FIRST YEAR II TERMINAL EXAMINATION - DECEMBER 2022

PHYSICS

HSE I

Section A

(1) Strong nuclear force (deleted)

(2) 2

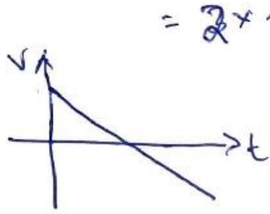
(3) $\frac{\Delta r}{r} \times 100\% = 4\%$ (deleted)

$A = 4\pi r^2$

$\frac{\Delta A}{A} \times 100\% = 2 \times \frac{\Delta r}{r} \times 100\%$

$= 2 \times 4\% = 8\%$

(4) (d)



(5) (c) $V_x = V_0 \cos\theta = V_0 \cos 45 = \frac{V_0}{\sqrt{2}}$

$V_y = V_0 \sin\theta = V_0 \sin 45 = \frac{V_0}{\sqrt{2}}$

(Range max $\Rightarrow \theta = 45^\circ$)

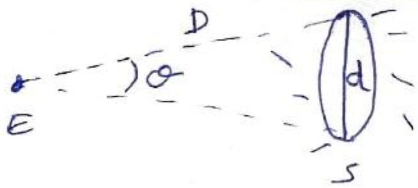
(6) (b) It's velocity.

(7) (d) $M^1 L^1 T^{-2}$

Section B

$\theta^\circ = \frac{\pi}{180} \times \theta$ rad

(8)



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$\theta = 1920'' = 1920 \times \frac{\pi}{60 \times 60 \times 180}$ rad

$= 0.0093$ rad

Angle = $\frac{arc}{radius}$

$\theta = \frac{d}{D}$

$d = \theta \times D = 0.0093 \times 1.496 \times 10^{11}$ m

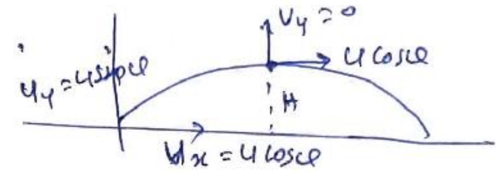
$= 0.014 \times 10^{11}$ m

$= 1.4 \times 10^9$ m

(9) speed → (i) Scalar quantity
(ii) always +ve.

velocity → (i) Vector quantity
(ii) +ve or -ve.

(10)



At maximum height, $V_y = 0$

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

$V_y^2 = u_y^2 + 2 \times -gH$

$0 = u^2 \sin^2\theta - 2gH$

$2gH = u^2 \sin^2\theta$

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

(11) It is the amount of motion contained in a moving body

OR

P = mass × velocity

unit → kg m/s

(12) Statement of I law.

i) Inertia of rest
ii) Inertia of motion
iii) Inertia of direction

(13) $F = ma = mg = 12 \times 10$
$= 120$ N

(14) a) Same ω, different v

Section C

(15) Statement

OR

Dimension of LHS = Dimension of RHS

$F = \frac{mV}{R}$

$[F] = [MLT^{-2}]$

$\left[\frac{mV}{R}\right] = \frac{M \times LT^{-1}}{L} = [MT^{-1}]$

Since dimensions are different, eqn. is wrong

(16) yes

At the top most position of a body thrown vertically upwards, $V = 0$ but $a = g$

