CBSE SAMPLE PAPER-01

Class – XI

PHYSICS (Theory)

Time allowed: 3 hours, Maximum Marks: 70

General Instructions:

1. All the questions are compulsory.
2. There are **26** questions in total.
3. Questions **1** to **5** are very short answer type questions and carry **one** mark each.
4. Questions **6** to **10** carry **two** marks each.
5. Questions **11** to **22** carry **three** marks each.
6. Questions **23** is value based questions carry **four** marks.
7. Questions **24** to **26** carry **five** marks each.
8. There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all three questions in five marks each. You have to attempt only one of the choices in such questions.
9. Use of calculators is **not** permitted. However, you may use log tables if necessary.
10. You may use the following values of physical constants wherever necessary: $c = 3 \times 10^8 m/s, h = 6.63 \times 10^{-34} Js, e = 1.6 \times 10^{-19} C, \mu_o = 4\pi \times 10^{-7} TmA^{-1}$, $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 Nm^2C^{-2}, m_e = 9.1 \times 10^{-31} kg$

1. If one mass of one electron is 9.11 x 10^{-31} kg, then how many electrons would weigh in 1 kg?

Ans. 9.11 x 10^{-31} x n = 1 kg

Therefore, n = 1.1 x 10^{30}

2. What do you understand by the term conservative force?

Ans. Any force is called conservative force if,

a) Work done against is independent of path.

b) Work done in a closed path is zero.

3. Give reason: "Liquid set in rotation comes to rest after some line".

Ans. The liquid comes to rest due to the viscous force, due to internal fluid friction between its different layers.

4. What is the number of degree of freedom of a molecule of a diatomic gas at room temperature?

Ans. A molecule of diatomic gas possesses five degrees of freedom at room temperature which is due to translational motion and rotational motion.

5. What is the slope of stress-strain body within the elastic limit?

Ans. Within elastic limit, the slope of stress-strain curve gives the value of modulus of elasticity of the given material.

6. If the velocity at the maximum height of a projectile is half its initial velocity of projection u, then find its range on the horizontal plane.

Ans. $\mathrm{u}\cos\theta = \frac{\mathrm{u}}{2}$

$\cos\theta = \frac{1}{2} \rightarrow \theta = 60^0$

Horizontal range =R = $\frac{\mathrm{u}^2 \sin 2\theta}{\mathrm{g}}$

$$\mathrm{R} = \frac{\mathrm{u}^2 \sin 2 \text{ x } 60^0}{8} = \frac{\mathrm{u}^2 \sin 120^0}{\mathrm{g}} = \frac{\sqrt{3}\mathrm{u}^2}{2\mathrm{g}}$$

7. What fraction of its mechanical energy is lost in each bounce, if a ball bounces to 80% of its original height?

Ans. Let the ball fall from height h then,

Kinetic energy of ball at the time of just striking the ground = Potential energy of ball at height h,

K = mgh

Similarly, on rebounding the ball moves to a maximum height h', then kinetic energy will be K' = mgh'

Loss of kinetic energy K – K' = mgh – mgh' = mg (h –h')

= mg (h – 80/100h) = mgh x (0.2)

Fractional loss in K.E. of ball in each re-bounce = K –K'/K

= mgh x (0.2)/mgh = 0.2

= 0.2 x 100% = 20%

8. What is the error in the estimation of g if the length and time period of an oscillating pendulum have errors of 1% and 2%?

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

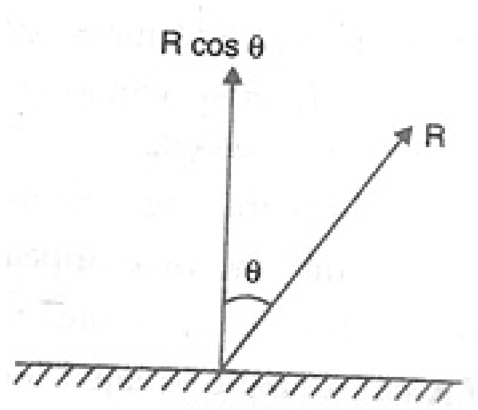
$g=4\pi\frac{l}{T^2}$

$\frac{\Delta g}{g}=\frac{\Delta l}{l}+2\frac{\Delta T}{T}$

% of error in g = 1% + 2 x 2% = 5%

9. Give reason: "One should take short steps rather than long steps when walking on ice".

Ans.



