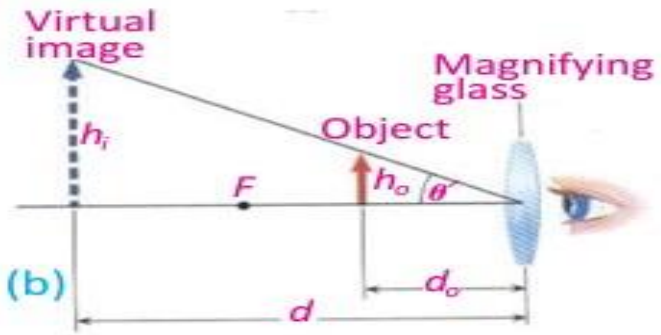
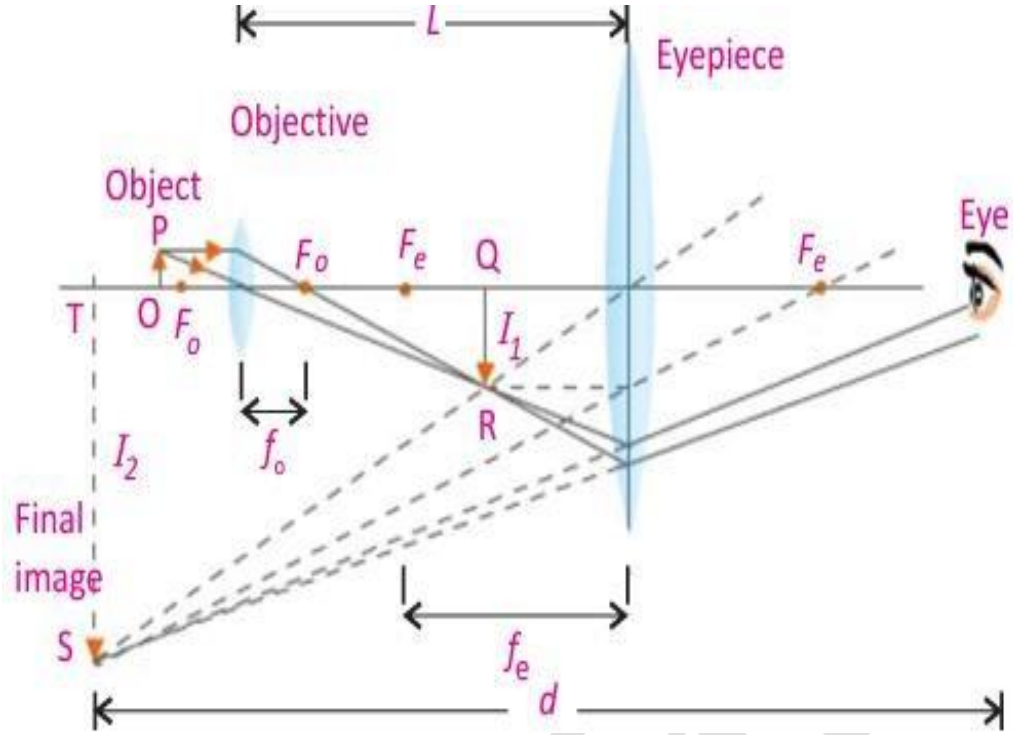


Fig.12.30



(b) Compound microscope.



(c) Refracting telescope

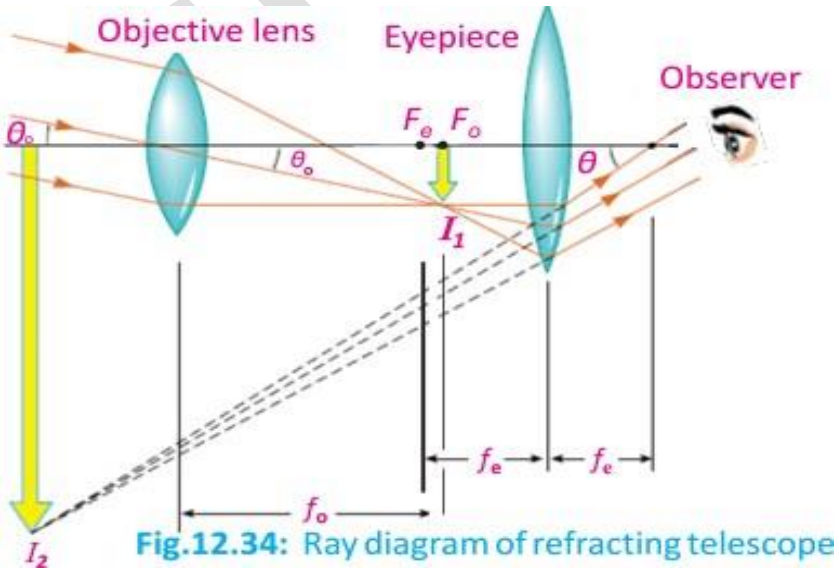


Fig.12.34: Ray diagram of refracting telescope

23.Mention the magnifying powers of the following optical instrument?

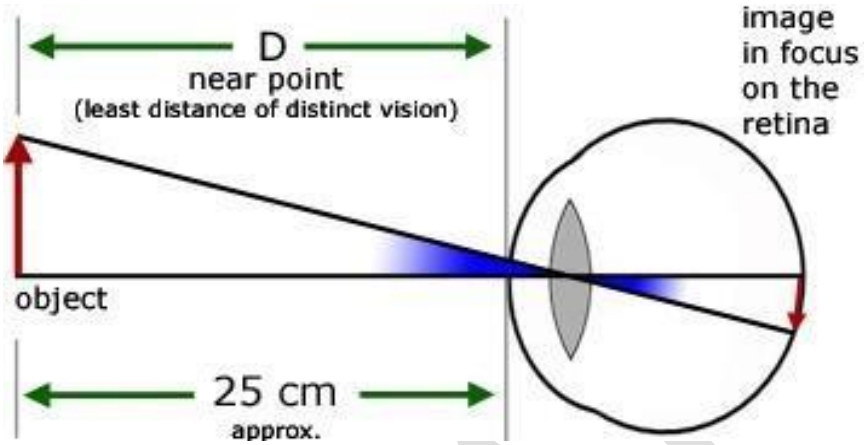
(a) Simple microscope

(b) Compound microscope

(c) Refracting telescope

24.Draw ray diagrams to show the formation of images in the normal human eye.

Ans.



25.What is meant by the terms nearsightedness and farsightedness? How can these defects be corrected?

Ans: **Nearsightedness (myopia):** *A person suffering from nearsightedness or shortsightedness cannot see distant objects clearly*.

i. This can be corrected by using diverging lens (concave lens).

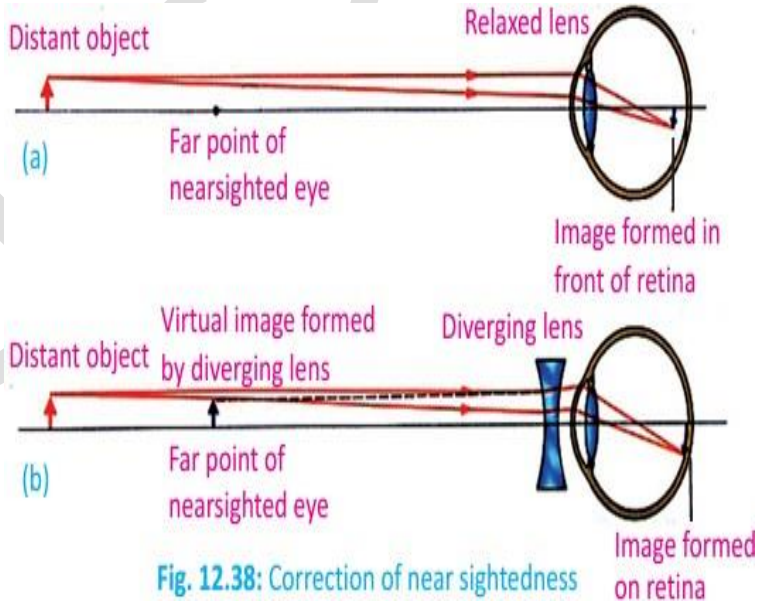


Fig. 12.38: Correction of near sightedness

Farsightedness (hypermetropia) : The disability of the eye to form distinct image of nearby objects on its retina is known as farsightedness.This can be corrected by using converging lens (convex lens).

