FIRST YEAR MODEL EXAMINATION - JUNE - 2022

PHYSICS

1) c) Strong Nuclear force

2) b) 10^{-10} m

3) b) Zero

4) c) Law of Inertia

5) a) Young's modulus

6) a) Pascal's law

7) b) Sublimation

8) Impulse, $I = F \times \Delta t$

$= \frac{\Delta P}{\Delta t} \times \Delta t$

$= \Delta P$

= change in momentum.

9) $S_1 \to$ Yield strength

$S_2 \to$ Ultimate strength

10) i) a) Weight of the body, mg

b) Resultant upthrust or Buoyant force

c) Viscous drag

(ii) Terminal velocity

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

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

$= \frac{9}{5} \times -56.6$

$= -101.88$

$F = -101.88 + 32$

$= -69.88\,°F$

12) The law states that the total energy of a molecule is equally distributed in all possible energy modes, with each modes having an average energy equal to $\frac{1}{2} k_B T$.

13) $V = -\omega A \sin(\omega t + \phi)$

$a = \frac{d}{dt}\left[-\omega A \sin(\omega t + \phi)\right]$

$= -\omega A \times \cos(\omega t + \phi) \times \omega$

$\boxed{a = -\omega^2 A \cos(\omega t + \phi)}$

OR

$\boxed{a = -\omega^2 y}$

(14) When two identical progressive waves propagating in opposite directions, they superimposed to get a steady wave pattern. This is called standing wave.

15) i) The dimensions of all the terms on either side of an equation are same.

Dimension of LHS = Dimension of RHS

ii) $\left[\frac{1}{2} mv^2\right] = M \times (LT^{-1})^2$

$= [ML^2T^{-2}]$

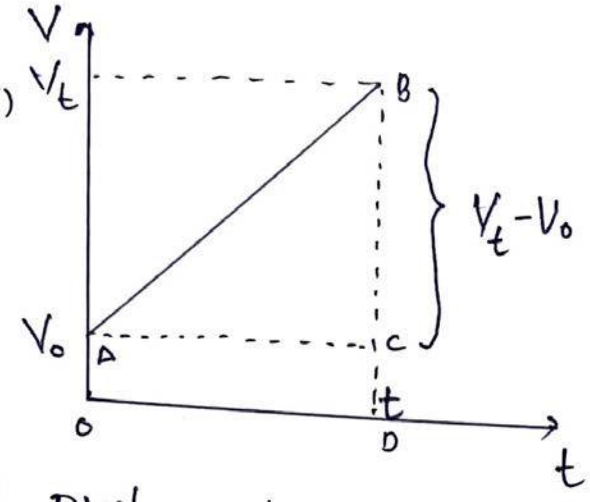
$[mgh] = M \times LT^{-2} \times L$

$= [ML^2T^{-2}]$

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

(2)

16) (i)



(ii) Displacement = Area

S = Area OACD + Area ABC

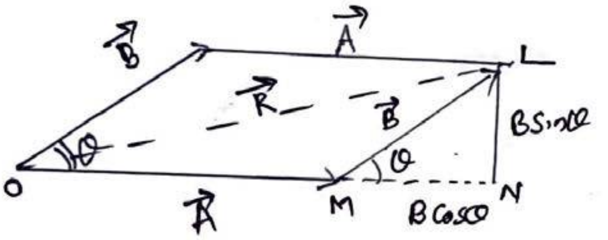
$= (OA \times OD) + \left(\frac{1}{2} \times AC \times BC\right)$

$= V_0 t + \frac{1}{2} \times t (V_t - V_0)$

$= V_0 t + \frac{1}{2} t \times at$

$$\boxed{S = V_0 t + \frac{1}{2} a t^2}$$

17)



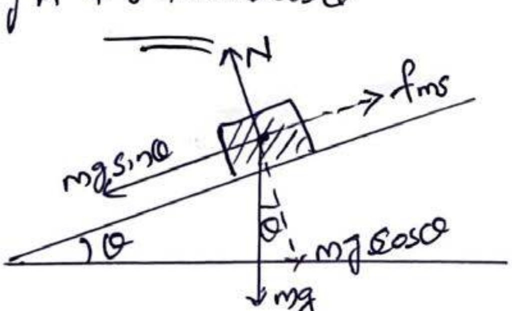
$R = \sqrt{ON^2 + NL^2}$

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

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

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

18)



$mg\sin\theta = f_{ms}$ —— (1)

$mg\cos\theta = N$ —— (2)