Let R represents the reaction offered by the ground. The vertical component R cosθ will balance the weight of the person and the horizontal component R sin θ will help the person to walk forward.

Normal reaction = R cosθ

Friction force = R sin θ

Coefficient of friction

$\mu = \frac{R\sin\theta}{R\cos\theta} = \tan\theta$

In along step, θ is more and tan θ is more. But μ has a fixed value. So, there is danger of shipping in along step.

10. A solid sphere of radius 10 cm is subjected to a uniform pressure equal to 5 x 10^8Nm$^-$

[2]. **Calculate the change in volume. [Given: Bulk modulus of the material of the sphere is 3.14×10^{11} Nm^{-2}]**

Or

A group of boys went for boating as a picnic. They were dancing and singing. Suddenly, their boat lost its balance and the boys fell into the river. By seeing this, many fishermen rushed for their help and provided them pieces of wood so that they could float and save themselves. The alertness of the fishermen saved the life of all the boys.

a) What would be the density of water if the boys saved themselves with a wood that floats with 1/4th of its volume above the water surface?

b) What is the use of life saving jackets while going on a boat?

Ans. $K = \frac{PV}{\Delta V}$

$\Delta V = \frac{PV}{V}$

$P = 5 \times 10^{8} Nm^{-2}$

$V = \frac{4}{3}\pi r^3 = \frac{4}{3}\pi(0.1)^3 m^3$

$V = 4.19 \times 10^{-3} m^3$

$K = 3.14 \times 10^{11} Nm^{-2}$

$\Delta V = \frac{5 \times 10^8 \times 4.19 \times 10^{-3}}{3.14 \times 10^{11}} = 6.67 \times 10^{-6} m^3$

Or

a) Here,

Volume of wood body outside water = V/4

Volume of wood body inside water = $V - \frac{V}{4}$

Now, weight of water displaced by wood = $\frac{3V}{4} \times 10^3 g$

Therefore, $V\rho g = \frac{3V}{4} \times 10^3 g$

Then, $\rho = 750$ kg/m^3

b) This is because the lives saving jackets have air in them which keeps us afloat if we accidently fall into water.

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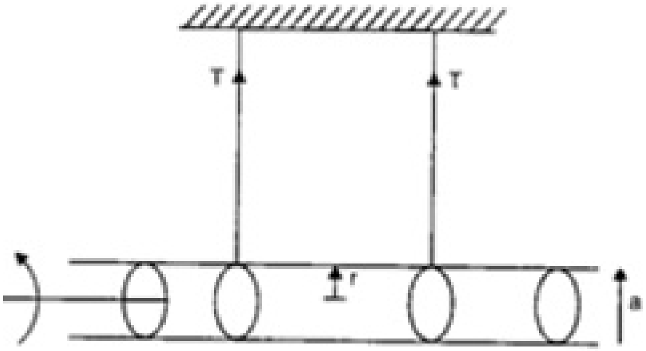
11. A cylinder is suspended by to strings wrapped around the cylinder near each end, the free ends of the String being attached to hooks on the ceiling, such that the length of the cylinder is horizontal. From the position of rest, the cylinder is allowed to roll down as suspension strings unwind. Calculate,

a) The downward linear acceleration of the cylinder.

b) The tension in the 12 kg.

Ans.