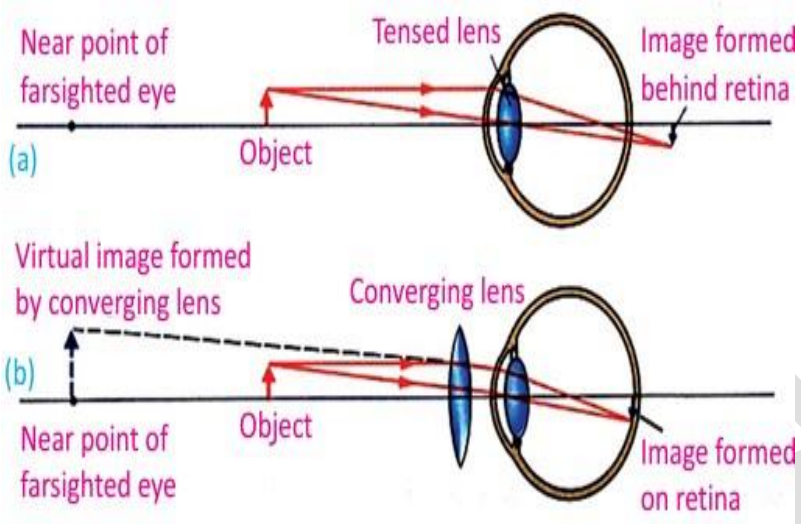


Fig. 12.39: Correction of farsightedness

26.What is near and far point?

Ans: **Near Point or Least distance of distinct vision:**

The minimum distance from the eye at which clear detail of an object can be seen is known as near point or least distance of distinct vision.

For young people in their early twenties with the normal vision the near point is 25cm. It increase about 50cm at the age of 4O and it is 500cm at the age of 60.

The far point of the eye is maximum distance of a distant

object from the eye on which fully relaxed eye can be focus. A person with normal eyesight can see the distant objects clearly which are far away such as planets, stars etc. Majority of people not have “normal eyes” in this sense.

27.What is Accommodation?

Ans:The „ciliary muscles" control the size of lens. In this way the focal length of lens can be increased or decreased. This is called accommodation.

Conceptual Questions

(1) A man raises his left and in a plane mirror, the image facing him is raising his right hand. Explain why?

Ans: Light rays from left and reflected in a mirror causing an inverted image. So, the image of whole body is inverted and image of left hand appears as right hand.

(2) In your own words, explain why light waves are refracted at a boundary between two materials?

Ans: Speed of light is different in different mediums. When light waves enter from one

material to other, their speed is changed which results in change in wavelength as well. Therefore, light waves deviate from their path and refract. Thus, light waves are refracted at a boundary between two materials.

(3) Explain why a fish under water appears to be at a different depth below the surface than it actually is. Does it appear deeper or shallower?

Ans: This phenomenon is due to refraction of light as light enters from air to water. it beds towards the normal. That‟s why image do not form at actual depth.

(4) Why or why not concave mirrors are suitable for make up?

Ans: If the object is at focus point then its magnified and real image is formed. In this case it is suitable for makeup but when the object is behind focus point then its clear image is not formed so in this case it is not suitable for makeup.

(5) Why is the driver‟s side mirror in many cars convex rather than plane or concave?

Ans: Convex mirror is a converging mirror which forms the clear image of far objects. So, in car the mirror gives the accurate picture of road and other vehicles.

(6)When an optician‟s testing room is small, he uses a mirror to help him test the eye sight of his patients. Explain why?

Ans: To increase the distance of alphabets from patient, the optician uses plane mirror if his testing room is small.

(7) How does the thickness of lens affect its focal length?

Ans: Thickness of lens is greatly affected by its focal length. If the thickness of lens is large, focal length will be short and vice versa.

(8)Under what conditions will a converging lens form a virtual image?

Ans:When an object is placed among principal focus and optical centre then the image formed will be virtual.

(9)Under what conditions will a converging lens form a real image that is same size as the object?

Ans:When the object is placed at “2F” from optical centre of convex lens, it forms a real image that has same size as that of object.

(10) Why do we use refracting telescope with large objective lens of large focal length?

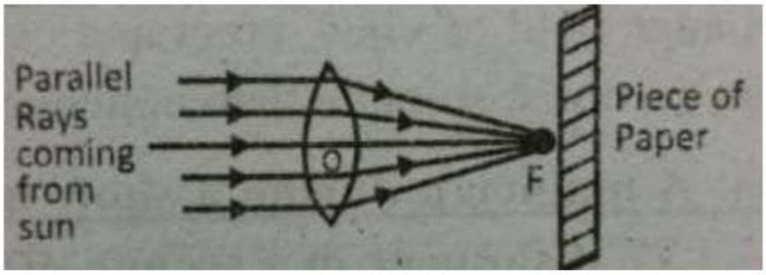
Ans: In refracting telescope, objective lens of larger focal length is used to gather more light from weak distant sources. It not only makes them more visible but increases resolving power of telescope.

Kpk Board

Give a brief response to the following questions.

Q1. Which type of lens would you use to start fire from light from sun concave or convex, would work best? At what distance from the lens should the paper be held for best results?

Ans: We will use a convex lens to start fire from light of sun. A convex lens focuses or converges the parallel sun rays to a single point after refraction through the lens. The focusing point is known as principle focus "F". The paper should be placed at a distance equal to the focal length of the lens. The lens converge sunlight on the paper. After sometime the paper heat up and catches fire instantly.



Q2. If a concave mirror produces a real image, is the image necessarily inverted? Explain.

Ans: A real image is an image formed when light rays actually pass through the point where the image is formed. Real image can be produced by a concave mirror only if the object is placed

beyond focal point (F) of the mirror. This real image will always be inverted. This is because a concave mirror focuses light rays, thus inverting the real image. However, if the object is placed between pole "P" and focus "F", the image formed will be upright and virtual not real. That is why it is said that a real image formed by a concave lens will always be inverted.

Q3. Are rearview mirrors use in cars concave or convex?

Ans. Convex mirrors are useful for rare view in vehicles, as they provide a larger field of view than the concave mirror. Convex mirrors give erect, virtual and diminished image of distant objects with a wider field of view.

On the other hand, concave mirror forms inverted images of the distant objects with a smaller field of view. Thus for a broader field of view, erect and clear images, convex mirrors are used.

Q4. A magician during a show makes a glass lens with n=1.47 disappear in a trough of liquid. What is the refractive index of the liquid? Could the liquid be water?

Ans. The refractive index of the liquid should be equal to the refractive index of glass lens (i.e. 1.47) for it to disappear in the liquid. Because if the lens is surrounded by liquid having the same refractive index as the lens, then no reflection and no refraction occurs and the lens becomes invisible.

The liquid could not be water because the refractive index of water is 1.33 which is much less than that of glass lens. It can be glycerin or turpentine both are "clear" liquid with their refractive index equal to 1.47.

Q5. Suppose that you were handed a lens and a ruler and told to determine the focal length of the lens. How would you proceed?

Ans. We can easily find the focal length of a lens using ruler (or meter rod). In open air, make the rays focused on a wall (finding the point where the all rays are concentrated, which will be the principal focus of lens) and measure the distance between the lens and the wall with the help of meter rod. This will be the focal length of the given lens.

Q6. Can we achieve total internal reflection from optically rare medium to optically dense medium?

Ans. No, we cannot achieve total internal reflection when light travels from optically rare medium to optically dense medium. For total internal reflection the following conditions must be satisfied.

