Inter (Part-I) 2015

Physics	Group-I	PAPER: I
Time: 20 Minutes	(OBJECTIVE TYPE)	Marks: 17

Note: Four possible answers, A, B, C and D to each question are given. The choice which you think is correct, fill that circle in front of that question with Marker or Pen ink in the answer-book. Cutting or filling two or more circles will result in zero mark in that question.

1-1- The dimensions of work are:

(a) $[MLT^{-1}]$ (b) $[MLT^{-2}]$

(c) $[ML^2T^{-2}]$ √ (d) $[MLT]$

2- The speed of sound in air does not depend upon:

(a) Density (b) Pressure √

(c) Humidity (d) Temperature

3- The S.I units of angular momentum are given by:

(a) $J.s^{-2}$ (b) $J.s^{-1}$

(c) J.s √ (d) J.m

4- The distance between two consecutive nodes is:

(a) $\frac{\lambda}{2}$ √ (b) $\frac{\lambda}{4}$

(c) λ (d) 2λ

5- S.I unit of intensity of light is:

(a) Ampere (b) Mole

(c) Candela √ (d) Joule

6- The S.I units of flow rate are:

(a) m^2s^{-1} (b) m^3s^{-2}

(c) m^3s^{-1} √ (d) m^2s^{-2}

7- **Number of spark plugs needed in the diesel engine are:**

(a) 0 √ (b) 1
(c) 2 (d) 3

8- **Bending of light around the edges of an obstacle is called:**

(a) Refraction (b) Polarization
(c) Interference (d) Diffraction √

9- **The difference between C_p and C_v is equal to:**

(a) Planck's constant (b) General gas constant √
(c) Molar gas constant (d) Boltzman constant

10- **The magnitude of $\hat{i} \cdot (\hat{j} \times \hat{k})$ is equal to:**

(a) 0 (b) 1 √
(c) –1 (d) $\hat{i}$

11- **One radian is equal to:**

(a) 57.3° √ (b) 56.3°
(c) 58.3° (d) 360°

12- **The light emitted from light emitting diode (LED) has a wavelength:**

(a) 1.3 μm √ (b) 1.2 μm
(c) 1.4 μm (d) 1.5 μm

13- **If amplitude of a simple pendulum is increased by 4 times, the time period will be:**

(a) Four times (b) Half
(c) Same √ (d) Two times

14- **Beats can be heard when difference of frequency is not more than:**

(a) 8 Hz (b) 10 Hz √
(c) 4 Hz (d) 6 Hz

15- **When the body moves with constant acceleration, the velocity time graph is:**

(a) Parabola (b) Hyperbola

(c) Straight line √ (d) Curve

16- **A man of mass 5 kg is falling freely, the force acting on it will be:**

(a) 5 N (b) 9.8 N

(c) 19.6 N (d) Zero √

17- **Motion of a projectile is:**

(a) One dimensional (b) Two dimensional √

(c) Three dimensional (d) Four dimensional

Inter (Part-I) 2015

Physics	Group-I	PAPER: I
Time: 3.10 Hours	(SUBJECTIVE TYPE)	Marks: 83

SECTION-I

2. Write short answers to any EIGHT (8) questions: 16

(i) What are the dimensions and unit of gravitational constant G in the formula: $F = G\frac{m_1 m_2}{r^2}$?

Ans

$$F = G\frac{m_1 m_2}{r^2}$$

$$[G] = \frac{[Fr^2]}{[m_1 m_2]}$$

$$[G] = \frac{[MLT^{-2}][L^2]}{[M^2]}$$

$$G = M^{-1} L^3 T^{-2}$$

Units of G are: $Nm^2 kg^{-2}$

(ii) How many seconds are there in one year?

Ans We know:

1 year = 365 days

Seconds in 1 year = 31536000 sec

$= 3.1536 \times 10^7$ sec

(iii) Write down the two uses of dimensional analysis.

Ans Following are the two uses of dimensional analysis:

1. We can check the correctness of a given formula or an equation and can also derive it.
2. Dimensional analysis makes use of the fact that expression of the dimensions can be manipulated as algebraic quantities.

(iv) What are the main frontiers of fundamental science?

Ans These are main frontiers of fundamental science:

(a) The world of extremely large (The universe itself).
(b) The world of extremely small (the particles such as protons, neutrons, etc.).
(c) The world of complex matter (the world of middle-sized things).

(v) Can a vector have a component greater than the vector's magnitude?

Ans No, component of a vector cannot have a magnitude greater than the magnitude of the vector, because component of a vector is a part of a vector. Maximum value, which a component can have, is equal to that of the vector.

(vi) Can you add zero to a null vector?

Ans Zero is a scalar number, whereas, null vector is a vector quantity. Different quantities cannot be added. Thus, zero can not be added to a null vector.

(vii) Define the two conditions of equilibrium.

Ans **1st condition:**

The vector sum of all forces acting on it must be zero.

Mathematically, $\Sigma F = 0$.

2nd condition:

For a body in equilibrium, the vector sum of all the torques acting on it about any arbitrary axis should be zero.

Mathematically, $\Sigma \tau = 0$.

(viii) Differentiate between distance and displacement.

Ans Length of a path between two points is called the distance between those points, while displacement is the shortest distance between two points which has magnitude and direction.

(ix) Define range and time of flight of a projectile.

Ans **Range of a projectile:**

Maximum distance which a projectile covers in the horizontal direction is called the range of the projectile.

Time of flight of a projectile:

The time taken by the body to cover the distance from the place of its projection to the place where it hits the ground at the same level is called the time of flight.

(x) Can the velocity of an object reverse the direction when acceleration is constant? If so, give an example.

Ans Yes, when the acceleration is constant, the velocity of an object reverses the direction.

For example, consider a body is thrown upward under gravity. As body goes up, its velocity goes on decreasing. During this process, magnitude of "g" remains constant. But the velocity of the object is opposite in both cases.

(xi) Explain the circumstances in which the velocity 'v' and acceleration 'a' of a car are:

(a) Parallel **(b) Anti-parallel**

Ans **(a) Parallel:**

When the velocity of a car is increasing along a straight line, $\vec{v}$ and $\vec{a}$ are parallel.

(b) Anti-parallel:

When velocity of a car is decreasing due to application of brakes, $\vec{v}$ and $\vec{a}$ are anti-parallel.

(xii) Explain the difference between laminar flow and turbulent flow.