Let the downward linear acceleration of the cylinder be a. if M be the mass of the cylinder then

Mg – 2T = Ma

T = ½ m (g – a) ------------------------- (i)

Torque = moment of inertia x angular acceleration

2Tr = Iα

2Tr = ½ mr^2 x (a/r)

T = ma /4 ----------------------------- (ii)

From equation (i) and (ii),

m a/4 = ½ m(g – a) ---------------------- (iii)

Solving equation (i) and (iii)

$$a = \left(\frac{2}{3}\right) g$$

Substituting the value of a in equation (ii) we get,

$$\mathrm{T} = \frac{\mathrm{m}\left(\frac{2}{3}\right)\mathrm{g}}{4} = \frac{\mathrm{m\ x\ 2g}}{12} = \frac{\mathrm{12\ x\ 2g}}{12} = \mathrm{2kgf}$$

12. An object weighing 70 kg is kept in a lift. Find its weight as a recorded by a spring balance when the lift

a) Moves upwards with a uniform velocity of ms^{-1}

b) Moves upwards with a uniform acceleration of 2.2 ms^{-2}

c) Moves downwards with a uniform acceleration of 2.8 ms^{-2}

d) Falls freely under gravity

Or

A body of mass 2 kg is at rest at a height of 10 m above the ground.

a) Calculate its potential energy and kinetic energy after it has fallen through half the height.

b) Find the velocity at this instant.

Ans. a. When the lift is moving upwards with a uniform velocity 5 ms^{-1}, the reaction R or the pressure on the base is

R = mg = 70 x 9.8 N = 686 N

b. When lift is moving upwards with a uniform acceleration of 2.2 ms^{-2}, the reaction R' or the pressure on the bass increase and is given by

R' = m (g + a) = 70(9.8 + 2.2) N = 840 N

c. When the lift descends with a uniform acceleration of 2.8 ms^{-2}, the reaction R'' is given by

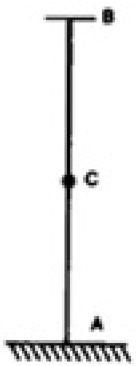
R'' = m (g – a) = 70(9.8 – 2.8) N = 490 N

d.When the lift falls freely under gravity , the reaction R''' is given by

R''' = m (g – g) =0

The object appears to have become weightless.

Or



Total energy at B = kinetic energy + potential energy

= 0 + mgh

= 2 x 9.8 x 10

= 198 J

It descends half the height, it loses potential; energy which is given by

$= \mathrm{mg}\frac{\mathrm{h}}{2}$

= ½ mgh = 98 J

Its potential energy at C = (196 – 98) = 98 J

The loss of potential energy = gain in kinetic energy

= 196 – 98

= 98 J

Kinetic energy = ½ mv^2

½ x 2 x v^2 = 98

v^2 = 98 = 7√2 m/s

13. If the potential energy of a spring when stretched through a distance 'a' is 25 J, then what is the amount of work done on the same spring so as to stretch it by an additional distance '5a'?

Ans. P. E = $\frac{1}{2}ka^2\frac{1}{2}kx^2$= 25

Additional distance of 5a becomes 6a

Substituting 'a' we get = 900 J

Additional work done = 900 – 25 = 875 J

14. If a copper plate has an area of 250 cm^2 at 0^0 C, then calculate the area of this plate at 60^0. Given: The coefficient of linear expansion of copper = 1.7 x $10^{-50}C^{-1}$

Ans. A_0 = 250 cm^2

β = 2 α = 2 x 1.7 x 10^{-5}

= 3.4 x $10^{-50}C^{-1}$

ΔT = (60 – 0) = 60^0

A_θ = A_0 (1 + βΔT)

A_{80^0c} = 250(1 + 3.4 x 10^{-5} x 60)

= 250(1 + 0.00204) = 250.51 cm^2

Area of copper plate at 60^0 = 250.51 cm^2.

15. If a progressive wave and a stationary wave have frequency 300 Hz and the same wave velocity 360 m/s, then calculate,

(i) The phase difference between two points on the progressive wave which are 0.4 m apart.

(ii) The equation of motion of progressive wave if its amplitude is 0.02 m

(iii) The equation of the stationary wave if its amplitude is 0.01 m

(iv) The distance between consecutive nodes in the stationary wave.