1. The incident light must pass from an optically dense medium into an optically rare medium (e.g from water to air or from glass to air).

2. The angle of incidence in denser medium must be greater than the critical angle of the medium.

Thus total internal reflection will not take place if light is travelling from optically rare medium to optically dense medium (e.g from air to water).

Q7. Will a nearsighted person who wears corrective lenses in her glasses be able to see clearly underwater when wearing those glasses?

Ans. She will not see clearly under water when wearing those glasses because of the different refractive index of water than air.

Water has a refractive index of 1.33 which is much greater than that of air (1.002). The high refractive index of water affects the refraction of light rays due to which she (near sighted person) will not be able to see clearly in water by wearing glasses having corrective lenses.

Q8. When you use a simple magnifying glass, does it matter whether you hold the object to be examined closer to the lens that its focal length or farther away? Explain.

Ans. A double convex lens may be used as a simple magnifying glass (or simple microscope). A convex lens always forms a real and inverted image on the opposite side of the lens, when the object is place away from the focal point. For virtual, erect and magnified image, the object should be placed within the focal length of the lens.

Thus, to use a simple magnifying glass, the object should lie within the focal length of the lens, so that to get an erect, enlarged and virtual image of the object.

Q9. In blind turns on hilly roads, mirrors are used to help drivers. Are these mirrors plane mirrors, concave mirrors or convex mirrors? Explain.

Ans. Convex mirrors are generally used at blind corners, as they give a wider field of view. They also form erect, virtual and diminished images of objects lying away from the focal point.

On the other hand, plane mirrors form erect images of the same size reducing the field of view. And concave mirrors form erect and virtual images only when the object lie within its focal length. So, only convex mirrors are used at blind turns on hilly roads to help drivers for safe driving.

ASSIGNMENTS

12.1) A dentist uses a concave mirror with focal length 2.0cm to examine some teeth. If the tooth under examination is 1.1cm high and mirror is place at 0.9 cm. Calculate the distance of image formed, the height of the image and magnification.

Given Data:

Focal length = f = 2cm

Height of object (tooth) = h_o=1.1cm

Distance of object = d_o= 0.9 cm

Required:

a) Distance of image = d_i= ?

b) Height of image = h_i =?

c) Magnification = M = ?

Solution:

(a) As it is knowing that

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$=> \frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o}$$

$$=> \frac{1}{d_i} = \frac{d_o - f}{f\, d_o}$$

$$=> d_i = \frac{f d_o}{d_o - f}$$ ---------eq(i)

Putting values in equation (i), we get

$$d_i = \frac{2 \times 0.9}{0.9 - 2}$$

$$d_i = \frac{1.8}{-1.1}$$

d_i =-1.64 cm

(b) Using Formula

$$\frac{h_i}{h_o} = \frac{d_i}{d_o}$$

By cross multiplication

$h_i \times d_o = d_i \times h_o$

Dividing "d_o" on both sides

$$\frac{h_i \times d_o}{d_o} = \frac{d_i \times h_o}{d_o}$$

$$h_i = \frac{d_{i \times h_o}}{d_o} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (ii)$$

Putting values, in eq (ii), we get

$$h_i = \frac{-1.64 \times 1.1}{0.9}$$

$$h_i = \frac{-1.804}{0.9}$$

h_i = -2.0cm

(c) we know that

$$M = \frac{h_i}{h_o}$$ ----------eq(iii)

Putting values in eq (iii), we get

$$M = \frac{-2.0}{1.1}$$

M = -1.8

Q12.2: A convex security mirror in a warehouse has a 0.50m focal length. A 2.0m tall forklift is 5.0m from the mirror. What is the image position and image height?

Given Data:

Focal length =f = -0.50m

Height of object= h_o= 2m

Distance of object = d_o= 5.0m

Required:

a) Image position (distance)=d_i=?

b) Height of image=h_i=?

Solution:

(a)As we know that

$$\frac{1}{f}=\frac{1}{d_i}+\frac{1}{d_o}$$

$$=>\frac{1}{d_i}=\frac{1}{f}-\frac{1}{d_o}$$

$$=>\frac{1}{d_i}=\frac{d_o-f}{fd_o}$$

$$=> \quad d_i=\frac{fd_o}{d_o-f}\ldots\ldots\ldots\ldots\ldots\ldots\text{(i)}$$

Putting values in eq (i), we get

$$d_i=\frac{-0.50\times5.0}{5.0-(-0.50\ )}$$

$$d_i=\frac{-2.5}{5.0+0.50}$$

$$d_i=\frac{-2.5}{5.50}$$

$$d_i=-0.45$$

The image is virtual and formed behind the mirror.

(b) We know that

$$\frac{h_i}{h_o}=\frac{d_i}{d_o}$$

by cross multiplication

$$h_i\times d_o=d_i\times h_o$$

Dividing "d_o" on both sides

$$\frac{h_i\times d_o}{d_o}=\frac{d_i\times h_o}{d_o}$$

$$=>\ h_i=\frac{d_i\times h_o}{d_o}\ldots\ldots\ldots\ldots\ldots\ldots\text{(ii)}$$

Putting values in eq (ii), we get

$$h_i=\frac{-0.45\times2}{5.0}$$

$$h_i=\frac{-0.9}{5.0}$$

$$h_i=\boxed{-0.18\text{m}}$$

Q2.3: If the speed of light in kerosene oil is 2.08×10^8 m/s, calculate the index of refraction.

Given that:

Speed of light in kerosene oil = v = $2.08 \times 2.08 \times 10^8$ m/s

Speed of light in vacuum = c = 3×10^8 m/s

Required:

Index of refraction = n= ?

Solution:

As we know that,

$n = \frac{c}{v}$

Putting values

$n = \frac{3 \times 10^8}{2.08 \times 10^8}$

$n = \frac{3}{2.08} \times 10^{8-8}$

$n = 1.44 \times 10^{\circ}$

$n = 1.44 \times 1 \quad (\therefore 10^{\circ} = 1)$

$n = 1.44$

Q 12.4: Find the index of refraction for medium 2, if medium 1 in air with index of refraction n_a= 1.00, the incident angle is 30.0° and the angle of refraction is 22.0°. Compare the result with the table and identify the nature of medium 2.

Given data:

Refractive index of air = n_1 = 1.00

Angle of incidence = θ_1= 30.0°

Angle of refraction = θ_2= 22.0°

Required:

Refractive index of medium 2 = n_2 =?

Solution:

As, we know that

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$\Rightarrow n_2 \sin\theta_2 = n_1 \sin\theta_2$

Dividing "$\sin\theta_2$" on both sides

$\frac{n_2 \sin\theta_2}{\sin\theta_2} = \frac{n_1 \sin\theta_1}{\sin\theta_2}$

$\Rightarrow n_2 = \frac{n_1 \sin\theta_1}{\sin\theta_2}$ .....(i)

Putting values in eq (i), we get

$n_2 = \frac{1.00 \times \sin 30.0^{\circ}}{\sin 22.0^{\circ}}$

$n_2 = \frac{1.00 \times 0.5}{0.375}$

$n_2 = \frac{0.5}{0.375}$

$n_2 = 1.33$

If we compare the values of "n_2" with the table, it match with refractive index of water, so the medium 2 is water.

Q12.5: What is the critical angle for light traveling in a polystyrene (a type of plastic with index of refraction for polystyrene as 1.49) pipe surrounded by air (take index of refraction of air to be 1.00)?

Given Data:

Refractive index of polystyrene = n_1 = 1.49

Refractive index of air = n_2 = 1.00

Required:

Critical angle = θ_c = ?