Ans The flow is said to be streamline or laminar, if every particle that passes a particular point, moves along exactly the same path, as followed by particles which passed that points earlier. While the irregular or unsteady flow of the fluid is called turbulent flow.

3. Write short answers to any EIGHT (8) questions: 16

(i) A force 'F' acts through a distance 'L'. The force is then increased to '3F' and then acts through a further distance of '2L'. Draw the work diagram to scale and calculate total work done.

Ans

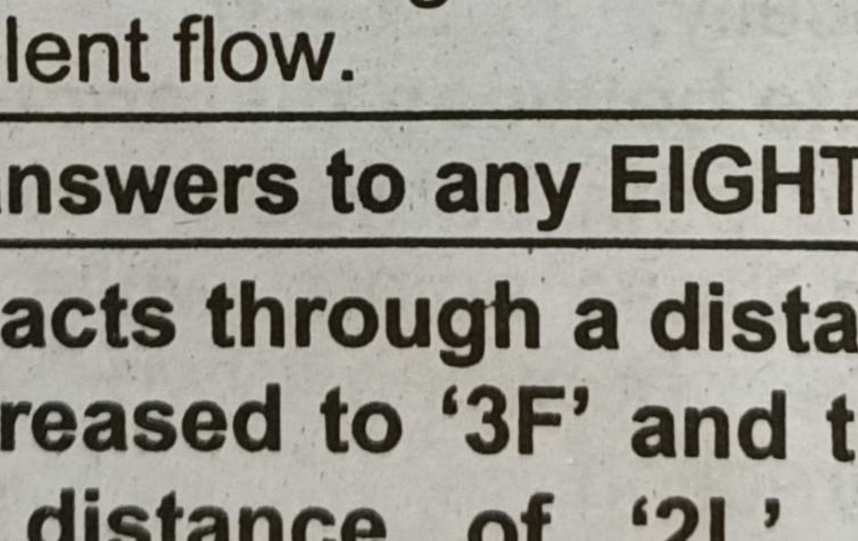


Fig. Work Diagram.

With the help of above diagram,

Total work = Shaded area

= FL + 3F × 2L

= FL + 6FL

= 7FL

(ii) When a rocket re-enters the atmosphere, its nose cone becomes very hot. Where does this heat energy come from?

Ans There is a large number of dust particles and water vapours present in the air. When a rocket re-enters the atmosphere, it has to face the resistance due to particles. Some K.E. of the rocket is converted into heat energy. Therefore, the cone nose of the rocket becomes very hot due to the heat energy produced by the fluid friction of atmosphere.

(iii) Define work energy principle. Also write down its equations.

Ans This principle states that,

"Work done on the body equals the change in its kinetic energy."

Whenever, work is done on a body, it increases its energy. Its equation is:

$$Fd = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

(iv) Explain what is meant by centripetal force. Why it must be furnished to an object if it is to follow a circular path?

Ans The force needed to bend the normally straight path of the particle into a circular path is called the centripetal force.

In a circular path, if the particle moves from one point to another with uniform speed, the velocity of the particle changes its direction but not its magnitude, so it must be furnished to an object.

(v) When mud flies off the tyre of a moving bicycle. In what direction does it fly?

Ans When the tyre rotates, a centripetal force acts on the mud equal to adhesive force. At one stage, adhesive force becomes unable to meet the demand of centripetal force and the mud will no longer move in the circular path and flies off along tangent due to centripetal force.

(vi) Show that orbital angular momentum $L_o = mvr$.

Ans Angular momentum is given as:

$$\vec{L} = \vec{r} \times \vec{p}$$

Magnitude of angular momentum is

$$L_o = r\,p \sin\theta \qquad \text{(i)}$$

Where θ is angled between r and p.

Linear momentum is given as:

$$\vec{p} = m\vec{v}$$

Magnitude of angular momentum is

$$p = mv$$

Putting this value in (i),

$$L_o = rmv \sin\theta$$

Let the object is moving in such a way that

$$\theta = 90^\circ$$

the $L_o = mvr \sin 90^\circ$

$$L_o = mvr \ldots (1)$$

$$L_o = mvr$$

(vii) Show that in simple harmonic motion, the acceleration is zero when the velocity is greatest and the velocity is zero when the acceleration is greatest.

Ans (i) $v = \omega\sqrt{x_o^2 - x^2}$

when $x = 0$ (at mean position)

$v_{max} = \omega x_o$

But $a = 0$

(ii) when $x = x_o$ (at extreme position)

$v_{min} = 0$

But $a = -\omega^2 x_0$

Both cases show that when velocity is maximum acceleration is zero and when velocity is minimum acceleration is maximum.

(viii) What happens to the period of a simple pendulum if its length is doubled? What happens if suspended mass is doubled?

Ans As we know:

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

According to given condition if length is doubled i.e. $l' = 2l$

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

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

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

$$= \sqrt{2}\,T$$

$$= 1.41T$$

It means time period increases by $\sqrt{2}$ times

→ The time period of simple pendulum is independent of mass, therefore, if mass is doubled there will be no change in 'T'.

(ix) Describe some common phenomena in which resonance plays an important role.

Ans Following are some common phenomenon in which resonance plays an important role:

1. Resonance may be built up by mechanical vibrations to such amplitude in some structures so as to produce very dangerous effects in them.
2. A swing has certain natural time period in which resonance takes place.
3. Tuning a radio is also common phenomenon in which resonance plays an important role.
4. The waves produced by microwave oven are absorbed due to resonance by fat molecules and

If unpolarized light is made incident on a sheet of polaroid, the transmitted light will be plane polarized. They can be distinguished by using polarizer. When light is viewed through polarizer and it can be seen continuously even if polarizer is rotated, the light seen is unpolarized. However, if on rotating the polarizer, the light becomes dim and cuts off by rotating the polarizer through 90°, then light observed is plane polarized light.

(ii) An oil film spreading over a wet footpath shows colours. Explain how does it happen.

Ans These colours are seen due to interference of light. It happens when the rays of white light fall on the surface of oil film. The rays of light reflected from upper and lower surface of oil film interfere destructively. Thus, due to this reason, coloured fringes appear.

(iii) Why the polaroid sunglasses are better than ordinary sunglasses?

Ans When light passes through plane polarized glasses, a polarized light is obtained. For example, light reflected from a surface produces lesser glare. In the same way, the glare of light can be reduced by using polaroid glasses. Hence, the polaroid sunglasses are better than ordinary sunglasses.