$\frac{(1)}{(2)} \Rightarrow \tan\theta = \frac{f_{ms}}{N} = \mu_s$

19) $\vec{F} \cdot \vec{d} = |\vec{F}||\vec{d}| \cos\theta$

$\cos\theta = \frac{\vec{F} \cdot \vec{d}}{|\vec{F}||\vec{d}|}$ —— (1)

$\vec{F} \cdot \vec{d} = (3\hat{i} + 4\hat{j} - 5\hat{k}) \cdot (5\hat{i} + 4\hat{j} + 3\hat{k})$

$= 15 + 16 - 15$

$= 16$

$|\vec{F}| = \sqrt{3^2 + 4^2 + (-5)^2} = \sqrt{9 + 16 + 25}$

$= \sqrt{50}$

$|\vec{d}| = \sqrt{5^2 + 4^2 + 3^2} = \sqrt{50}$

$(1) \Rightarrow \cos\theta = \frac{16}{\sqrt{50} \times \sqrt{50}} = \frac{16}{50} = 0.32$

$\theta = \cos^{-1}(0.32)$ or $\underline{\underline{\theta \approx 71^\circ}}$

(20) $\vec{l} = \vec{r} \times \vec{p}$

$\frac{d\vec{l}}{dt} = \frac{d}{dt}(\vec{r} \times \vec{p})$

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

$= (\vec{v} \times m\vec{v}) + \vec{r} \times \vec{F}$

$= 0 + \vec{\tau}$

$\frac{d\vec{l}}{dt} = \vec{\tau}$

21) i) a) poles

ii) $g = \frac{GM}{R_E^2}$ —— (1)

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

$= \frac{GM}{R_E^2 \left[1 + \frac{h}{R_E}\right]^2} = \frac{g}{\left(1 + \frac{h}{R_E}\right)^2}$

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

$1 + \frac{h}{R_E} = \sqrt{2}$; $\therefore \frac{h}{R_E} = \sqrt{2} - 1$ $\boxed{h = (\sqrt{2} - 1) R_E}$

22) (i) Stream line flow - The velocity of fluid particles passing through any given point is the same.

Turbulent flow - The velocity of fluid particles passing through any given point is changing with time, the flow is turbulent

(ii) Critical speed - It is the speed of fluid particles below which flow is streamline and above which flow is turbulent

23) (i) If we choose downward as +ve

$u = 0$

$a = +g$

$S = h$

$V = u + at$

$\boxed{V = 0 + gt}$

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

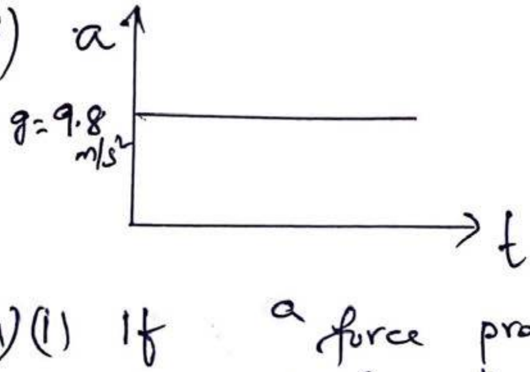
$\boxed{h = 0 + \frac{1}{2}gt^2}$

$V^2 = u^2 + 2as$

$V^2 = 0 + 2gh$

$V = \sqrt{2gh}$

ii)



24) (i) If a force produces displacement for the point of application of force in the direction of force, we can say that work is done.

OR

It is defined to be the product of component of force in the direction of displacement and magnitude of this displacement.

OR

$W = F\cos\theta \times d$

(ii) 1) work done by centripetal force in circular motion

2) A man holding weight on his head and moving horizontally. workdone against gravitational force is zero.

3) A man holding weight on his head for a long time steadily, $W = 0$

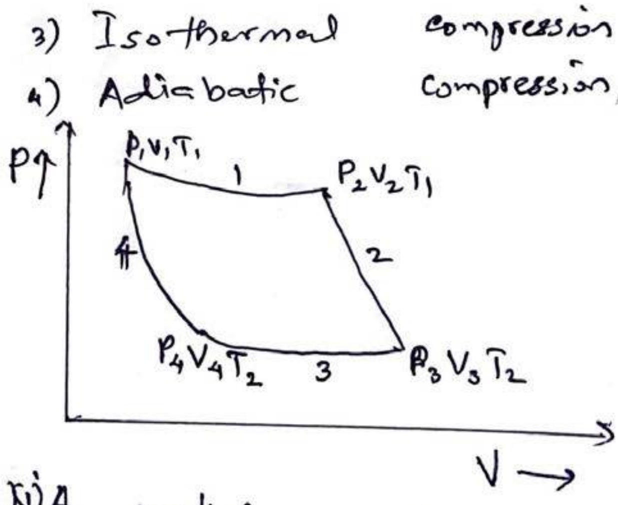
(iii) workdone by frictional force is -ve.