Solution:

We know that

$\sin\theta_c = \frac{n_2}{n_1}$

Putting values

$\sin\theta_c = \frac{1.00}{1.49}$

$\sin\theta_c = 0.671$

$\Rightarrow \theta_c = \sin^{-1}(0.671)$

$\theta_c = 42.14°$

$\boxed{\theta_c = 42.2°}$

Q 12.5: An object is placed 30.0 cm in front of a converging lens and then 12.5 cm in front of a diverging lens. Both lenses have a focal length of 10.0cm. For both cases, find the image distance and the magnification. Describe the images.

Given Data:

a) Object distance from convex lens = d_o = 30.0cm

b) Object distance from concave lens = d_o =12.5

Focal length = f = 10cm

Required:

a) Image distance =d_i = ?
Magnification = M = ?

b) Image distance = d_i = ?
Magnification = M = ?

Solution:

a) As, we know that

$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$

$\Rightarrow \frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o}$

$$\frac{1}{d_i} = \frac{d_o - f}{f d_o}$$

$=> d_i = \frac{f d_o}{d_o - f}$ .....(i)

putting values in eq (i), we get

$$d_i = \frac{10 \times 30}{30 - 10}$$

$$d_i = \frac{300}{20}$$

$d_i =$ 15 cm

Now for magnification, using formula

$M = -\frac{d_i}{d_o}$

Putting values

$M = -\frac{15}{30}$

M = -0.5

Therefore, when the object distance is greater than twice the focal length ($d_o > 2f$), for convex lens:

- The image distance is less than twice the focal length | (i.e. 15cm < 20cm)
- The image is real (distance positive)
- The image is inverted (magnification negative)
- The image is smaller than the object (magnification is less than 1)

(b) Putting values in eq (i), we get

Here f = -10cm (for concave lens)

$$d_i = \frac{f d_o}{d_o - f}$$

$$d_i = \frac{-10 \times 12.5}{12.5 - (-10)}$$

$$d_i = \frac{-125}{12.5 + 10}$$

$$d_i = \frac{-125}{22.5}$$

d_i = -5.555cm

or

d_i= -5.56cm

Now for magnification, using formula

$M = -\frac{d_i}{d_o}$

Putting values

$M = -\frac{(-5.56)}{12.5}$

$M = \frac{+5.56}{12.5}$

M = 0.4448

OR

M = 0.445

Therefore, in a concave lens, the image is virtual, erect and smaller in size than object.

Q12.7: An 8cm focal length converging lens is used as a jeweler's loupe, which is a magnifying glass. Estimate the magnification (a) when the eye is relaxed, and (b) if the eye is focused at its near point.

Given Data:

Focal length = f = 8cm

Near point distance = N = 25cm

Required:

a) Magnification (when eye is relaxed) = m_θ= ?

b) Magnification (when eye is focused at its near point = m_θ= ?

Solution:

(a) Magnification (when eye is relaxed) is given by formula,

$m_\theta = \frac{N}{f}$.....(i)

Putting values in eq (i), we get

$m_\theta = \frac{25}{8}$

m_θ= 3.12

0r

m_θ= 3 times

(b) Magnification (when eye is focused at its near point) is given by formula

$m_\theta = \frac{N}{f} + 1$ .....(ii)

Putting values in eq (ii), we get

$m_\theta = \frac{25}{8} + 1$

m_θ= 3.12 + 1

m_θ = 4.12

or

m_θ= 4

m_θ = 4 times

Q 12.8: If the focal length of the eye piece is increased, does the magnitude of the magnification increase or decrease. Check your response by calculating the magnification when the focal length of the eyepiece is 3.5cm.

Given Data:

We used data given in example (12.8)

Focal length of objective = f_o=1.0cm

Near point distance = N =25cm

Object distance = d_o = 1.1cm

Focal length of eyepiece $=f_e$ = 3.5cm

Required:

a) Effect on magnification =?

b) Magnification = m = ?

Solution:

First we fine image distance by using formula,

$$\frac{1}{f_o}=\frac{1}{d_i}+\frac{1}{d_o}$$

$$\frac{1}{d_i}=\frac{1}{f_o}+\frac{1}{d_o}$$

$$\frac{1}{d_i}=\frac{d_o-f_o}{f_o d_o}$$

$$\Rightarrow d_i=\frac{f_o d_o}{d_o-f_o}$$

$$d_i=\frac{1.0\times1.1}{1.1-1.0}$$

$$d_i=\frac{1.1}{0.1}$$

$$d_i = 11\text{cm}$$

Now, we know that magnification of compound microscope is given by,

$$\text{m}=-\frac{d_i}{f_o}\times\frac{N}{f_e}\ldots\ldots\ldots\ldots\ldots\ldots\text{(i)}$$

Eq (i) shows that the magnification of compound microscope is inversely proportional to the focal length of eye piece $'f_e'$.

i.e. if the focal length of eye-piece is increased then the magnification will be decreased.

(b) Now, find the magnification.

Putting the values of eq (i), we get

$$\text{m}=-\frac{11}{1.0}\times\frac{25}{3.5}$$

$$\text{m}=\frac{275}{3.5}$$

m = -78.57

m = -78.6

m = -79

Q.12.9: An astronomical telescope has the following specifications: f_o= 985 mm and f_o = 5.00mm. From these data points, find (a) the angular magnification and (b) the approximate length of this telescope.

Given data:

Focal length of objective = f_o = 985mm

Focal length of eye piece = f_e = 5.00mm

Required:

a) Angular magnification = m_θ= ?

b) Length of telescope = L = ?

Solution:

a) We know that, the angular magnification of telescope is given by,

$m_\theta = -\frac{f_o}{f_e}$

putting values

$m_\theta = -\frac{985}{5.00}$

m_θ = -197

b) Also we know that, the length of telescope is given by,

$L = f_o + f_e$

Putting values

L = 985 + 5.00

L = 990mm

NUMERICAL PROBLEMS

Q1. A 1.50cm high object is placed 20.0cm from a concave mirror with radius of curvature 30.0cm. Determine (a) the position of the image, and (b) its size, also draw the ray diagrams.

Given Data:

Height of object = h_o = 1.50cm

Distance of object = d_o = 20cm

Radius of curvature = R = 30cm

Required:

a) Position of image = d_i = ?

b) Size of image = h_i = ?

Solution:

a) As we know that

$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$

$\Rightarrow \frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o}$

$\frac{1}{d_i} = \frac{d_o - f}{f d_o}$

$\Rightarrow d_i = \frac{f d_o}{d_o - f}$ .....(i)

First we find focal length. So for focal length, we have

$f = \frac{1}{2} R$

Putting values

$f = \frac{1}{2} \times 30$

f = 15cm

Now, putting values in eq (i), we get

$d_i = \frac{15 \times 20}{20 - 15}$

$$d_i = \frac{300}{5}$$

$$d_i = \boxed{60\text{cm}}$$

(b) Now, using formula

$$M = \frac{h_i}{h_o} \ldots\ldots\ldots\ldots\ldots\ldots \text{(ii)}$$

Also

$$M = \frac{d_i}{d_o} \ldots\ldots\ldots\ldots\ldots\ldots \text{(iii)}$$

Comparing eq (ii) and (iii), we get

$$\frac{h_i}{h_o} = \frac{d_i}{d_o}$$

$$h_i = \frac{d_i}{d_o} \times h_o \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(iv)}$$

Putting values in eq (iv), we get

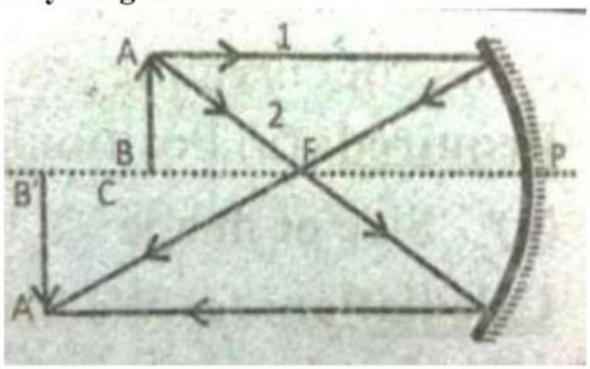
$$h_i = \frac{60}{20} \times 1.50$$

$$h_i = \frac{60 \times 1.50}{20}$$

$$h_i = \frac{90}{20}$$

$$h_i = \boxed{4.5\text{cm}}$$

Ray Diagram:



Q2. A candle of height 8.0cm is located at a distance of 300 mm from a convex mirror, its virtual image is formed behind the mirror at a distance of 3.0cm from the pole (or vertex). Find the focal length of the mirror and height of the image formed.

