FIRST YEAR HSS MODEL EXAMINATION - 2023
PHYSICS

Section A

(1) 11.2 km/s OR $V_e = \sqrt{\frac{2GM}{R}} = \sqrt{gR}$

(2) Linear momentum.

(3) (III) $h/2$

(4) True

(5) Longitudinal

(6) Displacement

(7) parallel [$AB \sin\theta = 0$
$\Rightarrow \theta = 0/180°$

Section B

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

$[mgh] = MLT^{-2} \times L = [ML^2T^{-2}]$

Since dimensions on both sides are same, the equation is dimensionally correct.

(9) (I) KE (II) PE (III) KE (IV) PE

(10) (a) All gases which obeys all gas laws at all conditions of pressure and temperature

(b) $P = \frac{1}{3} nm\bar{v}^2$

where n = number of molecules / unit volume

m = mass of molecule

$\bar{v}$ = average velocity of molecules

(11) a) It is the angle between the tangent at the point of contact at the liquid surface and the solid surface inside the liquid.

(b)

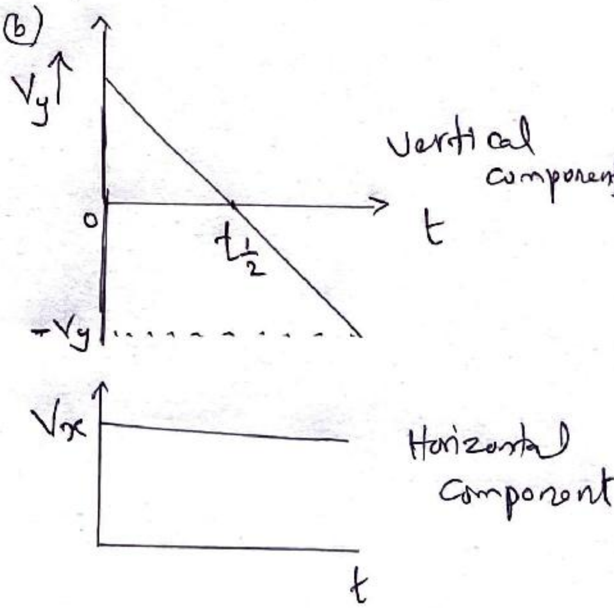
(12) (a) Torque
OR
Rotating effect of a force

(b) (i) when the force is applied exactly on the origin or axis of rotation
(ii) when the angle between position vector and force is 0 or 180°.

(13) (I) G
(II) V
(III) F
(IV) g

(14) (a) parabola

(b)



Section C

(15) (a) Significant figures are digits in the measured value that are reliable plus the digit which is uncertain.

(b) (i) 1 (ii) 3 (iii) 4 (iv) 4

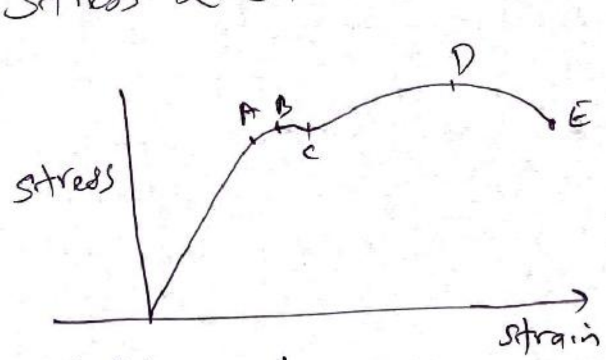
(16) (a) Impulse is the effect of a large force acting for a short interval of time.

(b) Frozen ice is harder ~~than~~ and fresh snow is softer. The impulse caused by falling on fresh snow is less than frozen snow.

(c) This is due to inertia of rest.

(17) (a) For small deformation, stress ∝ strain.

(b)



(i) Yield point → B

(ii) proportional limit → A

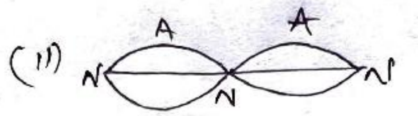
(iii) Fracture point. → E

(18) (a) In a standing wave, the points with zero displacement are nodes and points with maximum ~~displacement~~ displacement are antinodes

(b) (i)

First harmonic

(ii)



II Harmonic

(19) (a) If no external torque acting on a rotating body, total angular momentum is constant or conserved.