25) 1) Isothermal expansion

2) Adiabatic expansion

3) Isothermal compression

4) Adiabatic compression

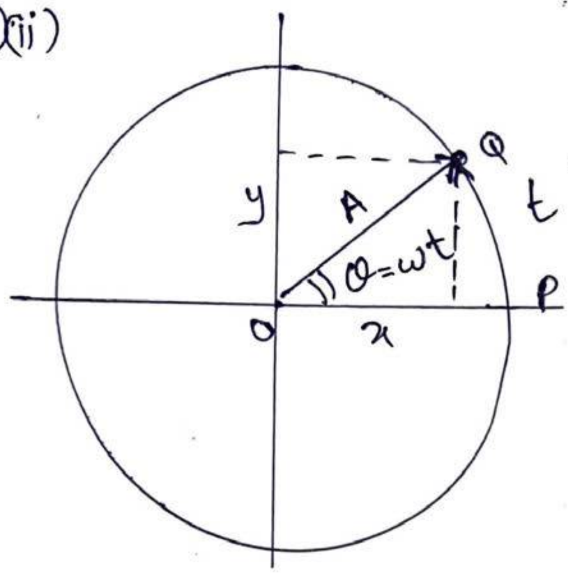


26) (i) A particle executing oscillations under the influence of a restoring force which is directly proportional to displacement and is always acting towards the mean position is an SHM.

for SHM $F \propto -x$

④ (i)

26)(ii)



Let a particle executing uniform circular motion with angular velocity ω. Let $\theta = \omega t$ be the angular displacement in a time t.

Now, from the figure.

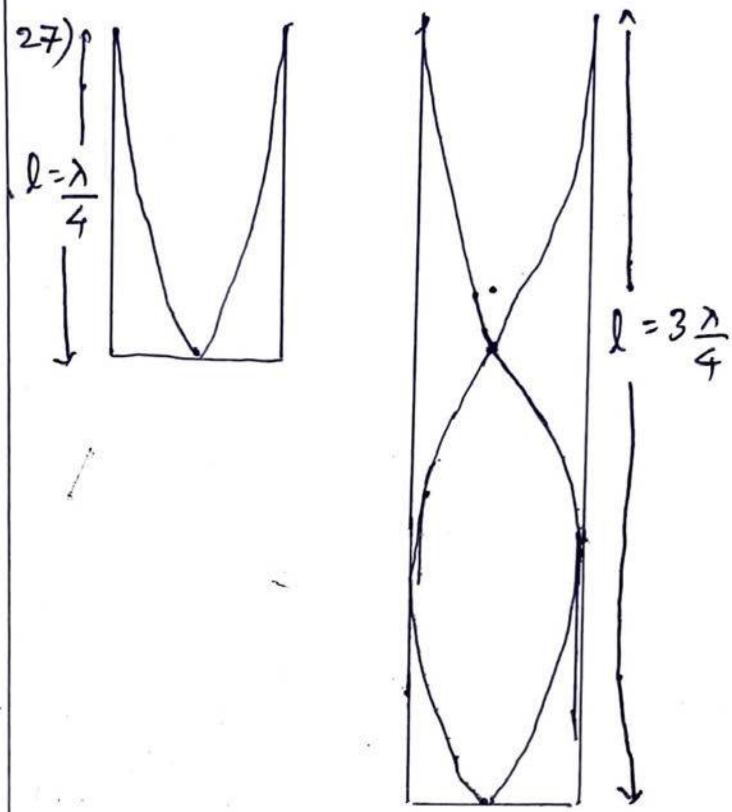
$$x = A\cos\theta = A\cos\omega t$$
$$y = A\sin\theta = A\sin\omega t$$

Let us take $y = A\sin\omega t$ as the displacement,

$$v = \frac{dy}{dt} = \frac{d}{dt}(A\sin\omega t)$$
$$= \omega \times A\cos\omega t$$
$$a = \frac{dv}{dt} = \frac{d}{dt}(\omega A\cos\omega t)$$
$$= \omega A \times -\sin\omega t \times \omega$$
$$= -\omega^2 A\sin\omega t$$
$$= -\omega^2 y$$

ie, $\boxed{a = -\omega^2 y}$ is the equation of a SHM.