Ans. Wave velocity v = 360 m/s

Frequency n = 300 Hz

Wavelength

$\lambda = \frac{V}{f} = \frac{300}{600}$ = 1.2 m

(i) The phase different between two points at a distance one wavelength apart is 2π. Phase difference between points 0.4 m apart is given by

$\frac{2\pi}{\lambda}$x $0.4 = \frac{2\pi}{1.2}$ x $0.4 = \frac{2\pi}{3}$ radian

(ii) The equation of motion of a progressive wave is

$y = A \sin 2\pi \left(\frac{t}{T} - \frac{x}{\lambda}\right)$

In the case given,

$y = 0.02 \sin 2\pi(300t - \frac{x}{1.2})$

(iii) The equation of the stationary wave is

$y = 2A \cos \frac{2\pi x}{\lambda} \sin \frac{2\pi t}{T}$

2A = 2 x 0.01 = 0.02

λ = 1.2m

$\frac{1}{T}$ =300 Hz

$y = 0.02 \cos \frac{2\pi x}{1.2} \sin 600\pi t$

(iv) The distance between the two consecutive nodes in the stationary wave is given by

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

16. Differentiate the different mode of heat transformation.

Ans. There are three mode of heat transformation are conduction, convection and radiation. The main differences between them are:

Conduction	Convection	Radiation
There is no bodily motion of the medium particles. Medium particles vibrate to and fro about their mean	Heat is transferred from one part of the system to another by the actual	Medium has no role as thermal radiation are transmitted without any

positions and pass on thermal energy to the neighboring particles	motion of the particles of the system.	material medium
No convection currents are formed	Convection currents are formed	Question of formation of convection currents does not arise.
Conduction of heat takes place in solids and few liquids like mercury and molten metals.	Convection of heat takes place in fluids	Radian energy directly flows from heat source to the given body at a speed of 3 x 10^8 m/s as electromagnetic waves.

17. A particle is executing SHM according to the equation x = 5 sin πt, where x is in cm. How long will the particle take to move from the position of equilibrium to the position of maximum displacement?

Ans. The displacement of the particle varies with time according to the equations

$x = 5 \sin \pi t$

Maximum displacement = amplitude = 5 cm

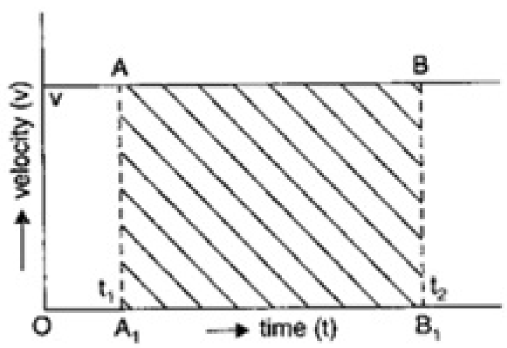
At time t =0, x =0. Hence time t taken by the particle to move from x = 0 to x = 5 cm is given by,

$x = 5 \sin \pi t$

t = 0.5 s

18. How does the velocity- time graph for uniform motion helps to calculate the displacement covered during a given time t?

Ans. Consider the velocity- time graph for uniform motion along a straight path. The graph is a straight line parallel tot eh time axis Ref below figure



Let A and B be two points on velocity – time graph corresponding to the instants t_1 and t_2. As the motion is uniform hence $AA_1 = BB_1 = v$

Area under v-t graph between t_1 and t_2 = area ABB_1A_1

$= AA_1 \times A_1B_1 = v(t_2 - t_1)$

Velocity is defined as $v = \frac{\text{displacement}}{\text{Time}} = \frac{x_2 - x_1}{t_2 - t_1}$

$v(t_2 - t_1) = x_2 - x_1$

Area $ABB_1A_1 = (x_2 - x_1)$

Hence displacement of a particle in time interval $(t_2 - t_1)$ is numerically equal to the area under velocity- time graph between the instant t_1 and t_2.

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19. If two bodies of different masses m_1 and m_2 are dropped from two different heights a and b, give the ratio of time taken by the two bodies to drop through these distance?

Ans. Let t_1 and t_2 are the time taken by two bodies of masses m_1 and m_2 to drop from heights ‘a’ and ‘b’.

