FIRST YEAR HSE MODEL EXAM - FEB 2024

HSE - I

PHYSICS

I Any 5 (1-7) $5 \times 1 = 5$

① (c) work

② (b) Instantaneous speed

③ poles

④ ⓐ Youngs modulus

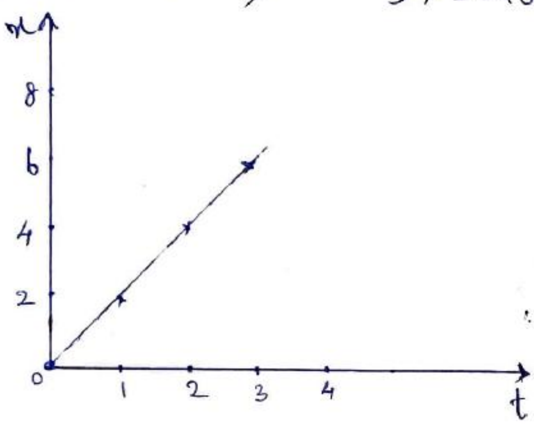
⑤ ⓐ Surface energy

⑥ sublimation

⑦ Absolute temperature

II Any 5 (8-14) $5 \times 2 = 10$

⑧



Velocity = slope

$= \frac{6-0}{3-0} = 2\,m/s$

⑨ $F_1 = 10N$; $F_2 = 8N$ $\theta = 60$

$F = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta}$

$= \sqrt{10^2 + 8^2 + 2 \times 10 \times 8 \times \frac{1}{2}}$

$= \sqrt{100 + 64 + 80}$

$= 15.62\ N$

(10) ⓐ Conservative – Electrostatic force

– magnetic force

Non-conservative – frictional force

– viscous force.

(b) velocity

(11) ⓐ $I = \text{mass} \times (\text{distance})^2$

(or) definition.

(b) Angular momentum, $(L = I\omega)$

(12) ⓐ same.

V_e is independent of mass of projecting body

(b) orbit of a planet is an ellipse with sun at one of the focii.

(13) (a) No change

(b) decreases.

(14) $V_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3 \times 8.3 \times 300}{0.032}}$

$= 483.15\ m/s$

III Any 6 (15-21) $6 \times 3 = 18$

(15) ⓐ Average velocity, $\bar{v} = \frac{s}{t} = \frac{x}{t}$

$x = \bar{v}t$

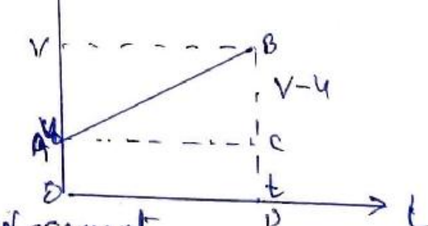
$= \left(\frac{v + v_0}{2}\right)t$

$= \left(\frac{v_0 + at + v_0}{2}\right)t$

$= \frac{2v_0t + at^2}{2}$

$x = v_0t + \frac{1}{2}at^2$

(OR)



Displacement

x = Area OABD

$= (v_0 \times t) + \frac{1}{2} \times t \times (v - v_0)$

$= v_0t + \frac{1}{2}t \times at$

$x = v_0t + \frac{1}{2}at^2$

15 (b) We have, $x = \left(\frac{v+v_0}{2}\right)t$

$$v + v_0 = \frac{2x}{t} \quad \text{--- (1)}$$

Also, $v - v_0 = at$ --- (2)

$$(v+v_0)(v-v_0) = 2ax$$

$$v^2 - v_0^2 = 2ax$$

$$\boxed{v^2 = v_0^2 + 2ax}$$

16 (a) When $F_{ext} = 0$, P = constant

(b) $\underset{m_A}{(A)} \xrightarrow{P_A}$ $\underset{m_B}{(B)} \xrightarrow{P_B}$ $(A)(B) \rightarrow$ $\underset{m_A}{(A)} \xrightarrow{P_A'}$ $(B) \xrightarrow{P_B'}$

$$\vec{F}_{AB} = \frac{\Delta P_A}{\Delta t} = \frac{P_A' - P_A}{\Delta t} \quad \text{--- (1)}$$

$$\vec{F}_{BA} = \frac{\Delta P_B}{\Delta t} = \frac{P_B' - P_B}{\Delta t} \quad \text{--- (2)}$$

III law, $\vec{F}_{AB} = -\vec{F}_{BA}$

$$P_A' - P_A = -(P_B' - P_B)$$

$$P_A + P_B = P_A' + P_B'$$

momentum before collision = momentum after collision

17 (a) moment of inertia

(b) $\vec{L} = \vec{r} \times \vec{p}$

$$\frac{d\vec{L}}{dt} = \vec{r} \times \frac{d\vec{p}}{dt} + \frac{d\vec{r}}{dt} \times \vec{p}$$

$$= \vec{r} \times \vec{F} = \vec{v} \times m\vec{v}$$

$$= \vec{\tau} + 0$$

18 (a) Young's modulus (Y)

(b) P

(c) P, $Y_P > Y_Q$

19 (a) Terminal velocity

(b) Forces acting on rain drop are

weight, $F_1 = mg$

$$= \frac{4}{3}\pi r^3 dg \quad \text{--- (1) downward} \downarrow$$

Upthrust, F_2 = weight of displaced liquid

$$= \frac{4}{3}\pi r^3 \rho g \quad \text{--- (2) up} \uparrow$$

Viscous drag, $F_3 = 6\pi r \eta v$ --- (3) up

At equilibrium,

$$F_{up} = F_{down}$$

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

$$6\pi r \eta v_T = \frac{4}{3}\pi r^3 (d-\rho) g$$

$$v_T = \frac{2r^2(d-\rho)g}{9\eta}$$

20 (a) Average distance travelled by gas molecules between two successive collisions.