27)



(ii) mode 1

$$l = \lambda/4$$
$$\lambda = 4l$$

Frequency, $\nu_1 = \frac{v}{\lambda} = \frac{v}{4l} = \nu_0$ — ①

First Harmonic

mode 2

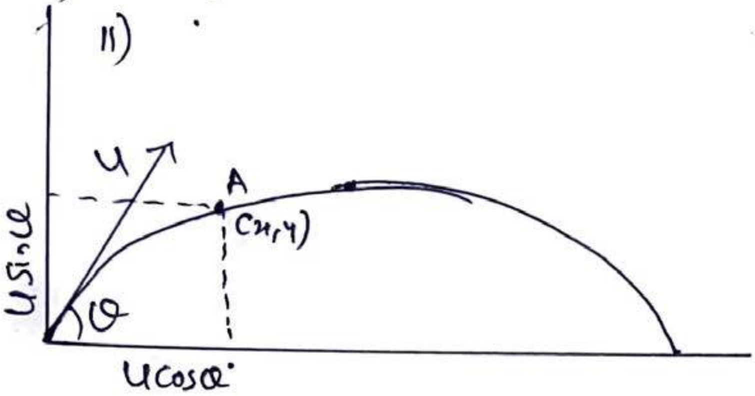
$$l = 3\lambda/4$$
$$\lambda = 4l/3.$$
$$\nu_2 = \frac{v}{\lambda} = \frac{v}{4l/3} = 3\frac{v}{4l} = 3\nu_0$$

3rd Harmonic

$$\nu_1 : \nu_2 = \nu_0 : 3\nu_0$$
$$= \underline{1 : 3}$$

28) i c) parabola

ii)



Let A be the position at any time 't'.

Horizontal displacement,

x = Horizontal velocity × time

$= u\cos\theta \times t$

$t = \frac{x}{u\cos\theta}$ —— ①

Vertical displacement is given by,

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

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

$= u\sin\theta \times \frac{x}{u\cos\theta} - \frac{1}{2} g \times \frac{x^2}{u^2\cos^2\theta}$

$$\boxed{y = x\tan\theta - \frac{g}{2u^2\cos^2\theta} x^2}$$

is the equation for the path (parabola)

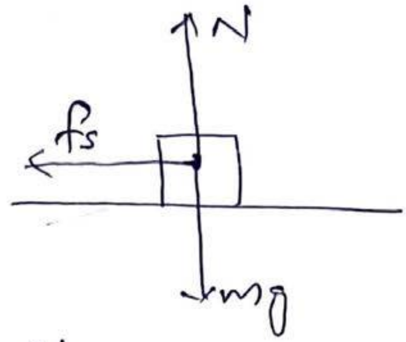
(iii) $u = 28$ m/s

$\theta = 30°$

$H = \frac{u^2\sin^2\theta}{2g} = \frac{28^2 \times (0.5)^2}{2 \times 9.8}$

$= 10$ m

29)

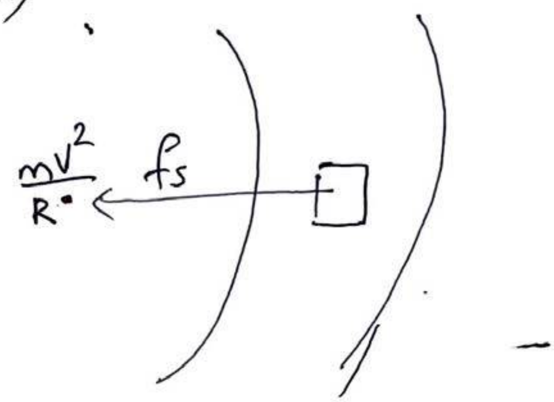


i) 1) weight, mg

2) Normal reaction, N

3) Static friction, f_s

ii)



For the safe speed

the centripetal force,

$f_c \leq f_s^{max}$

for maximum safe speed,

$f_c = f_s^{max}$

$\frac{mv^2}{R} = \mu_s N$

$= \mu_s mg$

$\frac{V^2}{R} = \mu_s g$

$V = \sqrt{\mu_s R g}$

30) (I) Statement (OR)

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

OR

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

(II) Proof

31) i) It is the speed of a satellite in its orbit.

ii) For the satellite orbiting it its orbit, the centripetal force is provided by gravitational force.

$$\frac{\cancel{m} V_o^2}{r} = \frac{GM\cancel{m}}{r^2}$$

$$V_o^2 = \frac{GM}{r}$$

$$V_o = \sqrt{\frac{GM}{r}}$$

iii) $V_e = \sqrt{2}\, V_o$

32) i) Moment of Inertia & Torque.

ii) Derivation of

$$KE_{rot} = \frac{1}{2} I \omega^2.$$

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