Using equation of motion $h = ut + ½ at^2$

$u = 0$ and $a = g$

$$a = \frac{1}{2}gt_1^2 \Rightarrow t_1 = \sqrt{\frac{2a}{g}}$$

$$b = \frac{1}{2}gt_2^2 \Rightarrow t_2 = \sqrt{\frac{2b}{g}}$$

$$\frac{t_1}{t_2} = \sqrt{\frac{2a/g}{2b/g}}$$

$$\frac{t_1}{t_2} = \sqrt{\frac{2a}{2b}} = \frac{\sqrt{a}}{\sqrt{b}}$$

$t_1 : t_2 = \sqrt{a} : \sqrt{b}$

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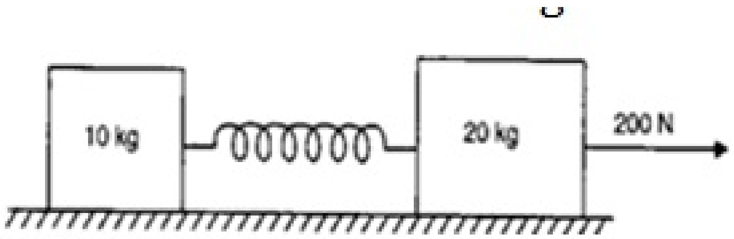
20. What will be the energy shared in the spring at the instant when the 10 kg mass has acceleration 12 m/s^2 if two masses 10 kg and 20 kg are connected by a massless spring. A force of 200 N acts a 20 kg mass?



Ans. Since F = ma

F = 10 x 12 = 120 N

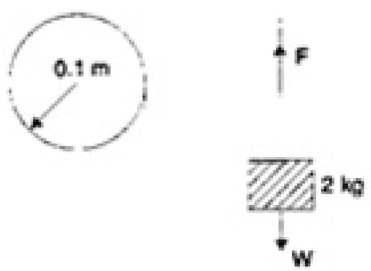
F = kx = 2400x

$x = \frac{1}{20}$

Energy stored in the spring E = ½ kx^2

E$=\frac{1}{2}$ x 2400 x $\left(\frac{1}{20}\right)^2$ = 3J

21. **In the diagram given below, a tangential force of 2 kg wt is applied round the circumference of the flywheel with the help of a string and mass arrangement. Now, if the radius of the wheel is 0.1 m, find the acceleration of the mass. Assume that the moment of inertia of a solid fly wheel about its axis is 0.1 kg m^{-2}.**



Ans. Let 'a' be the linear acceleration of the mass and 'T' the tension in the spring. It is clear that

mg – T = ma ----------------------- (i)

Let the angular acceleration of the flywheel be 'α'. The couple applied to the flywheel is

I α = TR ------------------------- (ii)

The linear acceleration α and angular acceleration are related to each other as

a = Rα ------------------------- (iii)

From equation (i), (ii) and (iii)

Mg – Iα/R = m R α

$\alpha = \frac{mgR}{(I+mR)^2}$

It is given that m = 2kg, R=0.1m and I=0.1kgm^2.

Substituting these values we get,

$\alpha = \frac{2 \text{ x } 9.8 \text{ x } 0.1}{(0.1+2 \text{ x } 0.1)^2}$ rad s^{-2}

= 16.7 rad s^{-2}

22. If an artificial satellite is moving in a circular orbit around the earth with a speed equal to half the magnitude of escape velocity from the earth, then

a. Determine the height of the satellite above the earth's surface.

b. If the satellite is stopped suddenly in its orbit and allowed to fall freely onto the earth, find the speed with which it hits the surface of the earth

Ans. a.

$\mathrm{v_u} = \sqrt{\frac{\mathrm{GM}}{\mathrm{r}}} = \mathrm{R}\sqrt{\frac{\mathrm{g}}{(\mathrm{R+h})}}$

$[\text{as } \mathrm{g} = \frac{\mathrm{GM}}{\mathrm{R}^2} \text{ and } \mathrm{r} = \mathrm{R+h}]$

In this problem

$\mathrm{v_u}$ =1/2 $\mathrm{v_u}$ = $\frac{1}{2}\sqrt{2\mathrm{gR}}$

$\frac{\mathrm{R^2 g}}{\mathrm{R+h}} = \frac{1}{2}\mathrm{gR}$

h = R = 6400 km

b. By conservation of ME.