(iv) What are uses of spectrometer?

Ans A spectrometer is an optical device used to study spectra from different sources of light. With the help of a spectrometer, the deviation of light by a glass prism and the refractive index of the material of the prism can be measured quite accurately. Using a diffraction grating, the spectrometer can be employed to measure the wavelength of the light.

(v) Why would it be advantageous to use blue light with a compound microscope?

Ans The resolving power is inversely proportional to the wavelength.

$$R = \frac{\lambda}{\Delta\lambda}$$

A grating with high resolving power can distinguish small difference in wavelength. If blue light is used in

water in the food, heating them up and so cooking the food easily.

(x) What features do longitudinal waves have in common with transverse waves?

Ans Following are the features do longitudinal waves have in common with transverse waves:

1. Particles of medium oscillate about their mean position.
2. Their velocity is given by $v = f\lambda$.
3. Velocity of waves depends on modulus of elasticity and density of medium.
4. They transport energy from one point to the other.

(xi) Explain the terms crest, trough, node and antinode.

Ans **Crest:**

The portion of disturbance of a transverse wave which is above the mean position is called crest.

Trough:

The portion of disturbance of a transverse wave which is below the mean position is called trough.

Node:

The points of zero displacement in stationary waves is called node.

Antinode:

Those points which have maximum displacement on either side of mean position are called antinodes.

(xii) Explain why sound waves travel faster in warm air than in cold air.

Ans Speed of sound in air is $v = \sqrt{\frac{\gamma p}{\rho}}$, when the gas is heated its density decreases. Since speed of sound is inversely proportional to the density. Thus, sound travels faster in warm air than in cold air.

4. Write short answers to any SIX (6) questions: 12

(i) How would you distinguish between unpolarized light and plane-polarized light?

Ans Ordinary light has components of vibration in all possible planes. Such a light is unpolarized light.

(i) Time of Flight:

"Time taken by the projectile to reach the ground is known as time of flight."

The time taken by the body to cover the distance from the place of its projection to the place where it hits the ground at the same level is called the time of flight.

This can be obtained by taking $S = h = 0$, because the body goes up and comes back to same level, thus covering no vertical distance. If the body is projecting with velocity v making angle θ with a horizontal, then its vertical component will be $v_i \sin\theta$. Hence, the equation is

$$S = v_i t + \frac{1}{2} g t^2$$

$$0 = v_i \sin\theta\, t - \frac{1}{2} g t^2$$

$$t = \frac{2 v_i \sin\theta}{g}$$

where t is the time of flight of the projectile when it is projected from the ground.

(ii) Maximum Height for Projectile:

In order to determine the maximum height the projectile attains, we use the equation of motion

$$2aS = v_f^2 - v_i^2$$

As body moves upward, so $a = -g$, the initial vertical velocity $v_{iy} = v_i \sin\theta$ and $v_{fy} = 0$ because the body comes to rest after reaching the highest point. Since,

$$S = \text{height} = h$$

So, $-2gh = 0 - v_i^2 \sin^2\theta$

or $$h = \frac{v_i^2 \sin^2\theta}{2g}$$

(b) Find the projection of vector $\vec{A} = 2\hat{i} - 8\hat{j} + \hat{k}$ in the direction of vector $\vec{B} = 3\hat{i} - 4\hat{j} - 12\hat{k}$. (3)

compound microscope, it increases the resolving power and more details of object can be studied.

(vi) Why is the average velocity of the molecules in a gas zero but the average of the square of the velocities is not zero?

Ans There are a large number of molecules in a gas and according to the kinetic molecular theory of gases, equal number of molecules move in all directions. This means that number of molecules moving in one direction is equal to the number of molecules moving in the opposite direction. Thus, the vector sum of their velocities is zero. But the square of negative velocity is positive, therefore, the average of the square of the velocities is not zero.

(vii) A thermoflask containing milk as a system is shaken rapidly. Does the temperature of the milk rise?

Ans When milk is shaken rapidly, the kinetic energy of the molecules increases *i.e.*, the work is done on molecules. Since, K.E is proportional to the temperature, therefore, the temperature of the milk rises.

(viii) Define absolute zero using carnot cycle.

Ans We can define absolute zero using carnot cycle, as the working substance returns to the initial state, there is no change in its internal energy, *i.e.*, $\Delta U = 0$.

(ix) Is it possible to construct a heat engine that will not expel heat into the atmosphere?

Ans No, it is impossible, because all practical heat engines reject some of input heat energy to a cold temperature reservoir which is atmosphere.

SECTION-II

NOTE: Attempt any Three (3) questions.

5.(a) Define projectile motion. Derive mathematical formula for its height and time of the flight. (5)

Ans Projectile Motion:

"Projectile motion is two dimensional motion under constant acceleration due to gravity."

Ans If θ is the angle between A and B, then A cos θ is the required projection.

By definition, $A.B = AB\cos\theta$

$$A\cos\theta = \frac{A.B}{B} = A.\hat{B}$$

Where $\hat{B}$ is the unit vector in the direction of B

Now $B = \sqrt{3^2 + (-4)^2 + (-12)^2} = 13$

Therefore, $\hat{B} = \frac{(3\hat{i} - 4\hat{j} - 12\hat{k})}{13}$

The projection of A on B $= (2\hat{i} - 8\hat{j} + \hat{k}) \cdot \frac{(3\hat{i} - 4\hat{j} - 12\hat{k})}{13}$

$$= \frac{(2)(3) + (-8)(-4) + 1(-12)}{13}$$

$$= \frac{26}{13} = 2$$

6.(a) Explain work done in gravitational field. Also define conservative field. (3)

Ans **Non-conservative field:**

The field in which work done be dependent of path followed or work done in away path is called non-conservative field.