(17) (a) Average velocity

$$\bar{V} = \frac{V+u}{2} = \frac{S}{t}$$

$$V + u = \frac{2S}{t} \quad \text{—(1)}$$

But we have, $V = u + at$ —(2)

$$V - u = at \quad \text{—(3)}$$

(1) × (3) ⟹

$$(V+u)(V-u) = \frac{2S}{t} \times at$$

$$V^2 - u^2 = 2aS$$

$$\boxed{V^2 = u^2 + 2aS}$$

(b) (2) in (1) ⟹

$$u + at + u = \frac{2S}{t}$$

$$2u + at = \frac{2S}{t}$$

$$\Rightarrow 2S = (2u + at) \times t$$

$$= 2ut + at^2$$

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

(18) A ——— B, $V_1 = 20$, $V_2 = 30$

$$\text{Average speed} = \frac{2V_1V_2}{V_1+V_2}$$

$$= \frac{2 \times 20 \times 30}{50}$$

$$= 24 \text{ m/s}$$

deleted

$$\text{Average velocity} = \frac{\text{Displacement}}{\text{time}}$$

$$= \frac{0}{t} = 0$$

(19) statement

OR

$$F = \frac{dP}{dt}$$

when $F = 0$, $dp = 0$

$p = \text{Constant}$

proof

P_A → A, P_B → B, P_A' P_B'

Force on A, $F_{AB} = \frac{\Delta P_A}{\Delta t} = \frac{P_A' - P_A}{\Delta t}$ —(1)

Force on B, $F_{BA} = \frac{\Delta P_B}{\Delta t} = \frac{P_B' - P_B}{\Delta t}$ —(2)

By 3rd law

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

$$\frac{P_A' - P_A}{\Delta t} = -\frac{(P_B' - P_B)}{\Delta t}$$

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

momentum before collision = momentum after collision

(20) $u = 28$ m/s

$\theta = 30°$

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

$$= 10 \text{ m}$$

$$t = \frac{2u\sin\theta}{g} = \frac{2 \times 28 \times 0.5}{9.8}$$

$$= 2.857 \text{ s}$$

(21) without friction, we cannot walk, we cannot hold anything, vehicles cannot run on roads. Also, we cannot climb a tree, cannot wear chappal, dress etc.. simply, we cannot do anything, without friction.

Section D

(22) $F_c \propto m^a v^b r^c$ — (1)

$F_c = k m^a v^b r^c$ — (2)

$[F_c] = [M^1 L^1 T^{-2}]$ — (3)

$[k m^a v^b r^c] = M^a (L T^{-1})^b L^c$

$= [M^a L^{b+c} T^{-b}]$ — (4)

From (3) and (4) ⇒

$a = 1$

$b + c = 1$

$-b = -2$

$b = 2$

$2 + c = 1$

$c = -1$

∴ (2) ⇒ $F_c = k m^1 v^2 r^{-1}$

$= k \frac{mv^2}{r}$

(23) $t = 3s$. ; $u = 0 = V_0$

(a) $V_1 = u + at_1 = 0 + 10 \times 1$

$= 10 m/s$

$V_2 = u + at_2 = 0 + 10 \times 2$

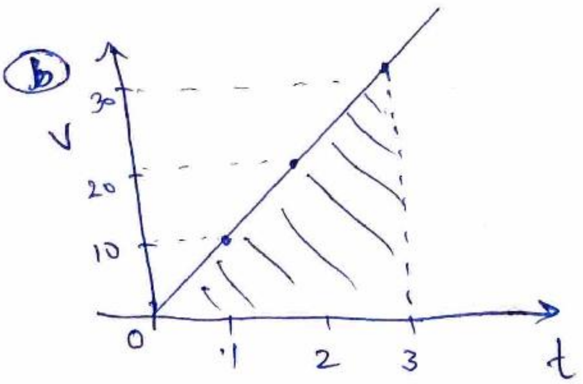
$= 20 m/s$

$V_3 = u + at_3 = 0 + 10 \times 3$.

$= 30 m/s$.

t	0	1	2	3
V	0	10	20	30

(b)



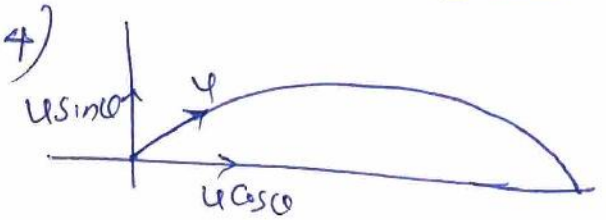
(c) Distance = Area.