$0 + \left(-\frac{\mathrm{GMm}}{\mathrm{r}}\right) = \frac{1}{2}\mathrm{mv^2} + \left(-\frac{\mathrm{GMm}}{\mathrm{R}}\right)$

$\mathrm{v^2} = 2\mathrm{GM}\left[\frac{1}{\mathrm{R}} - \frac{1}{2\mathrm{R}}\right]$

$\mathrm{v} = \sqrt{\frac{\mathrm{GM}}{\mathrm{R}}} - \sqrt{\mathrm{gR}}$

= 8 km/s

23. Pranav was climbing the stairs to meet his friend. On his way he saw a person was hypnotizing a lady with a pendulum moving to and fro. The lady was giving all her gold

jewels to him. Pranav immediately called the police and then went towards them and threw his pendulum. The police caught the person and the lady came out of the hypnotizing and thanked Pranav.

a) Give the values of Pranav.

b) What is the moral of the incident?

c) What is the length of the simple pendulum which ticks seconds?

d) What type of motion does the pendulum show?

Ans. a) Pranav is very shrewd and has good presence of mind.

b) We should not allow strangers inside our house.

c) The pendulum which ticks seconds is a second pendulum and its time period is T = 2s

If l is the length of the pendulum, then $T = 2\pi\sqrt{\frac{l}{g}}$

Substituting the values, we get l = 0.99m.

d) Oscillatory motion.

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24. Tunnel is dug through the earth from one side to the other side along with a diameter. The motion of a particle into the tunnel is simple harmonic motion. Find the time period, neglect all the frictional forces and assume that the earth has a uniform density. Assume that G = 6.67 x 10^{-11} Nm^2 kg^{-2} ; density of the earth = 5.51 x 10^3 kg m^{-3}.

Or

Explain the following:

(a) In a sound wave, the displacement node is a pressure antinode and vice versa

(b) Bats can ascertain distance, direction, nature and sizes of the obstacles without any eyes.

(c) Solids can support both longitudinal and transverse waves, but only longitudinal waves can properties in gases

(d) The shape of a pulse gets distorted during propagation in a dispersive medium.

Ans. The tunnel is dug along the diameter of the earth. Consider the case of a particle of mass m at a distance y from the Centre of the earth. There will be a gravitational attraction of the earth on this particle due to the portion of matter contained in a sphere of radius y. the mass of the sphere of radius y is given by

M = volume x density

$M = \frac{4}{3}\pi y^3 \text{x } d$

This mass can be regarded as concentrated at the centre of the earth. The force F between this mass and the particle of mass m is given by

$$F = -\frac{GMm}{y^2}$$

Negative sign shows that the force is of attraction

$$F = -G\left(\frac{4}{3}\pi y^3 d\right)\frac{m}{y^2} = -G\text{x}\left(\frac{4}{3}\pi yd\right)y$$

$$F \infty y$$

The force is directly proportional to the displacement hence the motion is simple harmonic motion.

The constant k = $\frac{4}{3}\pi mdG$

The time period

$$T = 2\pi\sqrt{(m/k)}$$

$$T = 2\pi\sqrt{\left(\frac{3m}{4\pi mdG}\right)} = 2\pi\sqrt{\left(\frac{3}{4\pi dG}\right)}$$

$$T = \sqrt{\left(\frac{3\pi}{dG}\right)} = \sqrt{\left(\frac{3 \text{ x } 3.14}{5.51 \text{ x } 10^5 \text{ x } 6.67 \text{ x } 10^{-11}}\right)}$$

T = 42.2 minutes

Or

(a) A sound wave decrease in displacement node cause an increase in the pressure there. Also an increase in displacement is due to the increase in pressure.