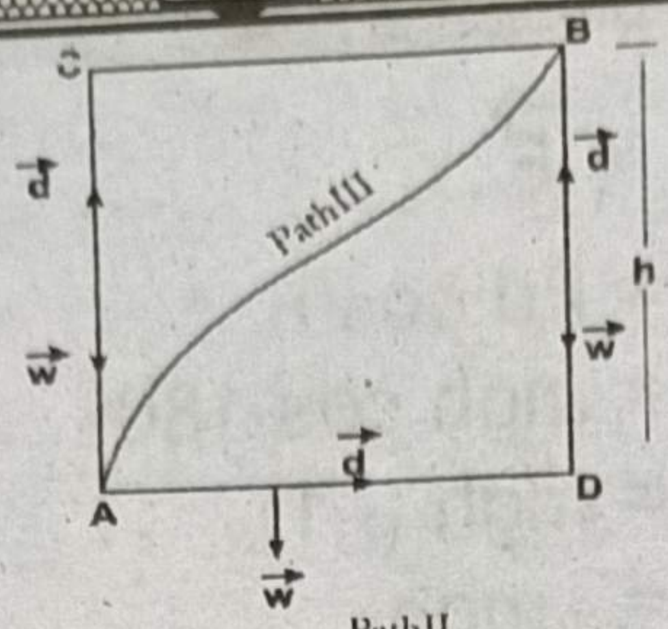
Conservation field:

The field in which work done be independent of path followed or work done in closed path be zero is called conservative field e.g. gravitational field, magnetic field.

Gravitational force:

The force acting in gravitational field is called as gravitational force.

Work done:



The work done in gravitational field is independent of path followed. Consider an object of mass 'm' which is displaced with constant velocity from point A to B along three paths in presence of gravitational force. We calculate work done along three paths in following.

Path I:

The work done by gravitational force along path ABD can split into two paths:

$$W_{ADB} = W_{AD} + W_{BD}$$

Here,

$$W_{AD} = \vec{F} . \vec{d}$$

$$= Fd \cos\theta$$

$$= mgh \cos 180^\circ$$

$$= mgh (-1)$$

$$= -mgh$$

$$W_{BD} = \vec{F} . \vec{d}$$

$$W_{BD} = Fd \cos\theta$$

$$W_{BD} = Fd \cos 90^\circ$$

$$W_{BD} = 0$$

So,

$$W_{ADB} = 0 + (- mgh)$$

$$= - mgh \quad (1)$$

Path II:

The work done along path ACB can be divided into second path:

$$W_{ACB} = W_{AC} + W_{BC}$$

here, $W_{AC} = \vec{F} . \vec{d}$

$= Fd \cos\theta$

$= mgh \cos 180^o$

$= mgh\ (-1)$

$= -mgh$

Again,

$W_{BC} = \vec{F} . \vec{d}$

$= Fd \cos\theta$

$= mg\ d \cos 90^o$

$= mgh\ (0)$

$= 0$

So,

$W_{ACB} = -mgh + 0$

$W_{ACB} = -mgh$ (2)

Path III:

It is curved path. We divide this path into a series of horizontal and vertical steps. There is no work done along horizontal steps because 'mg' is perpendicular to the displacement for these steps. The work is done by force of gravity along the vertical displacement (Δy_1, Δy_2, Δy_n)

$W_{AB} = \vec{F} . \Delta y_1 + \vec{F} . \Delta y_2 + - - - - - \vec{F} . \Delta y_n$

$= F\Delta y_1 \cos\theta + F\Delta y_2 \cos\theta - - - - - F\Delta y_n \cos\theta$

Here $F = mg$ and $\theta = 180^o$

$W_{AB} = mg\ \Delta y_1 \cos 180^o + mg\Delta y_2 \cos 180^o - - - - F\Delta y_n \cos\theta$

$= mg\Delta y_1\ (-1) + mg\Delta y_2 (-1) - - - - - mg\Delta y_n (-1)$

$= -mg\ (\Delta y_1 + \Delta y_2 - - - - - \Delta y_n)$

$= -mg\ (h)$

$= -mgh$ (3)

Conclusion:

From eq. (1), (2), (3) it is concluded that work done in earth's gravitational field is independent of path followed.

(b) What is the least speed at which an aeroplane can execute a vertical loop of 1.0 km radius, so that there will be no tendency for the pilot to fall down at the highest point?

Ans Radius of loop = r = 1.0 km
= 1000 m

Speed of aeroplane at highest point
v = ?

When aeroplane is in a vertical circular loop, the centripetal acceleration is provided by force of gravity, then

We know:

$$a_c = g$$

$$g = \frac{v^2}{r}$$

$$v^2 = g\,r$$

$$v = \sqrt{gr}$$

$$v = \sqrt{9.8 \times 1000}$$

$$v = \sqrt{9800}$$

$$v = 99 \text{ m / sec}$$

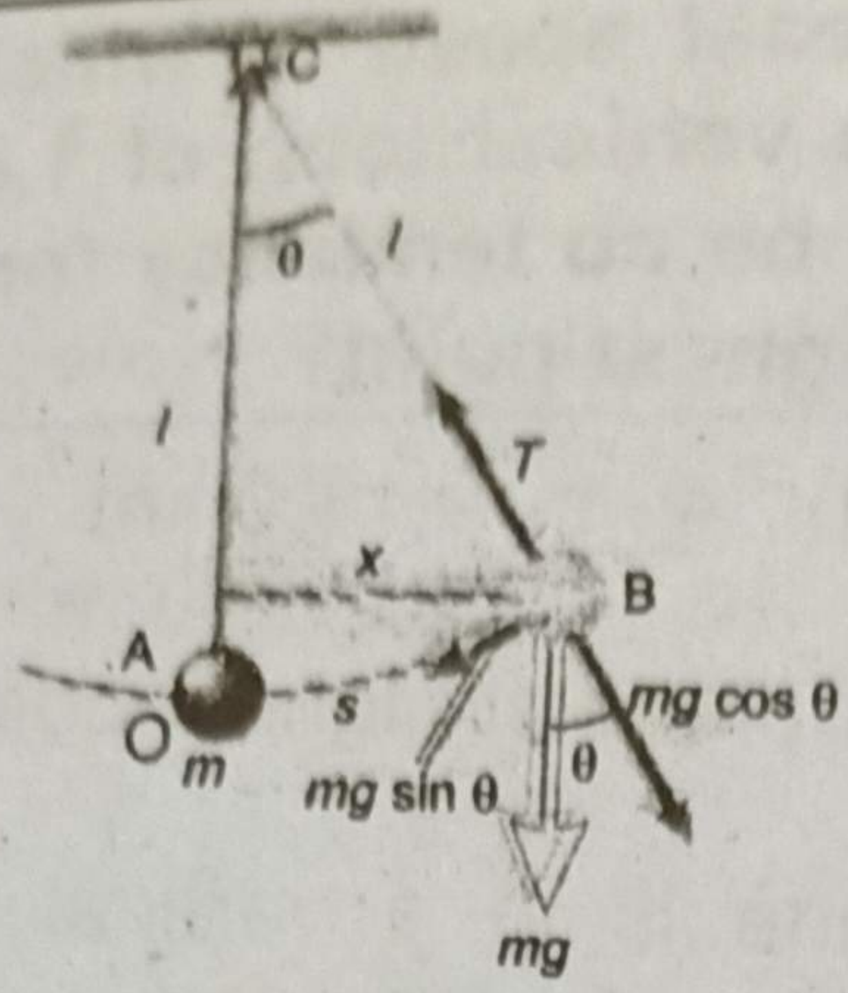
7.(a) What is simple pendulum? Show that its motion is S.H.M. Derive expression for its time period.(5)