⇒ Height = Area

$= \frac{1}{2} \times 3 \times 30$

$= 45 m$

24)



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

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

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

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

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

Range = Horizontal velocity × time

$= u\cos\theta \times \frac{2u\sin\theta}{g}$

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

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

(25) Statement

$F \propto \frac{\Delta P}{\Delta t}$

$F = k \frac{\Delta P}{\Delta t}$

$= k \frac{\Delta (mv)}{\Delta t}$

$= k m \frac{\Delta v}{\Delta t}$

$F = k m a$

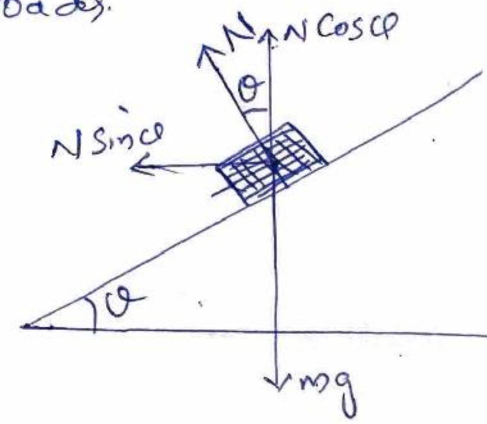
$k = 1$

$F = ma$

Section E

(26) (a) At curves, the outer edge is raised over the inner edge slightly to avoid skidding of vehicles. This is called banking of roads.

b)



(c) At equilibrium,

$$mg = N\cos\theta \quad \text{—(1)}$$

$$\frac{mv^2}{r} = N\sin\theta \quad \text{—(2)}$$

$$\frac{(2)}{(1)} \Rightarrow \frac{v^2}{rg} = \frac{\sin\theta}{\cos\theta} = \tan\theta$$

$$v^2 = rg\tan\theta$$

$$v = \sqrt{rg\tan\theta}.$$

[Since, without friction condition is not mentioned in (c) part,

$$v = \sqrt{rg\left(\frac{\mu + \tan\theta}{1 - \mu\tan\theta}\right)}$$ is also acceptable)

(d) $v = \sqrt{rg\tan\theta}$

$$= \sqrt{20 \times 10 \times \tan 5^\circ}$$

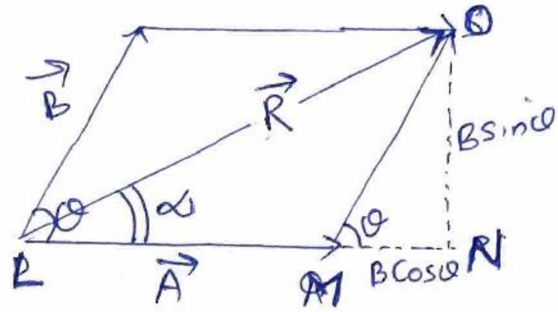
$$\tan 5^\circ \simeq 5^\circ = 5 \times \frac{\pi}{180} = 0.0872$$

$$\therefore v = \sqrt{20 \times 10 \times 0.0872}$$

$$= 4.177 \text{ m/s}$$

(27)

(a)