Given Data:

Height of object= h_o = 8.0cm

Distance of object = d_o = 300mm

$$= \frac{300}{10}\text{cm}$$

d_o =30cm

Distance of image = d_i = -3cm

Required:

Focal length= f =?

Height of image=h_i=?

Solution:

(a) We know that

$$\frac{1}{f}=\frac{1}{d_o}+\frac{1}{d_i}\text{.....(i)}$$

Putting values in eq (i), we get

$$\frac{1}{f}=\frac{1}{30}+\frac{1}{-3}$$

$$\frac{1}{f}=\frac{1}{30}-\frac{1}{3}$$

$$\frac{1}{f}=\frac{1-10}{30}$$

$$\Rightarrow \frac{1}{f}=\frac{-9}{30}$$

$$\Rightarrow f=\frac{-30}{9}$$

f = **-3.33cm** (-ive sign is because of convex mirror)

(b) We know that

$$M=\frac{h_i}{h_o}\text{.....(ii)}$$

And also,

$$M=\frac{d_i}{d_o}\text{.....(iii)}$$

Comparing eq (ii) and (iii)

$$\frac{h_i}{h_o}=\frac{d_i}{d_o}$$

$$h_i=\frac{d_i}{d_o}\times h_o\text{.....(iv)}$$

Putting values in eq(iv)

$$h_i=\frac{-3}{30}\times 8.0$$

$$h_i=\frac{-24}{30}$$

h_i= **-0.8cm**

Q3. Calculate the speed of light is zircon with index of refraction n = 1.923, a material used in jewelry to replicate diamond.

Given that:

Speed of light in vacuum = c = 3×10^8m/sec

Refractive index = n = 1.923

Required:

Speed of light in zircon = v =?

Solution:

By using formula

$$n = \frac{c}{v}$$

$$v = \frac{c}{n} \text{.....(i)}$$

Putting values in eq (i) we get

$$v = \frac{3\times10^8}{1.923}$$

$$v = \frac{3}{1.923} \times 10^8$$

$$v = 1.56 \times 10^8 \text{ m/sec}$$

So, speed of light in zircon is 1.56×10^8 m/sec

Q4. A light ray strikes an air / water surface at an angle of 46° with respect to the normal. The refraction index of water is 1.33. Find the angle of refraction when the direction of ray is (a) from air to water and (b) from water to air.

Given Data:

Angle of incidence = $\theta_i = 46°$

Refractive index of air = $n_{air}=1.00$

Refractive index of water = $n_w=1.33$

Required:

a) Angle of refraction (from air to water) = θ_r= ?

b) Angle of refraction (from water to air) = θ_r= ?

Solution:

a) From Snell's law, we have

$$\frac{n_1}{n_2} = \frac{\sin\theta_2}{\sin\theta_1} \text{.....(i)}$$

From air to water, we put

$n_1=n_{air}$, $n_2=n_w$, $\theta_1=\theta_i$ and $\theta_2=\theta_r$

So, equation (i) becomes

$$\frac{n_{air}}{n_w} = \frac{\sin\theta_r}{\sin\theta_i}$$

By cross multiplication

$n_{air}\sin\theta_i = n_w\sin\theta_r$

$$\Rightarrow n_w\sin\theta_r = n_{air}\sin\theta_i$$

$$\Rightarrow \text{Sin}\theta_r = \frac{n_{air}\sin\theta_i}{n_w}$$

$$\theta_r = \sin^{-1}\left(\frac{n_{air}\sin\theta_i}{n_w}\right) \text{.....(ii)}$$

Putting values in eq (ii), we get

$$\theta_r = \sin^{-1}\left(\frac{1.00\times\sin 46°}{1.33}\right)$$

$$\theta_r = \sin^{-1}\left(\frac{1.00\times0.72}{1.33}\right)$$

$$\theta_r = \sin^{-1}\left(\frac{0.72}{1.33}\right)$$

$\theta_r = \sin^{-1}(0.54)$

$\theta_r = 32.68^0$

$\theta_r = 33^0$

(b) From water to air, we put

$n_1 = n_w$, $n_2 = n_{air}$, $\theta_1 = \theta_i$ and $\theta_2 = \theta_r$

So, eq (i) becomes

$$\frac{n_w}{n_{air}} = \frac{\sin\theta_r}{\sin\theta_i}$$

By cross multiplication

$$\Rightarrow n_w \times \sin\theta_i = n_{air} \sin\theta_r$$

$$\Rightarrow n_{air} \sin\theta_r = n_w \times \sin\theta_i$$

$$\sin\theta_r = \left(\frac{n_w \times \sin\theta_i}{n_{air}}\right)$$

$$\theta_r = \sin^{-1}\left(\frac{n_w \times \sin\theta_i}{n_{air}}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{(iii)}$$

Putting values in eq(iii), we get

$$\theta_r = \sin^{-1}\left(\frac{1.33 \times \sin 46^\circ}{1.00}\right)$$

$$\theta_r = \sin^{-1}\left(\frac{1.33 \times 0.72}{1.00}\right)$$

$$\theta_r = \sin^{-1}\left(\frac{0.96}{1.00}\right)$$

$\theta_r = \sin^{-1}(0.96)$

$\theta_r = 73.73$

$\theta_r = 73.8$

Or

$\theta_r = 74^0$

Q5. An optical fiber is made from flint glass with index of refraction 1.666 and is surrounded by a cladding made of crown glass with index of refraction 1.52. What is the critical angle?

Given Data:

Refractive index of flint glass $= n_1 = 1.66$

Refractive index of crown glass $= n_2 = 1.52$

Required:

Critical angle $= \theta_c = ?$

Solution:

We know that

$$\sin\theta_c = \frac{n_1}{n_2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{(i)}$$

Putting values in eq(i), we get

$$\sin\theta_c = \frac{1.52}{1.66}$$

$\sin\theta_c = 0.915$

$\theta_c = \sin^{-1}(0.91566265)$

$\theta_c = 66.3^0$

FEDERAL BOARD BOOK

CH#13(ELECTROSTATICS)

Q.1 Rub plastic ruler with your hair. Place it near running water from tap. You see that thin stream of water is deflected. Explain why?

Ans: It is just because of Electrostatic Force. Electrostatic forces are non-contact forces, they pull or push an objects without touching them. When we rub a plastic ruler with our hair, friction is produced which charges the ruler. Now, if we place this charged ruler near running water from tap, it applies a pull (electrostatic force) on the water and it gets deflected.

Q.2 Two identical spheres have same masses. Then we charge both sphere oppositely N charged. After charging, will there be both bodies have same masses or different masses? Explain.

Ans: If a sphere gains a negative charge it means it gains number of electrons in the sphere. Hence the mass is increased in that sphere. And if a sphere gains a positive charge it means it loses number of electrons in the sphere. Hence the mass is decreased that sphere. An atom can gain only electrons which is the negatively charged particles. They become positively charged just by the loss of electrons. They never gain a positive charge. Thus an increase in electrons, the mass of the sphere increases.

Q.3 You take your car to service station to get it polished. After a while, you observe that your car attracts the dust. Why is dust attracted by the car?

Ans: The reason behind the attraction of dust particles is the presence of charged particles in paint that is applied to the car. The process of attraction takes place between the charged particles present in the paint and the particles of dust. Thus the dust particles are stick to the paint of the car.