(b) Any 2 postulates.

21 a) Statement

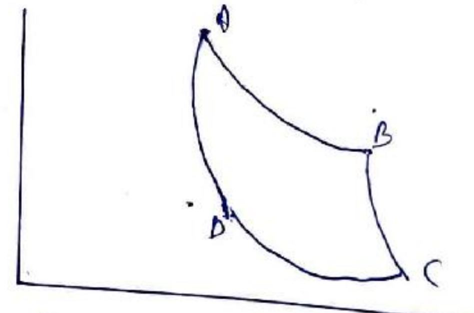
(OR)

$$\Delta Q = \Delta U + \Delta W$$

(OR)

$$\Delta Q = \Delta U + P\Delta V$$

(b)



AB → Isothermal expansion

BC → Adiabatic expansion

CD → Isothermal compression

DA → Adiabatic compression

IV Answer Any 3 (22-25) $3 \times 4 = 12$

(22) a) (i) 2

(ii) 2

(b) $[V] = [LT^{-1}]$

$[g] = [LT^{-2}]$

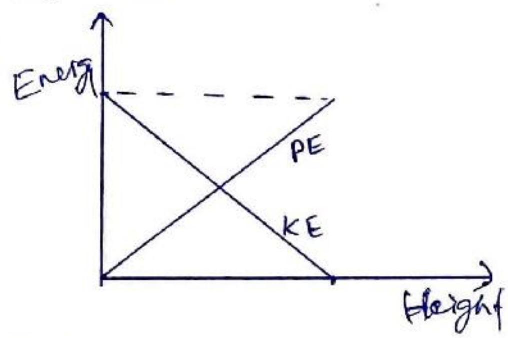
$[\frac{1}{2}mv^2] = M(LT^{-1})^2 = [ML^2T^{-2}]$

$[mgh] = M \times (LT^{-2}) L = [ML^2T^{-2}]$

(23) (a) (i) +ve

(ii) −ve

(b)



(24) (a) Definition of SHM (OR)

$a \propto -x$ (OR)

$a = -\omega^2 x$

(b) Restoring force,

$F = -mg\sin\theta$

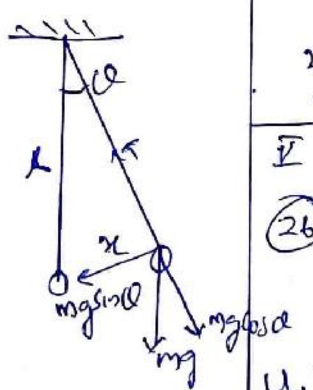
For small oscillations

$F = ma \approx -mg\theta$

$a = -g\theta$

$= -g\frac{x}{l}$

$a = -\frac{g}{l}x$



$\boxed{a \propto -x}$ is the conditions for SHM.

(c) Max KE at mean position

max PE at extreme positions

(25) $x = 0.005 \sin(80x - 3t)$

$x = A\sin(kx - \omega t)$

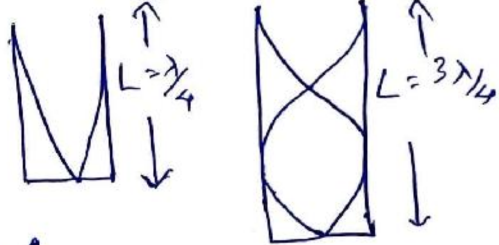
$k = \frac{2\pi}{\lambda} = 80$

$\lambda = \frac{2\pi}{80} = 0.0785$ m

$\omega = \frac{2\pi}{T} = 3$

$T = \frac{2\pi}{3} = 2.09$ sec

b)



mode I

$L = \lambda/4$, $\lambda = 4L$

frequency, $\nu_1 = \frac{V}{\lambda} = \frac{V}{4L}$ — (1)