If $\tau_{ext} = 0$, $L = I\omega$ = constant

(b) $\vec{r} = 3\hat{i} + 3\hat{j} + 3\hat{k}$

$\vec{F} = 2\hat{i} - 5\hat{j} + 4\hat{k}$

$\vec{\tau} = \vec{r} \times \vec{F}$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 3 & 3 \\ 2 & -5 & 4 \end{vmatrix}$$

$$= \hat{i}\left[(3\times4) - (3\times{}^{-}5)\right] - \hat{j}\left[(3\times4) - (3\times2)\right] + \hat{k}\left[(3\times{}^{-}5) - (3\times2)\right]$$

$$= \hat{i}\left[12+15\right] - \hat{j}(12-6) + \hat{k}(-15-6)$$

$$\boxed{\vec{\tau} = 27\hat{i} - 6\hat{j} - 21\hat{k}}$$

(20) Average velocity,

$$\bar{v} = \frac{s}{t} \quad -(1)$$

Also, $\bar{v} = \frac{v+u}{2} \quad -(2)$

$$\frac{s}{t} = \frac{v+u}{2}$$

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

$$= \left[\frac{u+at+u}{2}\right]t$$

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

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

(OR) (Derivation using v-t graph).

(21) (a) If the work done by a force is independent of path followed and depends only on initial and final position, the force is conservative.

(b) Restoring force, $F = -kx$

For a small displacement dx in the spring,

$$dw = +F\,dx$$

$$= +kx\,dx$$

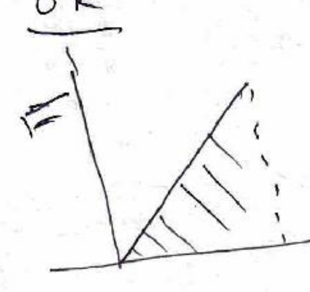
$$W = \int_0^x kx\,dx$$

$$= k\left(\frac{x^2}{2}\right)_0^x$$

$$W = \frac{1}{2}kx^2$$

This is the potential energy of spring $U_p = \frac{1}{2}kx^2$

OR



Workdone = Area of F–x graph

$$= \frac{1}{2} \times F \times x$$

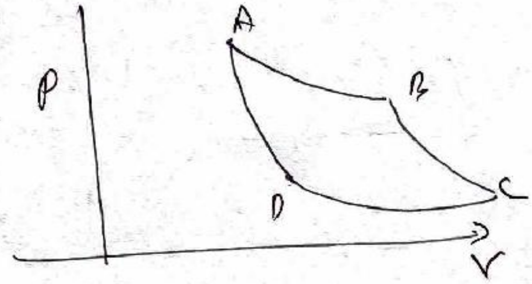
$$= \frac{1}{2}kx \times x$$

$$= \frac{1}{2}kx^2 = PE$$

(22) Section D

(a) A reversible heat engine operating between two temp:s

(b)



AB → Isothermal expansion

BC → Adiabatic expansion

CD → Isothermal compression

DA → Adiabatic compression

(c) No

(d) Efficiency of carnot engine

$$\eta = 1 - \frac{Q_2}{Q_1}$$

For $\eta = 1$, Q_2 must be zero, which is impossible.

(23) It is the decrease in velocity in one second.

OR

Rate of decrease in velocity.