(b) Bats emit ultrasonic waves of high frequency from their mouths. These waves after being reflected back from the obstacles on their path are observed by the bats. Using these waves' bats can find the direction, distance, nature and size of the object.

(c) This is due to the fact that gases have only the bulk modulus of elasticity whereas solids have both the shear modulus as well as the bulk modulus of elastically.

(d) A pulse of sound consists of a combination of waves of different wavelength. In a dispersive medium these waves travel with different velocities giving rise to the distortion in the wave.

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25. An artificial diamond crystal has been manufactured by subjecting carbon in the form of graphite to a pressure of 1.55 x 10^{10} Nm^{-2} at a high temperature. What must have been the original volume of the diamond, whose mass before cutting was about 175g? Assuming that natural diamonds were formed at similar high pressure within the earth, the density of the diamond = 3.5g cm^{-3} and its bulk modulus = 62 x 10^{10} Nm^{-2}.

Or

Derive the expression for excess pressure inside:

a) A liquid drop .

b) A liquid bubble.

c) An air bubble.

Ans. Mass of the diamond = 175 g

Density = 3.5 gcm^{-3}

Volume = $\frac{175}{3.5}$ = $50cm^3$

If the original volume of the diamond were V, then

V = 50 + ΔV

Where ΔV is the increase in volume under the pressure during its formation,

Bulk modulus = B = $\frac{PV}{\Delta V}$

Substituting (V – 50) for ΔV and the values of P and B, we have

$\frac{B}{P} = \frac{62 \text{ x } 10^{10}}{1.55 \text{ x } 10^{10}} = \frac{40V}{V - 50}$

V = 40V – 2000

39V = 2000

V = 51.28 cm^3

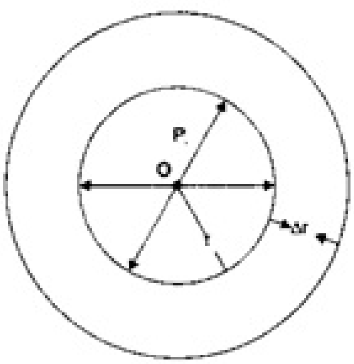
- ΔV can be calculated as,

$$(\text{-}\Delta V) = \frac{PV}{B} = \frac{1.55 \text{ x } 10^{10} \text{ x } 50}{62 \text{ x } 10^{10}} = 1.25cm^3$$

Now adding this value to the present value giving V = 51.25 cm^3. The difference is only in the second decimal place, less than 0.06%. Hence the original volume of the diamond must have been equal to $51.3cm^3$.

Or

(a)



Let r =radius of a spherical liquid drop of Centre O, T = surface tension of the liquid.

Let Pi and Po be the value of pressure inside and outside the drop.

Excess pressure inside the liquid drop = Pi -Po

Let Δr be the increase in its radius due to excess pressure. It has one free surface outside.

Increase in surface area of the liquid drop = $4\pi(r + \Delta r)^2 - 4\pi r^2$

$= 4\pi [r^2 + (\Delta r)^2 + 2r\Delta r - r^2]$

$= 8\pi r \Delta r$

Increase in surface energy of the drop is W = surface tension x increase in area = T x $8\pi r \Delta r$

W = force due to excess of pressure x displacement ---------- (i)

= Excess pressure x area of drop x increase in radius

= (Pi – Po) $4\pi r^2 \Delta r$ ------------ (ii)

From equation (i) and (ii) we get,

(Pi –Po) x $4\pi r^2 \Delta r$ = T x $8\pi r \Delta r$

Pi – Po = $\frac{2T}{r}$

(b) Inside the liquid Bubble: A liquid bubble has air both inside and outside it therefore it has two free surfaces.