Ans Simple Pendulum:

A simple pendulum consists of a small heavy mass *m* suspended by a light string of length *l* fixed at its upper end, as shown in Fig. When such a pendulum is displaced from its mean position through a small angle θ to the position B and released, it starts oscillating to and fro over the same path. The weight mg of the mass can be resolved into two components; mg sin θ along the tangent at B and mg cos θ along CB to balance the tension of the string. The restoring force at B will be:

$$F = -mg \sin\theta$$

When θ is small, $\sin\theta \approx \theta$



So $F = m\,a = -m\,g\,\theta$ (1)

or $a = -g\,\theta$

But $\theta = \dfrac{\text{Arc AB}}{l}$

When θ is small Arc AB = OB = x, hence $\theta = \dfrac{x}{l}$

Thus, $a = -\dfrac{gx}{l}$ (2)

At a particular place, 'g' is constant and for a given pendulum, '*l*' is also a constant.

Therefore, $\dfrac{g}{l} = k$ (a constant)

and the motion of the simple pendulum is simple harmonic. Comparing eq. (2) with $a = -\omega^2 x$

$$\omega = \sqrt{\frac{g}{i}}$$

As time period $T = \dfrac{2\pi}{\omega}$

Hence, $T = 2\pi\sqrt{\dfrac{l}{g}}$ (3)

This shows that the time period depends only on the length of the pendulum and the acceleration due to gravity. It is independent of mass.

(b) A stationary wave is established in a string which is 120 cm long and fixed at both ends. The string vibrates in four segments, at a frequency of 120 Hz. Determine its wavelength and the fundamental frequency. (3)

Ans (i)

Data:

Length of string = l = 120 cm

$$= \frac{120}{100} = 1.2 \text{ m}$$

Number of loops = n = 4

Frequency of vibration in four segments = f_4 = 120 Hz

To Find:

(i) Fundamental frequency = f_1 = ?

(ii) Wavelength = λ = ?

FORMULA:

(i) $\frac{\lambda}{2} \times 4 = l$ or $\lambda = l/2$

(ii) $f_n = nf_1$

CALCULATIONS:

We know that the distance between two consecutive nodes is $\lambda/2$. Since, the string vibrates in four segments, therefore, the length of the string is given by:

$$l = 4 \times \frac{\lambda}{2}$$

or $$\lambda = \frac{2l}{4} = \frac{l}{2}$$

Putting the value of 'l', we get

$$\lambda = \frac{1.2}{2} = 0.6 \text{ m}$$

Hence, $\boxed{\lambda = 0.6 \text{ m}}$ Ans.

(ii) Fundamental frequency:

When a string vibrates in n loops, the formula for the frequency of stationary waves is given by:

$$f_n = nf_1$$

where f_1 is the fundamental frequency and n is number of loops.

In the problem, number of loops is 4 *i.e.*, $n = 4$.

Therefore,

$$f_4 = 4f_1$$

Putting the value of $f_4 = 120$ Hz, we get

$$120 = 4\, f_1$$

$$f_1 = \frac{120}{4} = 30 \text{ Hz}$$

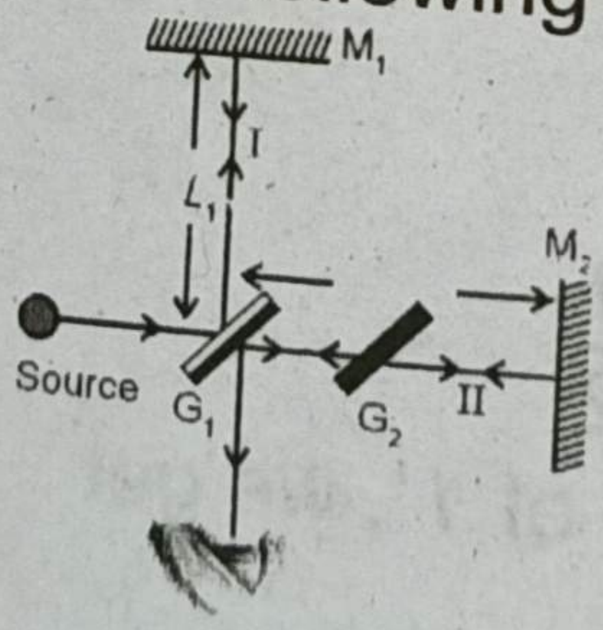
Hence, $\boxed{f_1 = 30 \text{ Hz}}$ **Ans.**

8.(a) Explain principle, construction and working of Michelson's interferometer. (5)

Ans **Principle:**

It splits a light beam into two parts and then recombines them to form an interference pattern after they have traveled over different paths.

Michelson's interferometer is an instrument that can be used to measure distance with extremely high precision. Albert A. Michelson devised this instrument in 1881 using the idea of interference of light rays. The essential features of a Michelson's interferometer are shown schematically in the following figure:



Monochromatic light from an extended source falls on a half-silvered glass plate G_1 that partially reflects it and partially transmits it. The reflected portion labeled as I in the figure travels a distance L_1 to mirror M_1, which reflects the beam back towards G_1. The half-silvered plate

G_1 partially transmits this portion that finally arrives at the observer's eye. The transmitted portion of the original beam labeled as II, travels a distance L_2 to mirror M_2 which reflects the beam back towards G_1. The beam II partially reflected by G_1 also arrive the observer's eye finally. The plate G_2, cut from the same piece of glass as G_1, is introduced in the path of beam II as a compensator plate. G_2, therefore, equalizes the path length of the beams I and II in glass. The two beams having their different paths are coherent. They produce interference effects when they arrive at observer's eyes. The observer then sees a series of parallel interference fringes.

