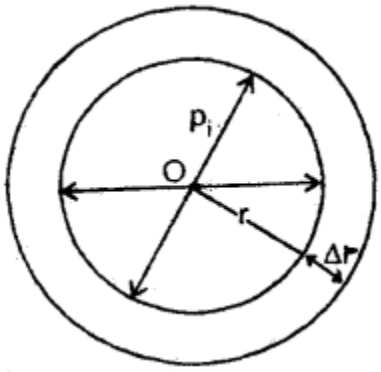
KENDRIYA VIDYALAYA SANGATHAN
KOLKATA REGION
SESSION ENDING EXAM 2022 (TERM-2)
CLASS- XI, MARKING SCHEME
SUB- PHYSICS

1. Let r = radius of a spherical liquid drop of center O.

   T – surface tension of the liquid. Let p_i and p_0 be the values of pressure inside and outside the drop.



   ∴ Excess of pressure inside the liquid drop = $p_i - p_0$

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

   ∴ increase in surface area of the liquid drop.

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

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

   $= 8\pi r\,\Delta r$ ....(i) (1 mark)

(∵ Δr is small Δr^2 is neglected.)

∴ increase in surface energy of the drop is

W = surface tension × increase in area

= T × 8πr Δr ….(ii)

Also W = Force due to excess of pressure × displacement

= Excess of pressure × area of drop × increase in radius

$$= (p_i - p_0)\, 4\pi r^2\, \Delta r \qquad .. (iii)$$

∴ From (*ii*) and (*iii*), we get

$$(p_i - p_0) \times 4\pi r^2\, \Delta r = T \times 8\pi r\, \Delta r$$

or $$p_i - p_0 = \frac{2T}{r}$$

- (1 mark)

1. L = latent heat of ice= 80 cal g^{-1}

   A = 4 cm^2 .

   K = 0.2 cal cm^{-1} s^{-1} $°C^{-1}$

   $\Delta\theta = \theta_2 - \theta_1 = 100 - 0 = 100°C$

   t = time = 10 minutes = 10 × 60 = 600s

   Let m = amount of ice melted = ?

   Using the formula for heat

   we get Q = 0.2×4×100×600

   Q = 24000 cal …(i) (1 mark)

   Also, Q = mL = m. 80 …(ii)

∴ From (i) and (ii), we get

m × 80 = 24000 ∴ m = 24000

80 = 300 g. (1 mark)

OR

Here, $\alpha = 18 \times 10^{-6}\ K^{-1}$

$\Delta T = 393 - 293\ K = 100\ K$

r = radius = 1 cm

∴ D = 2r = diameter = 2 cm

and it acts as the original length l (say).

∴ Let D' be the new diameter = ?

I f Δl be the increase in length, then using the relation,

$\Delta l = \alpha l \Delta t$, we get

$\Delta l = 18 \times 10^{-6} \times 2 \times 100 = 36 \times 10^{-4}$ cm

∴ increase in diameter, $\Delta D = \Delta l = 36 \times 10^{-4}$ cm

∴ D' = D + ΔD = 2 + 0.0036 = 2.0036cm.

2. Total K.E., average K.E. and pressure become 9 times, but the RMS velocity is tripled. (½ mark each)
3. Let Δl_s and Δl_c be the elongation produced in steel and copper wires respectively.

L_s, L_c be their respective lengths,

$L_s = L_c$ (∵ wires are similar)

$Y_s = 20 \times 10^{11}$ dyne cm^{-2}

$Y_c = 12 \times 10^{11}$ dyne cm^{-2}

$\Delta l_s + \Delta l_c = 1$ cm

A = area of cross-section of each wire.

F = equal force applied.

∴ Using the relation,

$$Y = \frac{F}{A} \times \frac{L}{\Delta l}, \text{ we get}$$

$$\Delta l_c = \frac{F}{A}\frac{L_c}{Y_c} \quad \text{.... (i)}$$

and

$$\Delta l_s = \frac{F}{A}\frac{L_s}{Y_s} = \frac{F}{A}\frac{L_c}{Y_s} \quad \text{.... (ii)}$$

Dividing (ii) by (i), we get

$$\therefore \quad \frac{\Delta l_s}{\Delta l_c} = \frac{Y_c}{Y_s} = \frac{12 \times 10^{11}}{20 \times 10^{11}}$$

$$= \frac{3}{5} = 0.6 \qquad \text{.... } (iii)$$

Also $\quad \Delta l_s + \Delta l_c = 1 \text{ cm}$

or $\quad 0.6\,\Delta l_c + \Delta l_c = 1 \text{ cm}$

or $\quad 1.6\,\Delta l_c = 1 \text{ cm}$

$$\therefore \quad \Delta l_c = \frac{1}{1.6} = 0.625 \text{ cm}$$

From (*iii*)

$$\therefore \quad \Delta l_s = 0.6 \times 0.625 = 0.375 \text{ cm.}$$

OR

Let M = mass of metal

V = mass of volume

∴ ρ = M/V ....(i)

Let ΔV = Decrease in its volume when a pressure P is applied.