Q.4 Take two oppositely charged rods, place them separately near small pieces of paper. Why do they both attract small pieces of paper? Is there any third type of charge on papers which attracts both positive and negative charges?

Ans: The pieces of paper are not initially charged. They either have a charge induced on them by the rod, or they are polarized by the electric field of the rod. This works the same way whether the rod is positive or negative. For example a positive rod would induce a negative charge on the paper, and the opposite charges attract. Likewise a negative rod would induce a positive charge on the paper, and again the opposite charges attract.

Q.5 **The force between two point charges is 10N. If their charge is doubled and distance N between them is reduce to half, what will be magnitude of force between them?**

Q.6 A 100C charged body of mass 20kg repels 1C charged body of 10g with a force of 2000N. Will smaller charged body apply force same/smaller/greater force on 20kg charged body?

Ans: The smaller body will exert the same amount of force on the 20kg charged body. The forces between two point charges are action and reaction forces and according to Newton's 3rd law of motion, action and reaction are equal in magnitude but opposite in direction. Therefore, both the charged masses will exert same forces on each other. However, the smaller mass will accelerate more as compared to the heavy mass in accordance with Newton's 2nd law of motion.

Q.7 Why is it dangerous for construction workers to hold long workers steel pole upright during lightning weather condition?

Ans: During lightning weather conditions, the taller structures are more prone to thunder and lightning because they are closer to clouds. Hence it is dangerous for construction workers to hold long steel pole upright during lightning weather condition. Because the charge is carried to the ground via the long steel pole, so it may cause of death of the worker.

Q.8 According to equation of capacitance of capacitor, capacitance is numerically equal to ratio between charge store on one of its plates and potential difference between its plates. Does its value depend upon amount of charge and potential difference?

Ans: We have capacitance, C = Q/V

Where Q= charge on capacitor, V= potential difference across the plates. When the potential difference V is increased, charge on capacitors also increases such that remains constant. Because depends upon plate area medium between plates and distance between plates.

Q.9 Do two capacitors of different plate area gain same or different amount of charge if connected with the same battery?

Ans: The capacitor with large plate area will gain more amount of charge than the capacitor with small plate area.

For constant separation and medium between the plates, capacitance of capacitor is directly proportional to the area of the plate. Therefore, the capacitor with large plate area will store more charge as compared to the capacitor with small plate area.

Q.10 A device has capacitance of 250nC. You are asked to decrease its capacitance to 50nC. How can you get it by connecting another capacitor with it?

Hence, we can get equivalent capacitance equal to 50nC, by connecting a capacitor of 62.5nC in series with 250nC capacitor.

Ch#14(Current Electricity)

Q.1 Can current flow through a circuit without potential difference? Explain.

Ans: If no potential difference then no work is being done on charge so there should be no net displacement of charge but we know that the current flows. Current flows from higher potential to lower potential but across two ends potential is same its mean potential difference is zero, so no current should flow through the circuit.

Q.2 If aluminum and copper wires of the same length have the same resistance, which has the larger diameter?Why?

Ans: Resistance of any material is given as: R =

Where R is the resistance, A is the cross sectional area, L is the length and p is the resistivity of material. Now, resistance and length is same, so the area will depend on the resistivity of the material. Area (A) ∝ Resistivity (p) Resistivity of copper= 1.68×10^{-8} Ωm, Resistivity of aluminum = 2.65×10^{-8} Ωm Since, resistivity of aluminum is higher than resistivity of copper so the area is higher for aluminum.

Q.3 What is resistance across open switch and close switch of a circuit?

Ans "Short circuit" is usually equivalent to "closed switch" whereas "open circuit" is equivalent to "open switch". The resistance of a closed switch is considered to be zero as current will flow without any opposition. Whereas, the resistance of an open switch is considered to be infinity as no current will flow.

Q.4 A bird is sitting on a high voltage transmission line, but it is not electrocuted. Why? When it tries to fly, it touches another bird that is sitting on second transmission line of the pole. Now, it is heavily electrocuted. Why?

Ans: A bird sitting on a high voltage transmission line do not electrocuted because the bird is sitting on a wire don't touch the ground (or anything in contact with the ground), so electricity does not flows through the bird.

When the bird tries to fly and it touches another bird that is sitting on second transmission line of the pole then electricity gets the path to flow from the bird hence it is heavily electrocuted.

Q.5 You are given five resistances of different magnitudes. But you are asked to form a circuit whose resistance is smaller than any given resistance. How can you make such circuit with given resistances?

Ans: For the resultant resistance to be smaller than the given resistances, we should connect the given resistance in a parallel combination. Because the equivalent resistance is smaller than smallest of individual resistance in parallel combination of the resistances. The resistances are connected in parallel to decrease resistance.

Q.6 You are given n wires, each of resistance R. What is the ratio of maximum to minimum resistance obtainable from these wires?

Ans: Maximum resistance can be obtained when the resistance are connected in series and minimum resistance can be obtained when the resistances are connected in parallel.

Q.7 Two electric bulbs marked 100W, 220V and 200W, 220V have tungsten filaments of the same length. Which bulb will have thicker filament?

Ans:

If both have same length and made of same material.

$$R1 > R2 \text{ , then } A2 > A1$$

Hence 200W, 220V bulb has more thickness of filament.

Q.8 Why are we advised not to touch electric switches with wet hand, first dry your hands?

Ans: One should not touch electrical appliances with wet hands. When we wash our hands with tap water which contains a lot of salt and ions this gets transmitted to our hands. Small amounts of mineral salts present naturally in water are beneficial for human health. However, these salts make water conducting. So, we should never handle electrical appliances with wet hands

Q.9 Why is it dangerous to touch a live wire while standing on earth bare footed?

Ans: The live wire is dangerous one because it is at 230V. If you touch a live wire while standing on earth with bare footed, you may complete a circuit between the live wire and the earth. As the current flows when two points are at different potential so the current will flow from body which will results a shock.

Q.10 Sometimes, if your one of the car's head lamp is burnt or not working but second lamp still gives light. What do you conclude about connection of head lamps from this observation?

Ans: The head lights in a car are connected in parallel. So, if one of the car's head lamp is burnt or not working then second lamp will gives light. The alternative of connecting bulbs in series would be that if one failed then all those in series would go out.

Q.11 Show that volt ampere is equal to watt (SI unit of power).

Ans: Watt is a SI unit of power. If a machine or any entity is producing one Joule of work or energy in one second, then we'll say that power of the machine is 1 watt. As

$$P = VI$$

Watt = Volt Ampere

Punjab Board

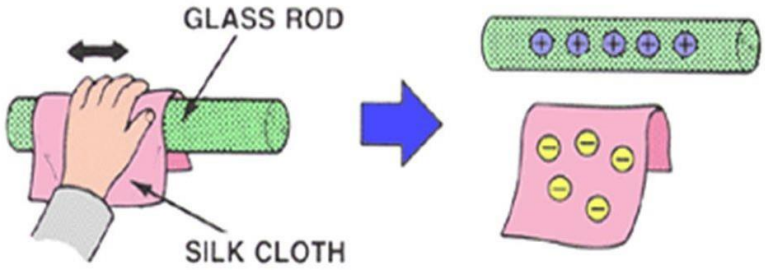
1.How can you show by simple experiments that there are two types of electric charges?

Ans: Ans:Experiment: Take a glass rod and rub it with silk and suspend it horizontally. When we bring the plastic rod rubbed with fur near to the suspended glass rod, we observe that both the rods attract each other because the rods are unlike and their attraction implies that charges on two rods are not of the same kind but of opposite nature.

STATIC ELECTRICITY : Voltage potential with NO electron flow.

