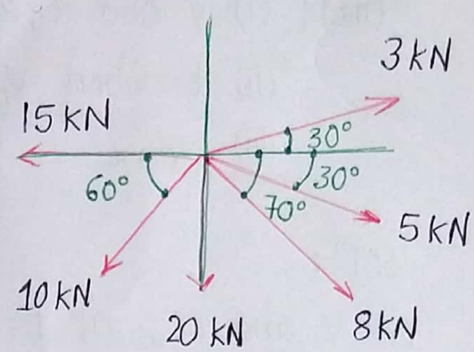
# Prelims 2019-20 [Engineering Mechanics] - Model Answer Key

Q.1 Attempt any four.

a] Find: R and $\theta$




Sol$^n$:

$\Sigma F_x = 3\cos 30^\circ + 5\cos 30^\circ + 8\cos 70^\circ - 10\cos 60^\circ - 15$

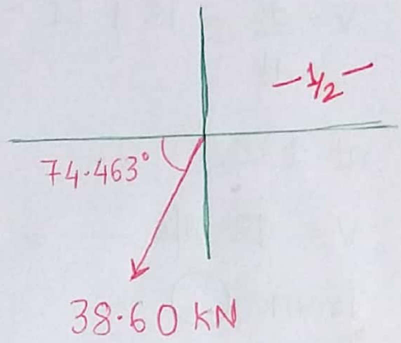
$= -10.336$ kN —$1\frac{1}{2}$—

$\Sigma F_y = 3\sin 30^\circ - 5\sin 30^\circ - 8\sin 70^\circ - 20 - 10\sin 60^\circ$

$= -37.178$ kN —$1\frac{1}{2}$—

$R = \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2}$

$= 38.60$ kN —1—




—½—

$\tan\theta = \dfrac{\Sigma F_y}{\Sigma F_x}$

$\theta = 74.463^\circ$ —½—

b] Find: $T_{AC}$

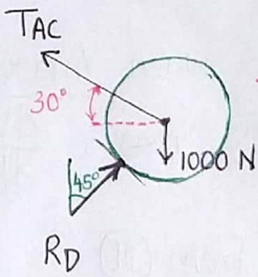
Sol$^n$:

Using Lami's Theorem

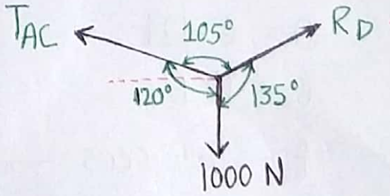
$\dfrac{T_{AC}}{\sin 135^\circ} = \dfrac{R_D}{\sin 120^\circ} = \dfrac{1000}{\sin 105^\circ}$ —1—

$R_D = 896.575$ N —1—

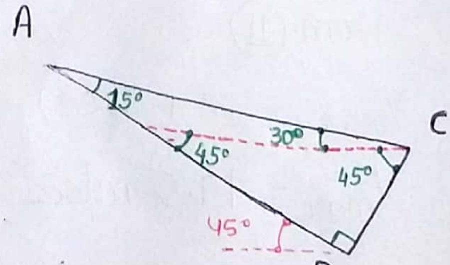
$T_{AC} = 732.051$ N —1—




—1—




—1—



c] Given: $S = 18t + 3t^2 - 2t^3$

Find: (i) V and a, at $t = 0$ secs

(ii) t when $V_{max}$

(iii) $V_{max}$

Sol$^n$:

(i) V and a, at $t = 0$ secs

$$S = 18t + 3t^2 - 2t^3 \rightarrow \text{I}$$

$$V = \frac{ds}{dt} = 18 + 6t - 6t^2 \rightarrow \text{II} \quad -1-$$

at $t = 0$,

$V = 18$ m/s $\longrightarrow$ Ans —½—

From II

$$a = \frac{dV}{dt} = 6 - 12t \rightarrow \text{III} \quad -1-$$

at $t = 0$,

$a = 6$ m/s$^2$ $\longrightarrow$ Ans —½—

(ii) t when $V_{max}$

For $V_{max}$, $\frac{dV}{dt} = 0$

from III

$0 = 6 - 12t$

$6 = 12t$

$t = 0.5$ secs $\longrightarrow$ Ans —1—

(iii) $V_{max}$

from II

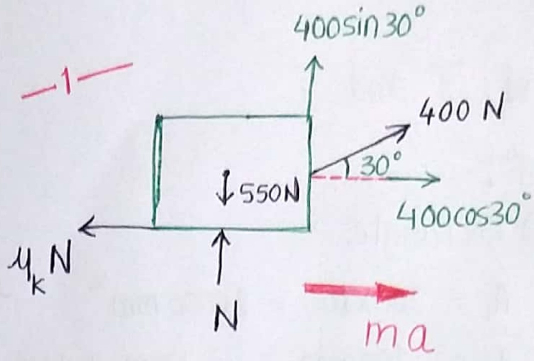
$V_{max} = 18 + 6(0.5) - 6(0.5)^2$

$V_{max} = 19.5$ m/sec $\longrightarrow$ Ans —1—

d] Find: $V$ when $t = 4$ secs

sol$^n$:

According to Newton's 2$^{nd}$ Law of motion




—1—

(i) $\Sigma F_x = m a_x$

$400\cos 30° - \mu_k N = \frac{550}{9.81} a$

$346.410 - 0.32 N = 56.065 a \longrightarrow$ (I) —1—

(ii) $\Sigma F_y = m a_y$

$400 \sin 30° - 550 + N = 0$ —1—

$N = 350$ Newton —½—

from (I)