(b) An astronomical telescope having magnifying power of 5 consists of two thin lenses 24 cm apart. Find the focal lengths of the lenses. (3)

Ans. Magnifying power $M = 5$

Distance between lenses $L = 24$ cm

Focal length of objective $f_o = ?$

We know that

$$L = f_o + f_e$$

$$24 = f_o + f_e \quad \text{(i)}$$

$$M = \frac{f_o}{f_e}$$

$$5 = \frac{f_o}{f_e}$$

$$F_o = 5 f_e$$

Putting in (i),

$$24 = 5 f_e + f_e$$

$$6 f_e = 24$$

$$f_e = \frac{24}{6}$$

$$\boxed{f_e = 4 \text{ cm}}$$

$$f_o = 5 f_e$$

$$f_o = 5(4)$$

$$\boxed{f_o = 20 \text{ cm}}$$

9.(a) Define terminal velocity. Show that terminal velocity is directly proportional to the square of radius. (5)

Ans Terminal velocity:

"When weight of falling object and drag force become equal in magnitude and velocity of object becomes maximum, then this constant velocity is called as terminal velocity."

Consider water droplet such as fog falling vertically under action of gravity. The air drag on the water droplet increases with speed.

The upward drag force on it increases as the speed of droplet increases. So, net force on it is given by:

$$F_{net} = w - F$$

$$ma = mg - 6\pi\eta r v_t$$

As speed continues to increase, the drag force also increases. Finally, it becomes equal to the weight i.e. F = w. And the net force acting on droplet is zero. Now droplet falls with constant speed called terminal velocity. At this stage, the acceleration becomes zero i.e. a = 0. Therefore,

$$0 = mg - 6\pi\eta r v_T$$

$$6\pi\eta r v_T = mg$$

$$v_T = \frac{mg}{6\pi\eta r}$$

This is expression for terminal velocity in terms of mass. Since,

$$\therefore \quad m = \rho v$$

$$\therefore \quad v = \frac{4}{3} \rho \pi r^3$$

$$v_T = \frac{\frac{4^2}{3}\pi r^3 \rho g}{{}_3 6\pi\eta r}$$

$$v_T = \frac{2\rho g r^2}{9\eta}$$

$$\because \quad \frac{2\rho g}{9\eta} = \text{constant}$$

$$v_T \propto r^2$$

This is relation for terminal velocity in terms of density. This shows that terminal velocity is directly proportional to square of radius i.e $v \propto r^2$.

(b) 336 J of energy is required to melt 1 g of ice at 0°C. What is the change in entropy of 30 g of water at 0°C as it is changed to ice at 0°C by a refrigerator? (3)

Ans Given data:

$H_f = 336$ J

$m = 30$ g

$T = 0°C = 0°C + 273 = 273$ K

Find: $\Delta S = ?$

Formula:

$$\Delta S = \frac{\Delta Q}{T} \qquad \text{(i)}$$

$$\Delta Q = mH_f = 30 \times 336 \text{ J}$$

Put in equation (i),

$$\Delta S = \frac{-30 \times 336}{273} = \frac{-10080}{273}$$

$$\boxed{\Delta S = -36.92 \text{ JK}^{-1}}$$

SECTION-III

(Practical Part)

A- Attempt any Four (4) questions. (8)

(i) Derive the formula $g = \frac{2S}{t^2}$ to be used in free fall experiment.

Ans Using the relation:

$$S = v_i t + \frac{1}{2} g t^2$$

As, $v_i = 0$

$$\therefore \quad S = \frac{1}{2} g t^2$$

or $$g = \frac{2S}{t^2}$$

(ii) What is meant by pitch of screw gauge? Also give its least count.

Ans When circular scale completes one rotation, the linear distance covered on linear scale is called as pitch.

Least count is the shortest distance which a screw gauge can measure.

Formula:

$$L.C = \frac{\text{Pitch of the screw gauge}}{\text{No. of circular scale division}}$$

(iii) If the bob of the pendulum is replaced by another bob of different material, what will be the effect on time period?

Ans Time period remains the same for bobs of different masses.

(iv) What is end correction?

Ans In resonance tube, the anti-node does not lie at open end of tube but slightly above it. Thus, a correction is to be applied for its anti-node shift which is known as end correction. Its value is 0.3.

(v) Find the critical angle of glass, if its refractive index is 1.52.

Ans We have formula

Refractive index of glass:

$$x = \frac{1}{\sin \theta_c}$$

where θ_c is critical angle and n is refractive index.

Thus, $$\sin \theta_c = \frac{1}{n}$$

$$\sin \theta_c = \frac{1}{1.52}$$

$$\theta_c = \sin^{-1} (0.6579)$$

$$\theta_c = 41.14^o$$

(vi) What are the sources of errors during the experimental determination of focal length of convex lens by displacement method?

Ans (a) Environmental factors
(b) Physical variations
(c) Lag time etc.

(vii) Why does the paper rider fly off a fixed length of wire of sonometer?

Ans When the length of the vibrating wire is adjusted such that its frequency becomes equal to that of tuning fork, resonance occurs and the wire begins to vibrate in a single loop with a large amplitude.

Due to vigorous vibrations, the rider at the center of the wire flies off.

(viii) Design a table of observations to prove law of simple pendulum *i.e.*, time period is independent of the amplitude.

Ans

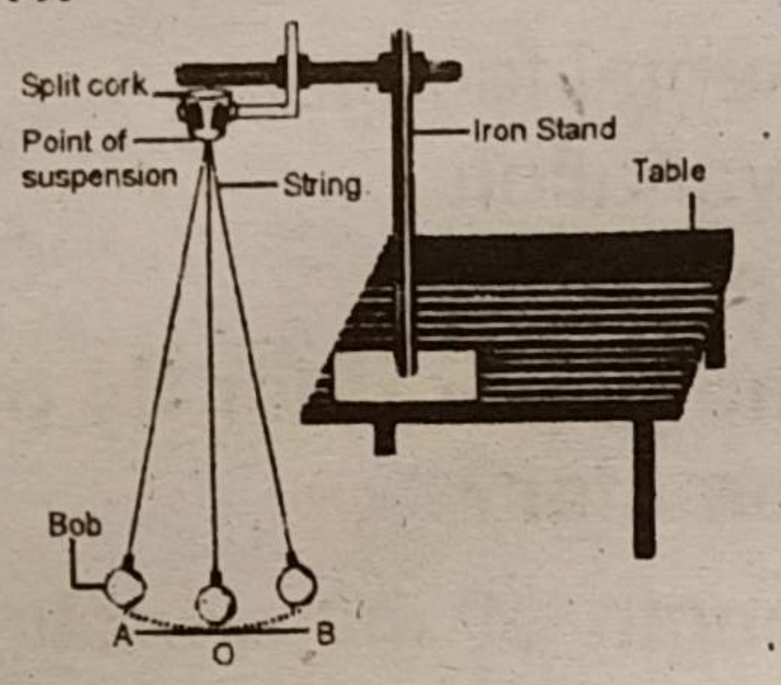
No. of observations	Amplitude	Time for 20 vibrations		Mean for 20 vibrations	Time period $T = \frac{t}{20}$
		t_1	t_2	$t = \frac{t_1 + t_2}{2}$	
	cm	sec	sec	sec	sec
1	5	40	39.5	$\frac{40 + 39.5}{2} =$	$\frac{39.75}{20} =$