(23) (b) $u = 126$ km/hr

$= 126 \times \frac{5}{18}$ m/s

$= 35$ m/s

$v = 0$

$s = 200$ m.

$$a = \frac{v^2 - u^2}{2 \cdot s} = \frac{0 - 35^2}{2 \times 200}$$

$$= -3.06 \ m/s^2$$

Retardation $= 3.06 \ m/s^2$

$v = u + at$

$$t = \frac{v - u}{a} = \frac{0 - 35}{-3.06}$$

$$= 11.44 \ s$$

(24) (a) A pendulum whose time period is 2 second

(b) $L = 1$ m.

$$T = 2\pi\sqrt{L/g}$$

$$L = \frac{gT^2}{4\pi^2}$$

$$\frac{L'}{L} = \frac{g'}{g}$$

$$L' = \frac{g'}{g} \times L =$$

$$= \frac{g_{moon}}{g_{earth}} \times 1$$

$$= \frac{1.6}{9.8} = 0.163 m$$

(25) (a) Conduction → transfer of heat through a body without the actual movement of particles

Convection → Transfer of heat from one point to another by actual motion of particles

(b) (i) Temperature difference

(ii) Area of cross section

(iii) Length of iron bar

(c) $\frac{C}{100} = \frac{F - 32}{180}$

For same value.

$$\frac{C}{100} = \frac{C - 32}{180}$$

$$180 = 100C - 3200$$

$$80C = -3200$$

$$C = \frac{-3200}{80} = -40$$

Section E

(26) (a) on the surface,

$$g = \frac{GM}{R^2} = \frac{G \times \frac{4}{3}\pi R^3 \rho}{R^2}$$

$$= G \times \frac{4}{3}\pi R \rho \quad \text{—(1)}$$

At a depth,

$$g_d = G \times \frac{4}{3}\pi (R - d)\rho$$

$$= G \times \frac{4}{3}\pi R \rho \left(1 - \frac{d}{R}\right)$$

$$= g\left(1 - \frac{d}{R}\right)$$

OR

Any other method

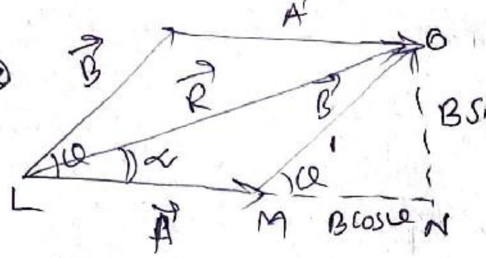
(b) $$g_d = 9.8\left[1 - \frac{250}{6400}\right]$$

$$= 9.8 \times 0.96$$

$$= 9.42 \ m/s^2$$

(27)

(a)



$R = \sqrt{LN^2 + NO^2}$

$= \sqrt{(A + B\cos\theta)^2 + (B\sin\theta)^2}$

$= \sqrt{A^2 + 2AB\cos\theta + B^2\cos^2\theta + B^2\sin^2\theta}$

$R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$

Direction is given,

$\tan\alpha = \frac{NO}{LN} = \frac{B\sin\theta}{A + B\cos\theta}$

(b) $\theta = 15^\circ$

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

$u^2 = \frac{Rg}{\sin 30} = \frac{50 \times 9.8}{0.5}$

$= 980$

$u = \sqrt{980} = 31.3$ m/s

(28) (a) For a streamline flow of liquid, the sum of pressure, kinetic energy per unit volume and potential energy per unit volume at any point are conserved.

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

(b) It is the ratio of shearing stress to strain rate of a ~~liquid~~ fluid.

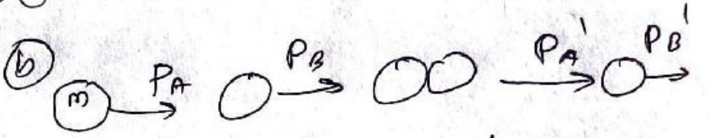
$\eta = \frac{\text{stress}}{\text{strain rate}}$

(c) (i) Area of contact of liquid layers (A)

(ii) Velocity gradient ($\frac{V}{L}$)

(29) (a) Statement of II law

(b)



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

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

$\vec{F}_{AB} = -\vec{F}_{BA}$

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

$P_A + P_B = P_A' + P_B'$

Total momentum is conserved

(c) $m = 0.010$ kg

$M = 100$ kg

$v = 50$ m/s

$V = \frac{mv}{M} = \frac{0.010 \times 50}{100}$

$= 0.005$ m/s

$= 5 \times 10^{-3}$ m/s

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