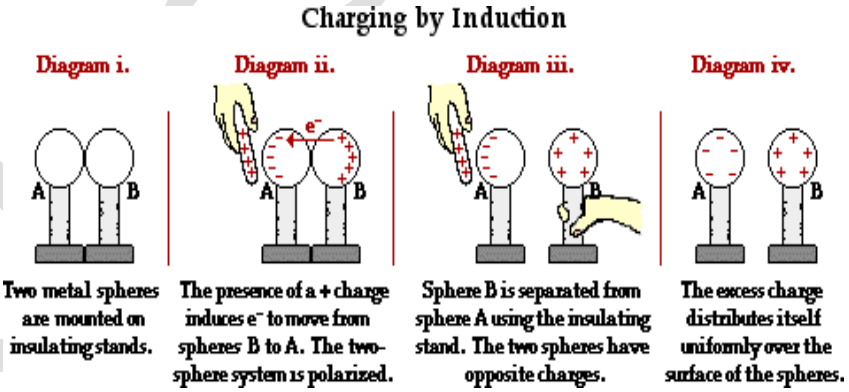
Example:

By rubbing a silk cloth on a glass rod, you physically remove electrons from the glass rod and place them on the cloth. The cloth now has a surplus of electrons (negatively charged), and the rod now has a deficiency of electrons (positively charged).



2.Describe the method of charging bodies by electrostatic induction.

Ans: Method of charging bodies by electrostatic induction: If we bring charged plastic rod near suspended neutral aluminium rod, both rods attract each other as shown in Fig. this attraction between the charged and uncharged rods shows as if both rods have unlike charges, but this is not true. Charged plastic rod produced displacement of positive and negative charges on the neutral aluminium rod which is the cause of attraction between them. But total charge on aluminium rod is still zero. This shows that a body can be charged by electrostatic induction.



3.What is charge and write its properties

Ans: Charge is property of a material body due to which it attracts or repels another object.

(1) Friction produces two different types charge on different material (such glass and plastic).r
(2) Like charges always repel each other.
(3) Unlike charges always attract each other.
(4) Repulsion is the sure test of charge on a body.

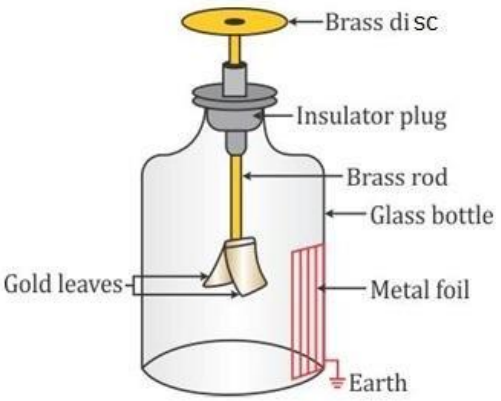
4.How does electrostatic induction differ from charging by friction?

Ans:Electrostatic induction is different from charging by friction because in electrostatic induction we charge a body with another charged body without physical contact but in friction, body is charged by rubbing or physical contact.

5.What is gold leaf electroscope? Discuss its working principle with a labeled diagram.

Ans: **Gold leaf electroscope:** The gold leaf electroscope is a sensitive instrument for detecting presence and nature charges.

Principle: It works on electrostatic induction.



Working: It consist of a brass rod with a brass disk at the top and two thin leaves of gold foil hanging at the bottom. The rod passes through an insulator that keeps the rod in place. Charges can move freely from the disk to the leaves through the rod. A thin aluminium foil is attached on the lower portion of the inside of the jar. Usually, the aluminium foil is grounded by connecting a copper wire. This protects the leaves from the external electrical disturbances.

6. Suppose you have a glass rod which becomes positively charged when you rub it with wool. Describe how would you charge the electroscope.

(a) Negatively **(b) Positively**

Ans:**Charging on Electroscope:** Electroscope can be charged by the process of electrostatic induction.

Negatively: Electroscope can be charged by process of conduction. Touch a negatively charged rod with disk of a neutral electroscope. Negative charge from rod will transfer to electroscope and will cause its leaves to diverge.

Positively: in order to produce positive charge on the electroscope, bring a negatively charged body near the disk of the electroscope. Positive charge will appear on the disk of the electroscope while negative charges will shift to the leaves. By connecting to earthed aluminium foil, charge of the leaves will flow to the Earth through the wire. Now break the Earth connection, remove the rod, the electroscope will be left with positive charge.

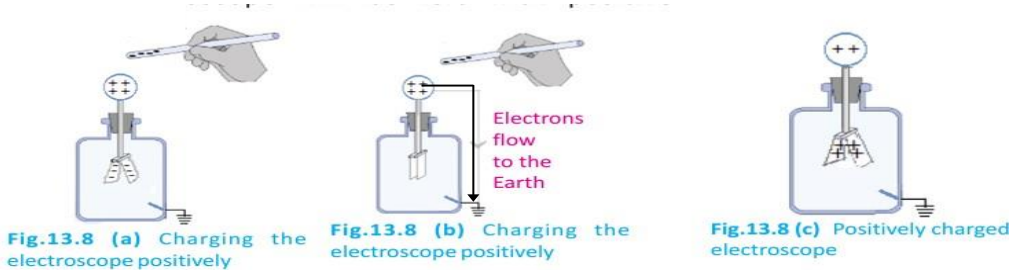


Fig.13.8 (a) Charging the electroscope positively

Fig.13.8 (b) Charging the electroscope positively

Fig.13.8 (c) Positively charged electroscope

7.With the help of electroscope how you can find presence of charge on a body?

Ans: Detecting presence of charge: In order to detect the presence of charge on anybody, bring the body near the disk of an uncharged electroscope. If the body is neutral there will be no deflection of the leaves. But if the body is positively or negatively charged, the leaves of the electroscope diverge. For example, if the body is negatively charged then due to electrostatic induction, positive charge will appear on the disk while negative charge will appear on the leaves. The leaves of electroscope repel; each other and diverge because each leave gets similar charge. The divergence of leaves will depend on the amount of charge.

8.Describe how you would determine the nature of charge on a body by using electroscope?

Ans: Detecting the nature of charge: For the detection of type of charge on a body, electroscope is first charged either positively or negatively. Suppose the electroscope is positively charged as explained before. Now in order to detect the type of charge on a body, bring the charged body near the disk of the positively charged electroscope. If the divergence of the leaves increases the body carries positive charge. On the other hand if the divergence decreases, the body has negative charge.

9.**Explain Coulomb‟s law of electrostatic and write its mathermatical form.**

Ans: **Coulomb‟s law:“***The force of attraction or respulsion between two point charges is directly proportional to the product of the magnitude of charges and inversely proportion to the square of the distance between them***”**. Therefore,

Mathematical expression: F =

10.What is meant by electric field and electric intensity?

Ans: Electric field:“It is a region around the charge in which it exerts electrostatic force on another charge.”

Electric intensity:“The strength of electric field at any point in space is called electric field intensity.”

11.Is electric intensity a vector quantity? What will be its direction?

Ans: **Yes,** electric intensity is vector quantity.

Direction: its direction is same as that of the force acting on the positive charge. If the test charge free to move it will move in the direction of electric intensity.

12.How would you define potential difference between two points? Define its unit.

Ans:**Potential difference:"***The energy supplied by a unit charge as it moves from one point to other in the direction of field is called potential difference*.**"**

Unit: The unit of potential difference is **volt (V)**.

Volt:"*If one joule of work is done against electric field in bringing one coulomb positive charge from infinity to a point in the electric field then potential at that point is one volt*."

13.Show that potential difference can be described as energy transfer per unit charge between the two points?

Ans: If the potential of point A is V_a and that of point B is V_b, the potential energy of the charge at these points will be qV_a and qV_b respectively.the change in potential energy of the charge when it moves from point A to B will be equal to $qV_a - qV_b$. This energy is utilized in doing some useful work

Thus energy supplied by the charge =

14.What do you mean by the capacitance of a capacitor? Define unit of capacitance.

Ans:**Capacitance:"***Capacitance is the ability of a capacitor to store charge*."