				39.75	1.9875
2	10	40	40.1	$\frac{40 + 40.1}{2}$ = 40.05	$\frac{40.05}{20}$ = 2.0025
3	12	40	40	$\frac{40 + 40}{2}$ = 40	$\frac{40}{20}$ = 2

B- Write down the brief procedure to verify that time period is directly proportional to the square root of length of simple pendulum. (3)

Ans Apparatus:

A metallic ball with hook (bob), thread, split cork, iron stand with clamp, metre-rod, vernier callipers, piece of chalk and stop watch.



Procedure:

1. Find the diameter of the bob of the simple pendulum by a vernier callipers and calculate its radius.
2. Take a fine thread about (70 cm – 120 cm) long. Tie one end of the thread to the hook of the bob and place its other end between two halves of a cork, and clamp the cork tightly to an iron stand such that the pendulum should vibrate in a vertical plane perpendicular to the cut of the cork.
3. With a piece of chalk draw a straight line AB on the floor and mark its midpoint O. Adjust the position of the stand and the clamp, so that the bob lies just above the point O (about 2 cm above the floor).

No. of obs.	Length of pendulum	Time for 20 vibrations	Time period (T)	$\sqrt{l}$	$\frac{T}{\sqrt{l}}$

	(*l*)	(t)			
	cm	sec	sec		0.20
1	60.95	31.41	$\frac{31.41}{20}$ = 1.5705	$\sqrt{60.95}$ = 7.807	
2	70.95	33.34	$\frac{33.34}{20}$ = 1.667	$\sqrt{70.95}$ = 8.423	0.20
3	80.95	33.51	$\frac{33.51}{20}$ = 1.6755	$\sqrt{80.95}$ = 8.997	0.20

Result:

It is verified that time period is directly proportional to the square root of length of simple pendulum.

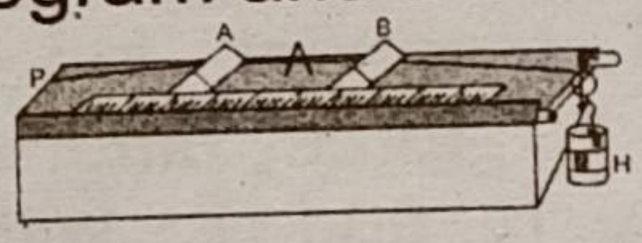
Hence, $T \propto \sqrt{l}$

OR

Write down the brief procedure to verify the law of length of stretched string by using a sonometer.

Ans **Apparatus:**

Sonometer, three tuning forks of different frequencies, rubber pad, two wedges, screw gauge, slotted weights in kilogram and a sensitive balance.



Law of Length:

$\therefore f \propto \frac{1}{l}$, when T and m are constant.

Inference:

The product $f \times l$ is constant within the limit of experimental error, we infer that

$$f \times l = \text{Const.}$$

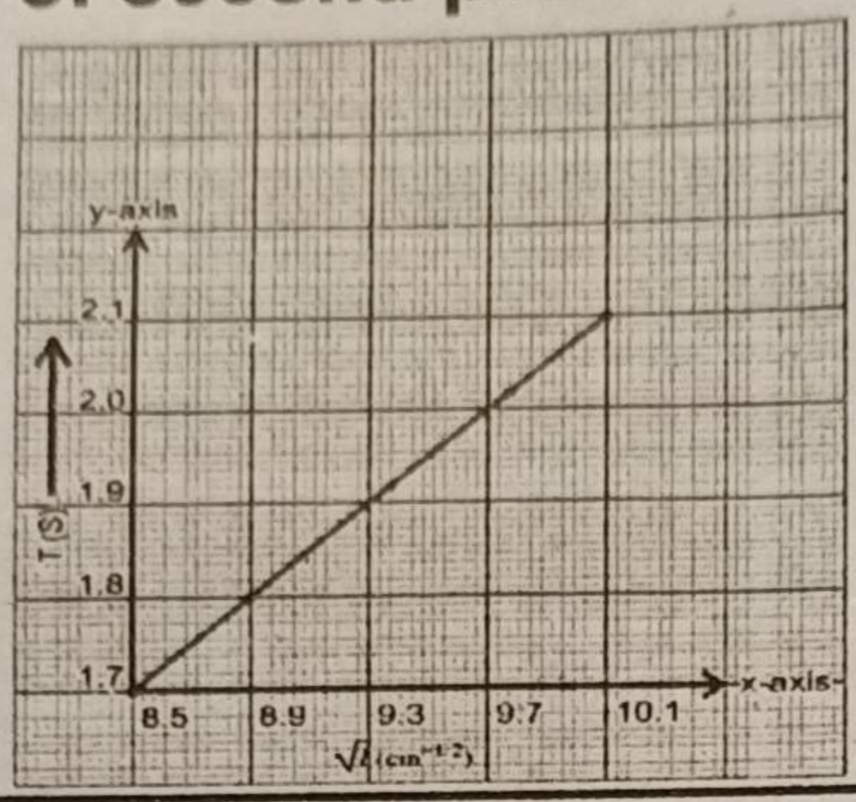
or $$f = (\text{Constant})\frac{1}{l}$$

or $$f \propto \frac{1}{l}$$

C- Answer the following questions on the basis of graph below: (4)

(i) Find slope of graph.

(ii) Find length of second pendulum.