If ρ' be its new density, then

(by using binomial expansion theorem)

or $$\frac{\rho'}{\rho} - 1 = \frac{\Delta V}{V}$$

or $$\frac{\rho' - \rho}{\rho} = \frac{\Delta V}{V}$$

or $$\frac{\Delta \rho}{\rho} = \frac{\Delta V}{V} \qquad \text{.... } (iii)$$

Also by definition, $$K = \frac{P}{\frac{\Delta V}{V}}$$

(by using binomial expansion theorem)

or $$\frac{\rho'}{\rho} - 1 = \frac{\Delta V}{V}$$

or $$\frac{\rho' - \rho}{\rho} = \frac{\Delta V}{V}$$

or $$\frac{\Delta \rho}{\rho} = \frac{\Delta V}{V} \qquad \text{.... } (iii)$$

Also by definition, $$K = \frac{P}{\frac{\Delta V}{V}}$$

or $$\frac{\Delta V}{V} = \frac{P}{K} \quad \text{.... } (iv)$$

∴ From (*iii*) and (*iv*), we get

$$\frac{\Delta\rho}{\rho} = \frac{P}{K}.$$

$$\rho' = \frac{M}{V'} = \frac{M}{V - \Delta V} \quad \text{.... } (ii)$$

$$\therefore \quad \frac{\Delta\rho}{\rho} = \frac{\rho' - \rho}{\rho}$$

= fractional increase in density.

Dividing (*ii*) by (*i*), we get

$$\frac{\rho'}{\rho} = \frac{V}{V - \Delta V} = \frac{1}{1 - \frac{\Delta V}{V}}$$

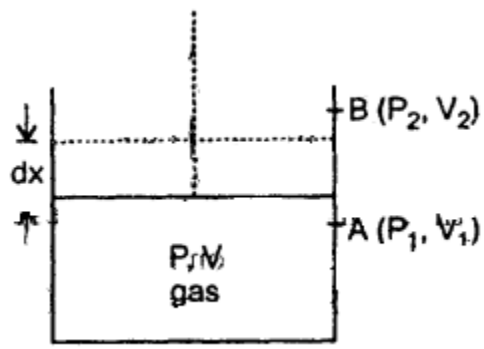
$$= \left(1 - \frac{\Delta V}{V}\right)^{-1} = 1 + \frac{\Delta V}{V}$$

4. (a) Triple point of water has a unique value i.e., 273.16 K. The melting point and boiling points of ice and water respectively do not have unique values and change with the change in pressure.

   (b) On Kelvin's absolute scale, there is only one fixed point, namely, the triple-point of water and there is no other fixed point.

   (c) On Celsius scale 0 °C corresponds to the melting point of ice at normal pressure and the value of absolute temperature is 273.15 K. The temperature 273.16 K corresponds to the triple point of water.

5. Consider one mole of a perfect gas contained in a cylinder having conducting walls and fitted with a movable piston.



Let P, V be the pressure and volume of the gas corresponding to this state.

Let dx = distance by which piston moves outward at constant pressure P so that its volume increases by dV.

Let a = area of cross-section of the piston.

(a) If dW = work done in moving the piston by dx, then .

dW = force on piston × dx = P a dx

= PdV …(i)

Where dV = a dx = volume

Let the system goes from initial state A(P_1, V_1) to final state B(P_2, V_2)

If W = total work done from A to B, then

$$W = \int_A^B dW = \int_{V_1}^{V_2} PdV \qquad .... (ii)$$

Also we know that $PV = RT$ (n = 1 here)

$$P = \frac{RT}{V} \qquad .... (iii)$$

∴ From (*ii*) and (*iii*), we get

$$W = RT \int_{V_1}^{V_2} \frac{1}{V} dV = RT\left[\log_e V\right]_{V_1}^{V_2}$$

$= RT (\log_e V_2 - \log_e V_1) = RT \log V_2/V_1 = 2.303\ RT \log_{10} V_2/V_1$

(b) From equation (ii) of case (a), we get

$$W = \int_{V_1}^{V_2} PdV \qquad .... (ii)$$

We know that an adiabatic process is represented mathematically by the equation:

PV^{γ} = constant = K

or

P =

K

V

γ

...(iii)

∴ from (ii) and (iii), we get

$$W = \int_{V_1}^{V_2} KV^{-\gamma} dV = K\left[\frac{V^{1-\gamma}}{1-\gamma}\right]_{V_1}^{V_2}$$

$$= \frac{K}{1-\gamma}\left[V_2^{1-\gamma} - V_1^{1-\gamma}\right]$$

$$= \frac{1}{1-\gamma}\left[KV_1^{1-\gamma} - KV_2^{1-\gamma}\right]$$

$$= \frac{1}{1-\gamma}\left[P_1V_1^{\gamma}V_1^{1-\gamma} - P_2V_2^{\gamma}V_2^{1-\gamma}\right]$$

$$= \frac{1}{1-\gamma}\left[P_1V_1 - P_2V_2\right]$$

$$= \frac{1}{1-\gamma}\left[RT_1 - RT_2\right] \quad (\because PV = RT)$$

$$W = \frac{R}{\gamma-1}\left[T_1 - T_2\right].$$

6. When bullet falls to the same level its velocity is same i.e. 840 ms^{-1}.

   K.E. of bullet on returning to the same level

   $mv^2 = 12\times$

   $500.1000\times (840)^2$

   or

   W = 17640 J

   This K.E. will be converted into heat energy on striking the cake of ice.∴ Heat produced Q is given by