Increase in surface area = $2[4\pi (r+\Delta r)^2 - 4\pi r^2]$

= 2 x $8\pi r \Delta r$

= $16\pi r \Delta r$

W = T x $16\pi r \Delta r$ ----------------------- (1)

W = (Pi – Po) $4\pi r^2$ x Δr ---------------- (2)

From equation (1) and (2)

(Pi-Po) x $4\pi r^2$ x Δr = T x $16\pi r \Delta r$

Pi-Po = $\frac{4T}{r}$

(c) Inside an air bubble: Air bubble is formed inside the liquid, thus air bubble has one free surface inside it and liquid is outside.

r = radius of the air bubble, Δr = increase in its radius due to excess of pressure (Pi-Po) inside it, T = surface tension of the liquid in which bubble is formed

Increase in surface area = $8\pi r \Delta r$

W = T x $8\pi r \Delta r$

W = (Pi-Po) x $4\pi r^2 \Delta r$

(Pi-Po) x $4\pi r^2 \Delta r$ =T x $8\pi r \Delta r$

Pi-Po = $\frac{2T}{r}$.

26. A SHM is expressed by the equation x = A cos (ωt + ϕ) and the phase angle ϕ =0. Draw graphs to show variation of displacement, velocity and acceleration for one complete cycle in SHM.

Or

If two tuning forks A and B give 9 beats in 3 seconds and a sound with a closed column of air 15 cm long and B with an open column 30.5 cm long, then calculate their frequencies

Ans. Let x = A cos (ωt + ϕ) and if phase angle ϕ is zero

x = A cosωt,

$v = \frac{dx}{dt}$

= -Aω sin ωt

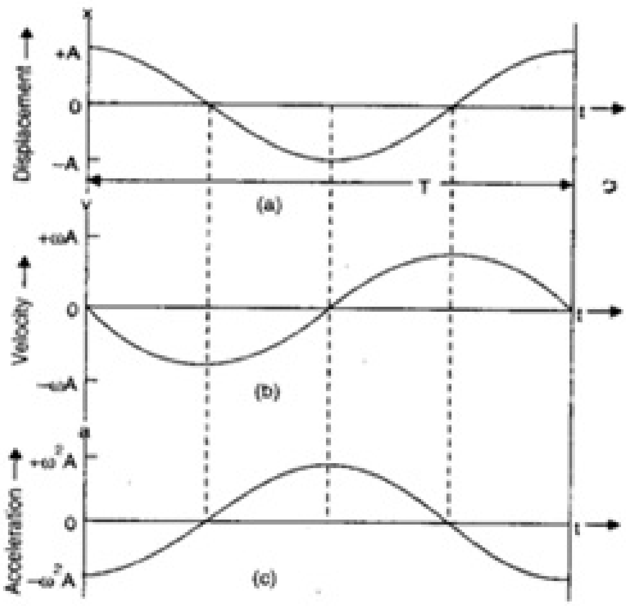
$a = v = \frac{dv}{dt}$

= $-A\omega^2$ cosωt = - $\omega^2 x$

The values of 'x', 'v' and 'a' at different times over one complete cycle as follow:

Time t	0	T/4	T/2	3T/4	T
ωt	0	$\pi/2$	π	$3\pi/2$	2π
x	A	0	-A	0	A
v	0	-Aω	0	+Aω	0
a	$-A\omega^2$	0	$A\omega^2$	0	$-A\omega^{2s}$

Using the given data, x – t, v– t and a – t graphs are plotted as shown below:



Or

For closed column l = 15 cm or 0.15 m

For open column l = 30.5 cm or 0.305m

Let v_1 and v_2 be the frequencies of the tuning fork A and B.

As tuning fork A resounds with a closed column

$v_1 = \frac{v}{4l} = \frac{v}{4\text{x } 0.15} = \frac{v}{0.60}$ ------------------------------ (i)

The fork B resounds with an open air column

$v_2 = \frac{v}{2l} = \frac{v}{2\text{x } 0.305} = \frac{v}{0.61}$ ------------------------------ (ii)

Fork A and B produces 9/3 = 3 beats per second.

$v_1 - v_2 = 3$

$\frac{v}{0.60} - \frac{v}{0.61} = 3$

$v(0.61 - 0.60) = 3 \text{ x } 0.60 \text{ x } 0.61$

$v = \frac{3 \text{ x } 0.60 \text{ x } 0.61}{0.01} = 109.8\text{ms}^{-1}$