mode 2

$L = \frac{3\lambda}{4}$; $\lambda = \frac{4L}{3}$

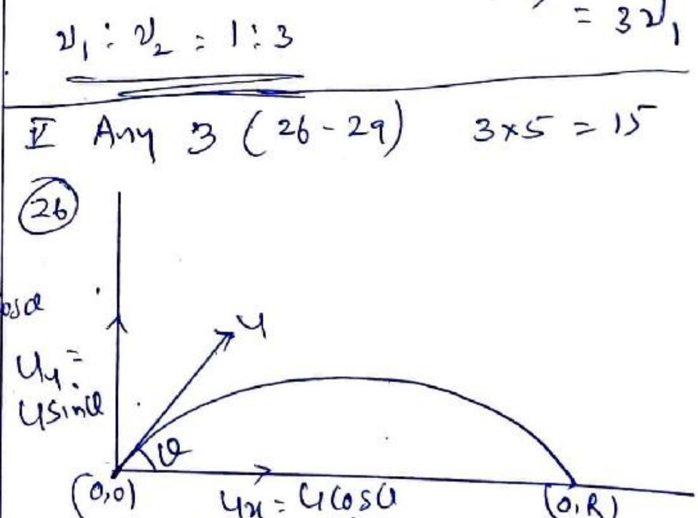
$\nu_2 = \frac{V}{\lambda} = \frac{V}{(4L/3)} = \frac{3V}{4L}$

$= 3\nu_1$

$\nu_1 : \nu_2 = 1 : 3$

V Any 3 (26-29) $3 \times 5 = 15$

(26)



$s = ut + \frac{1}{2}at^2$

$y = u_y t + \frac{1}{2}a_y t^2$

$u_y = u\sin\theta$

$a_y = -g$

$y = 0$

$0 = u\sin\theta \times t + \frac{1}{2} \times -gt^2$

$\frac{1}{2}gt^2 = u\sin\theta \times t$

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

26 b) $H = \frac{R}{4}$

$$\frac{u^2 \sin^2\theta}{2g} = \frac{1}{4} \times \frac{u^2 \sin 2\theta}{g}$$

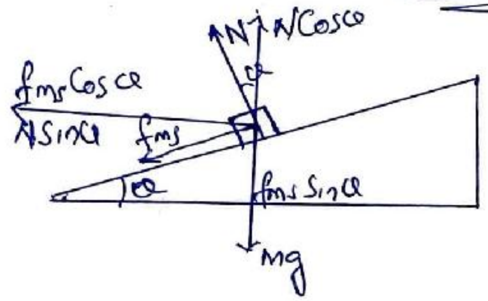
$$\sin^2\theta = \frac{1}{2} \times 2\sin\theta\cos\theta$$

$$\sin\theta = \cos\theta$$

$$\tan\theta = 1 \Rightarrow \underline{\theta = 45^0}$$

27)

(a)



(b) $\frac{mv^2}{r} = f_{ms}\cos\theta + N\sin\theta$ —— (1)

$$mg + f_{ms}\sin\theta = N\cos\theta$$

$$mg = N\cos\theta - f_{ms}\sin\theta \quad \text{—— (2)}$$

$$\frac{(1)}{(2)} \Rightarrow \frac{v^2}{rg} = \frac{f_{ms}\cos\theta + N\sin\theta}{N\cos\theta - f_{ms}\sin\theta}$$

$\div$ ing by $N\cos\theta$

$$\frac{v^2}{rg} = \frac{\left[f_{ms}/N + \frac{\sin\theta}{\cos\theta}\right]}{1 - \frac{f_{ms}}{N}\frac{\sin\theta}{\cos\theta}}$$

$$= \frac{\mu + \tan\theta}{1 - \mu\tan\theta}$$

$$v = \sqrt{rg\left[\frac{\mu + \tan\theta}{1 - \mu\tan\theta}\right]}$$

28 (a) statement (OR)

$$F \propto \frac{m_1 m_2}{r^2} \text{ (OR)}$$

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

(b) Acc^n due to gravity independant of mass of freely falling body

(c) $g = \frac{GM}{R^2}$

$$g_h = \frac{GM}{(R+h)^2}$$

$$\frac{g_h}{g} = \frac{R^2}{(R+h)^2}$$

$$= \frac{R^2}{R^2\left(1+\frac{h}{R}\right)^2}$$

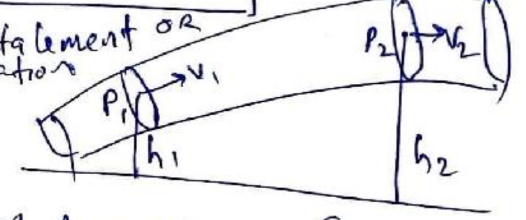
$$= \left(1+\frac{h}{R}\right)^{-2}$$

$$\approx \left(1 - \frac{2h}{R}\right) \quad \text{for } h \ll R$$

$$\boxed{g_h = g\left(1 - \frac{2h}{R}\right)}$$

29 (a) (i) statement OR equation

(ii)



Net work done $W = (P_1 - P_2)V$ —— (1)

$$\Delta KE = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2$$

$$\Delta PE = mgh_2 - mgh_1$$

$$W = \Delta KE + \Delta PE$$

$$(P_1 - P_2)V = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2 + mgh_2 - mgh_1$$

$$P_1V + \frac{1}{2}mv_1^2 + mgh_1 = P_2V + \frac{1}{2}mv_2^2 + mgh_2$$

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$$

$$P + \frac{1}{2}\rho v^2 + \rho g h = \text{Constant}$$

29 (b) Definition (OR) $\eta = \frac{\text{stress}}{\text{strain rate}}$

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