(b) $R = \sqrt{LN^2 + ON^2}$

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

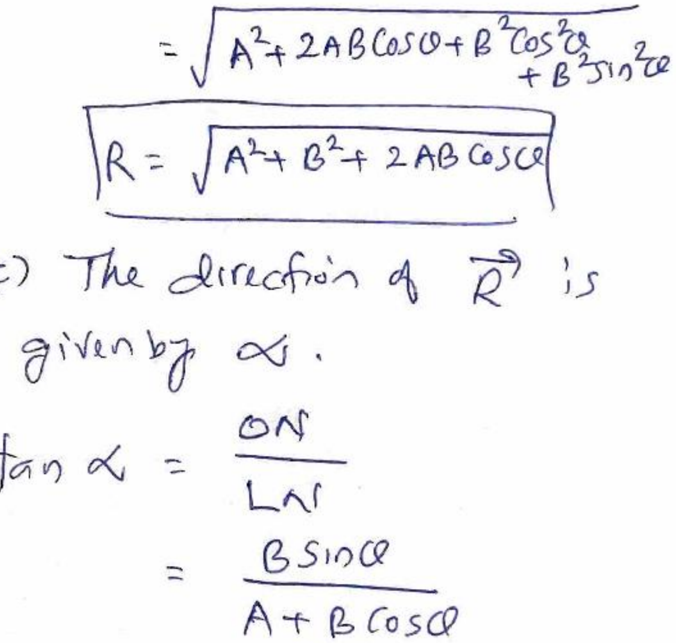
$$= \sqrt{A^2 + 2AB\cos\theta + B^2\cos^2\theta + B^2\sin^2\theta}$$

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

(c) The direction of $\vec{R}$ is given by α.

$$\tan\alpha = \frac{ON}{LN} = \frac{B\sin\theta}{A + B\cos\theta}$$

(28)



(a) Portion AB is uniform motion i.e., from 10 s to 30 s, $acc^n = 0$
$\Rightarrow F = 0$

(b) acc^n = Slope of OA

$= \frac{20-0}{10-0}$

$= 2 m/s$

(c) From 10 to 30 second, acc^n is zero

$\Rightarrow$ at $t = 20s$, $a = 0$

(d) Distance = Area

$= \left(\frac{1}{2} bh\right)_{OA} + (l \times b)_{AB} + \left(\frac{1}{2} bh\right)_{BC}$

$= \left(\frac{1}{2} \times 10 \times 20\right) + (20 \times 20) + \left(\frac{1}{2} \times 10 \times 20\right)$

$= 100 + 400 + 100$

$= 600 m$

29 (a) It is the velocity of one body with respect to another.

OR deleted

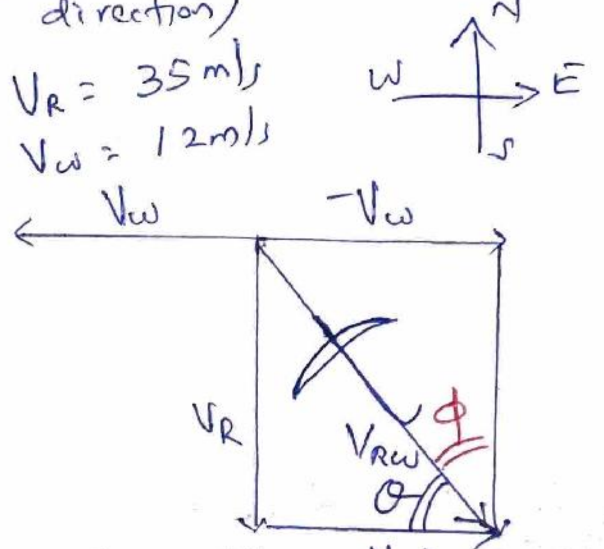
It is the rate of relative change in position of one body w.r.to another.

$RV = \frac{\text{change in Rel: position}}{\text{time}}$

(b) when the two objects are moving with the same velocity (OR same speed in the same direction)

(c) $V_R = 35 m/s$

$V_W = 12 m/s$



$\tan\theta = \frac{V_R}{V_W} = \frac{35}{12} = 2.916$

$\theta = \tan^{-1}(2.916)$

She should hold her umbrella in the opposite direction of relative velocity of rain w.r.to women in the west direction at an angle $\theta = \tan^{-1}(2.916)$ with the horizontal.

OR

$\tan\phi = \frac{V_W}{V_R} = \frac{12}{35} = 0.343$

Angle ϕ with vertical.

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