Ans (i) Slope of graph $= \frac{y_2 - y_1}{x_2 - x_1}$

$= \frac{2.0 - 1.9}{9.7 - 9.3} = \frac{0.1}{0.4} = 0.25$

(ii) As the time period of second pendulum:

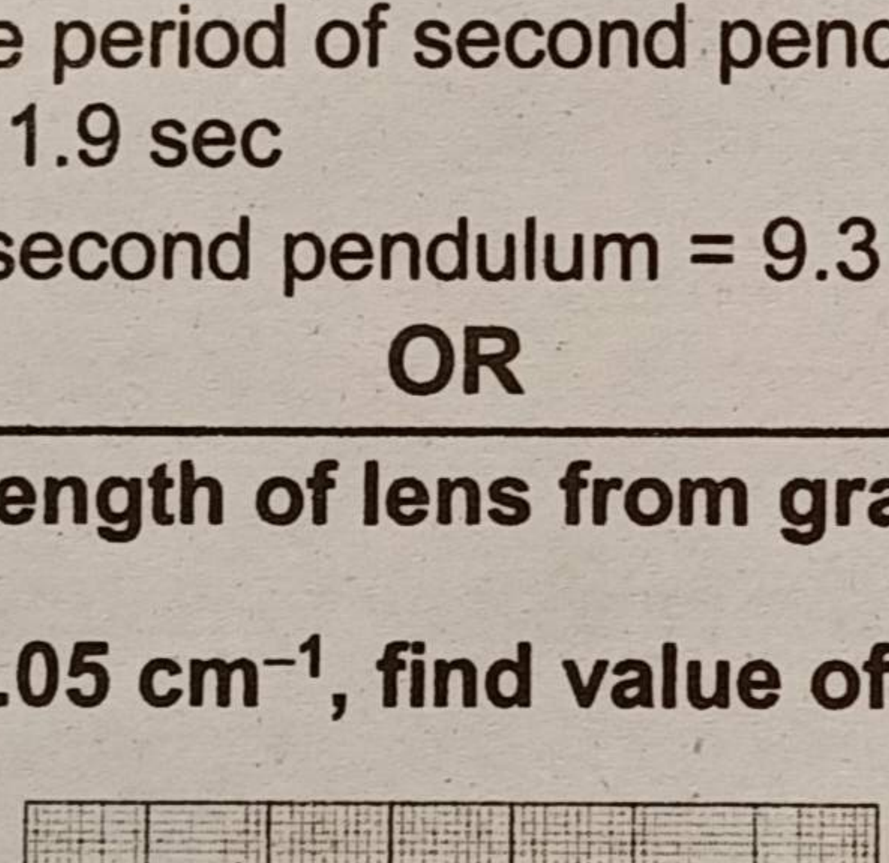
$T = 1.9$ sec

Length of second pendulum $= 9.3\ cm^{-1/2}$.

OR

(i) Find focal length of lens from graph.

(ii) When $\frac{1}{p} = 0.05\ cm^{-1}$, find value of $\frac{1}{q}$.



Ans (i) Take any pair of x-axis and y-axis from graph, *i.e.*,

$\frac{1}{p} = 0.015$, $\frac{1}{q} = 0.045$

Procedure:

1. Take two sharp and equal height wedges A and B and place them under the sonometer wire fairly away from each other. Put the weight of 2 or 3 kg in the hanger. And place a small paper rider (of shape ∧) on the wire at the mid point between the wedges.
2. Strike a tuning fork (of highest frequency) on the rubber pad and place it gently with the stem touching the board in between the wedges A and B. Keep any one wedge fixed and shift the other very slowly towards it. At some particular distance, the paper rider begins to flitter. Re-vibrate the tuning fork and press its stem against the surface of the sonometer board gently again and again, with slightly changing the distance between the wedges till a position is secured when the rider flies off the wire. Now the wire is in resonance with the tuning fork.
3. Note this distance by measuring it with meter rod. This distance gives the resonant length L_1 of the wire between the wedges.
4. Repeat by placing the wedges close to each other, keeping one bridge fixed, move the other away from it very slowly till resonance occurs. Measure again the length L_2 of the vibrating segment. Take the mean l_1 of the two lengths L_1 and L_2.

Obtain mean resonant length l_1, l_2 and l_3 corresponding to three different tuning forks of frequencies f_1, f_2 and f_3 without changing the stretching force of the wire.

Observations and Calculations:

No. of Obs.	Frequency of tuning fork	Resonant length of the wire			
		L_1	L_2	Mean	$f \times l$
	Hz	cm	cm	cm	cms^{-1}
1	$f_1 = 512$	11.5	12.5	$l_1 = 12$	$f_1 \times l_1 = 6144$
2	$f_2 = 480$	12.1	14.1	$l_2 = 13.1$	$f_2 \times l_2 = 6288$

In both cases, $f \times l$ = constant.

Using $\frac{1}{f} = \frac{1}{p} + \frac{1}{q} = \frac{1}{0.015} + \frac{1}{0.045}$

$= 66.67 + 22.22$

$= 88.89$

Focal length = $f = \frac{1}{88.89} = 0.01\ cm^{-1}$

(ii) From above graph, we can obtain:

at $\frac{1}{p} = 0.05\ cm^{-1}$

$\therefore \frac{1}{q} = 0.009$

Inter (Part-I) 2015

Physics	Group-II	PAPER: I
Time: 20 Minutes	(OBJECTIVE TYPE)	Marks: 17

Note: Four possible answers, A, B, C and D to each question are given. The choice which you think is correct, fill that circle in front of that question with Marker or Pen ink in the answer-book. Cutting or filling two or more circles will result in zero mark in that question.

1-1- The centripetal acceleration is also called:

(a) Tangential (b) Radial √

(c) Angular (d) Rotational

2- The No. of spark plugs used in diesel engine is:

(a) 0 √ (b) 1

(c) 2 (d) 3

3- The distance between two consecutive nodes:

(a) $\frac{\lambda}{2}$ √ (b) $\frac{\lambda}{4}$

(c) λ (d) 2λ

4- The direction of vector in space is specified by:

(a) 1-Angle (b) 2-Angles

(c) 3-Angles √ (d) 4-Angles

5- $1\ \frac{\text{rev}}{\text{min}}$ is equal to:

(a) $\frac{\pi}{6}$ rad s^{-1} (b) $\frac{\pi}{15}$ rad s^{-1}

(c) $\frac{\pi}{20}$ rad s^{-1} (d) $\frac{\pi}{30}$ rad s^{-1} √

6- Half wavelength corresponds to:

(a) 0^o (b) 90^o

(c) 180^o √ (d) 360^o