   Q = WJ=17640 4.2 = 4200 cal

Heat given up by the bullet ih cooling to 0°C from 30°C is given by

$Q_2 = mc\Delta\theta = 50 \times 0.02 \times 30 = 30$ cal

∴ Total heat given to the ice = 4200 + 30 = 4230 cal

Let m = mass ice melted

∴ 4230 = mL

or

m = 4230cal L=4230 80cal g_1

7. Let the particle executing SHM starts oscillating from its mean position. Then displacement equation is

$$x = A \sin \omega t$$

∴ Particle velocity, $v = A\omega \cos \omega t$

∴ Instantaneous K.E., $K = \frac{1}{2}mv^2 = \frac{1}{2}mA^2\omega^2 \cos^2 \omega t$

∴ Average value of K.E. over one complete cycle

$$K_{av} = \frac{1}{T}\int_0^T \frac{1}{2}mA^2\omega^2 \cos^2 \omega t \, dt = \frac{mA^2\omega^2}{2T}\int_0^T \cos^2 \omega t \, dt$$

$$= \frac{mA^2\omega^2}{2T}\int_0^T \frac{(1+\cos 2\omega t)}{2}\,dt$$

$$= \frac{mA^2\omega^2}{4T}\left[t+\frac{\sin 2\omega t}{2\omega}\right]_0^T$$

$$= \frac{mA^2\omega^2}{4T}\left[(T-0)+\left(\frac{\sin 2\omega t-\sin 0}{2\omega}\right)\right]$$

$$= \frac{1}{4}mA^2w^2 \qquad ...(i)$$

Again instantaneous P.E., $U = \frac{1}{2}kx^2 = \frac{1}{2}m\omega^2x^2 = \frac{1}{2}m\omega^2A^2\sin^2\omega t$

$\therefore$ Average value of P.E. over one complete cycle

$$U_{av} = \frac{1}{T}\int_0^T \frac{1}{2}m\omega^2A^2\sin^2\omega t = \frac{m\omega^2A^2}{2T}\int_0^T \sin^2\omega t\,dt$$

$$= \frac{m\omega^2A^2}{2T}\int_0^T \frac{(1-\cos 2\omega t)}{2}\,dt$$

$$= \frac{m\omega^2A^2}{4T}\left[t-\frac{\sin 2\omega t}{2\omega}\right]_0^T$$

$$= \frac{m\omega^2A^2}{4T}\left[(T-0)-\frac{(\sin 2\omega t-\sin 0)}{2\omega}\right]$$

$$= \frac{1}{4}m\omega^2A^2 \qquad ...(ii)$$

Simple comparison of (*i*) and (*ii*), shows that

$$K_{av} = U_{av} = \frac{1}{4}m\omega^2A^2$$

8. The given equation is y 0.34 cos (3000 t + 0.74) .... (1)

   Comparing eqn. (i) with the standard equation of displacement of harmonic oscillation,

   y = r cos (ωt + Φ_o), we get

   r = amplitude = 0.34 cm (1 mark each)

9. 3 expressions (1 mark each)

10. (a) In a sound wave, a decrease in displacement i.e., displacement node causes an increase in the pressure there i.e., a pressure antinode is formed. Also, an increase in displacement is due to the decrease in pressure. (1 mark)

    (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. These waves give them an idea of distance, direction, nature and size of the obstacles.
    (1 mark)

    (c) The quality of a violin note is different from the quality of sitar. Therefore, they emit different harmonics which can be observed by human ear and used to differentiate between the two notes. (1 mark)

11. Wave motion is a form of disturbance that travels in a medium due to repeated periodic motion of the particles of the medium.

    The wave velocity is different from the particle velocity.

    The vibrating particles of the medium possess both K.E. and P.E.

    The particle velocity is different at different positions of its vibrations whereas wave velocity is constant throughout a given medium.

    Waves can undergo reflection, refraction, diffraction, dispersion, and interference.

    Progressive waves:

    The disturbance travels onward. It is1 handed over from one particle to the next.

    Energy is transported in the medium along with the propagation of waves.

    Each particle of the medium executes S.H.M. with the same amplitude.

No particle of the medium is permanently at rest.

Changes in pressure and density are the same at all points of the medium.

Stationary waves:

The disturbance is confined to a particular region and there is no onward motion.

No energy is transported in the medium.

All the particles of the medium except at nodes execute S.H.M. with different amplitude.

The particles of the medium at nodes are at rest.

The changes of pressure and density are maximum at nodes and minimum at antinodes.

12. (i) D

(ii) B

(iii)D

(iv)B

(v) C