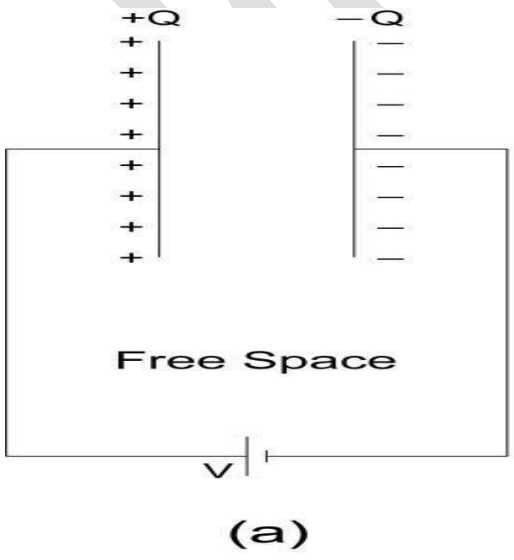
$$C = \frac{Q}{V}$$

Units: Its unit is **Farad (F)**.

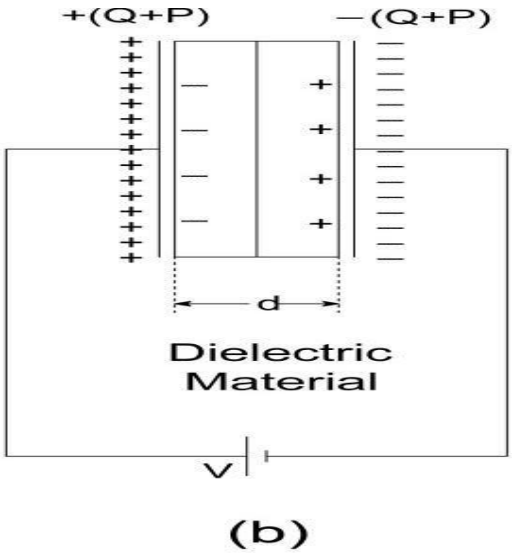
One Farad:" If one coulomb of charge given to the plates of a capacitor produces a potential difference of one volt between the plates of the capacitor then its capacitance would be one farad."

15.Define a capacitor?

Ans: A device which is used to store the charge called capacitor. It consists of two thin metal plates, parallel to each other.



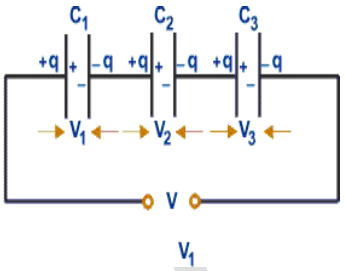
(a)



(b)

16.Derive the formula for the effective capacitance for a series combination of a number of capacitors.

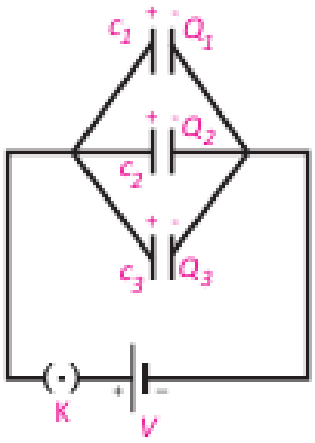
Ans:Effective capacitance of series combination:



V_1

17.Derive the formula for the effective capacitance for a parallel combination of a number of capacitors.

Ans:Effective capacitance of parallel combination



18.Discuss different types of capacitors.

Ans:**Types of capacitors:** Capacitors are generally of two types:

i. Variable capacitors ii. Fixed capacitors

Fixed capacitors: Fixed capacitors are further types:

i. Parallel plate capacitors
ii. Spherical capacitors
iii. Paper capacitor
iv. Mica capacitor

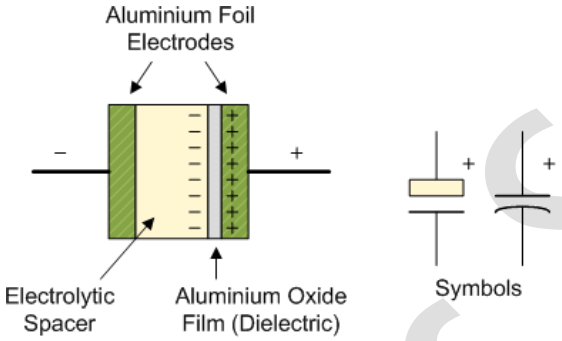
Cylindrical capacitor

19.What is the difference between variable and fixed type capacitor?

Fixed Capacitor	Variable Capacitor
"The capacitor which has fixed capacitance is called fixed capacitor."	*"The capacitor whose capacitance is variable is called variable capacitor."*

20.What is electrolytic capacitor?

Ans: An electrolytic capacitor is a type of capacitor that uses an electrolyte to achieve a larger capacitance than other capacitor types. An electrolyte is a liquid or gel containing a high concentration of ions.



21.Enlist some uses of capacitors.

Ans: Uses of capacitors:

i. They are used for tuning transmitter and radio.
ii. They are used in fan motors.
iii. They are used in circuits of computer etc.

22.Discuss one application of static electricity.

Ans: Electrostatic air cleaner: An electrostatic air cleaner is used in homes to relieve the discomfort of allergy sufferers. Air mixed with dust and pollen enters the device across a positively charged mesh. The airborne particles become positively charged when they make contact with the mesh. Then they pass through a second, negatively charged mesh. The electrostatic force of attraction between the positively charged particles in the air and the negatively charged mesh causes the particles to precipitate out on the surface of the mesh. Through this process we can remove a very high percentage of contaminants from the air stem.

23.What are hazards of static electricity?

Ans: Hazards of static electricity: Static electricity is a major cause of fires and explosions at many places. A fire or an explosion may occur due to excessive build-up of electric charges produced by friction. Static electricity can be generated by the friction of the gasoline begin pumped into a vehicle or container. It can also be produced when we get out the car or remove an article of clothing. Static charges are dangerous. If static charges are allowed to discharge through the areas where there is petrol vapour a fire can occur.

23.An electrified rod attracts pieces of paper. After a while these pieces fly away! Why?

Ans: When electrified rod attracts pieces of paper, after while these pieces fly away because some electrons move to rod and rod becomes neutral.

24.How much negative charge has been removed from a positively charged electroscope, if it has a charge of 7.5×10^{-11} C?

Ans:Charge of -7.5×10^{-11} C has been removed from positively charged electroscope beacause negative charge is equal to positive charge

25.In what direction will a positively charged particle move in an electric field?

Ans: The positively charged particle move along the direction of electric intensity. In an electric field the direction of electric field intensity can also be represented by electric lines of force. So, the positive charge particle move in the direction of electric lines of force. i.e. from higher to lower potential.

26.Does each capacitor carry equal charge in series combination explain.

Ans: Yes, each capacitor carries equal charge because if the battery supplies charge on the left plate of a capacitor (C1), -Q charge is induced, then on its right plate, +Q charge on the left of the capacitor C2 is induced. i.e. $Q_1 = Q_2 = Q$

27.Each capacitor in parallel combination has equal potential difference between its two plates justify the statement.

Ans: Each capacitor carries equal potential difference because each capacitor is connected directly with the terminals of battery. i.e. V = V1 = V2

28.Perhaps you have seen a gasoline truck trailing a metal chain beneath it. What purpose does the chain serve?

Ans: Due to friction the truck body gets charged and it may cause explosion. So, the metal chain continuously transfers the charge from truck to ground and the spark is removed.

29.If a high-voltage power line fell across your car while you were in the car, why should you not come out of the car?

Ans: Because the tyres of the car are insulator. So, that the current can‟t pass through them but when we come out and in contact with the car and from the body of car the current will pass through our body which may cause death.

30.Explain why, a glass rod can be charged by rubbing when held by hand but an iron rod cannot be charged by rubbing, if held by hand?

Ans:By rubbing glass rod, charge does not flow to our body (which is a good conductor) and remains on rod. But charge of iron rod flows to earth through our body and rod loses its charge.