$a = 4.181 \ m/s^2$ —½—

For uniform acceleration motion, we have

$V = u + at$

$V = 0 + 4.181(4)$

$V = 16.724 \ m/s \longrightarrow$ Ans —1—

e] Find: $e$

Given: $h = 4m$

$h' = 2.25 \ m$

$n = 2$

sol$^n$:

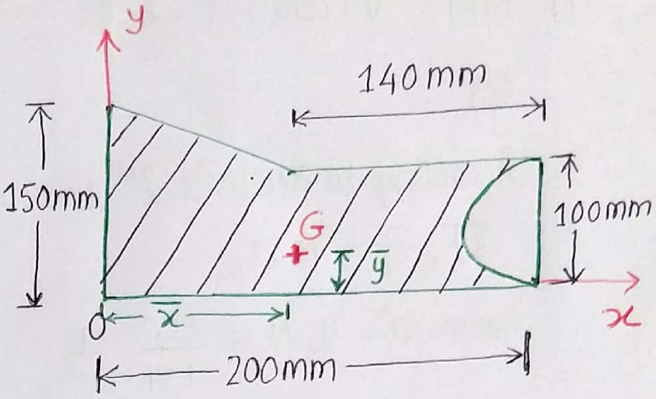
$e = \left[\frac{h'}{h}\right]^{\frac{1}{2n}}$ —2—

$e = \left[\frac{2.25}{4}\right]^{\frac{1}{4}}$ —2—

$e = 0.866 \longrightarrow$ Ans —1—

Q.2]

a) Find : $\bar{x}$ and $\bar{y}$




Sol$^n$ :-

① Rectangle

$A_1 = 200 \times 100 = 20000\ mm^2$ —½—

$\bar{x}_1 = 100mm$ from y-axis —½—

$\bar{y}_1 = 50\ mm$ from x-axis —½—

② Triangle

$A_2 = \frac{1}{2} \times 60 \times 50 = 1500\ mm^2$ —½—

$\bar{x}_2 = \frac{60}{3} = 20\ mm$ from y-axis —½—

$\bar{y}_2 = 100 + \frac{50}{3} = 116.667\ mm$ from x-axis —½—

③ Semicircle

$A_3 = \frac{\pi (50)^2}{2} = 3927\ mm^2$ —½—

$\bar{x}_3 = 200 - \frac{4(50)}{3\pi} = 178.78\ mm$ from y-axis —½—

$\bar{y}_3 = 50\ mm$ from x-axis —½—

Therefore,

$$\bar{x} = \frac{A_1\bar{x}_1 + A_2\bar{x}_2 - A_3\bar{x}_3}{A_1 + A_2 - A_3} \qquad \bar{y} = \frac{A_1\bar{y}_1 + A_2\bar{y}_2 - A_3\bar{y}_3}{A_1 + A_2 - A_3}$$

—1½—

$$\bar{x} = \frac{20000(100) + 1500(20) - 3927(178.78)}{20000 + 1500 - 3927} \qquad \bar{y} = \frac{20000(50) + 1500(116.667) - 3927(50)}{20000 + 1500 - 3927}$$

$\bar{x} = 75.566\ mm$ ⟶ Ans —1—

$\bar{y} = 35.7736\ mm$ ⟶ Ans —1—

b] Find: R

Given: $F_1 = 70N \longrightarrow OA$

$F_2 = 80N \longrightarrow OB$

$F_3 = 100N \longrightarrow OC$

A (2, 1, 3)

B (-1, 2, 0)

C (4, -1, 5)

O (0, 0, 0)

Sol$^n$:

$$\bar{F_1} = F_1 \left[ \frac{(2-0)i + (1-0)j + (3-0)k}{\sqrt{(2-0)^2 + (1-0)^2 + (3-0)^2}} \right] \quad -1-$$

$$= 70 \left[ \frac{2i + 1j + 3k}{3.74166} \right]$$

$$= 18.708 \, [2i + 1j + 3k]$$

$$\bar{F_1} = 37.416\, i + 18.708 j + 56.124\, k \longrightarrow \text{I} \quad -½-$$

$$\bar{F_2} = F_2 \left[ \frac{(-1-0)i + (2-0)j + (0-0)k}{\sqrt{(-1-0)^2 + (2-0)^2 + (0-0)^2}} \right] \quad -1-$$

$$= 80 \left[ \frac{-i + 2j + 0k}{2.236} \right]$$

$$= 35.777 \, [-i + 2j]$$

$$\bar{F_2} = -35.777\, i + 71.554\, j \longrightarrow \text{II} \quad -½-$$

$$\bar{F_3} = F_3 \left[ \frac{(4-0)i + (-1-0)j + (5-0)k}{\sqrt{(4-0)^2 + (-1-0)^2 + (5-0)^2}} \right] \quad -1-$$

$$= 100 \left[ \frac{4i - j + 5k}{6.4807} \right]$$

$$= 15.430 \, [4i - j + 5k]$$

$$\bar{F_3} = 61.72\, i - 15.430 j + 77.15\, k \longrightarrow \text{III} \quad -½-$$

$\bar{R} = \bar{F_1} + \bar{F_2} + \bar{F_3}$ — ½ —

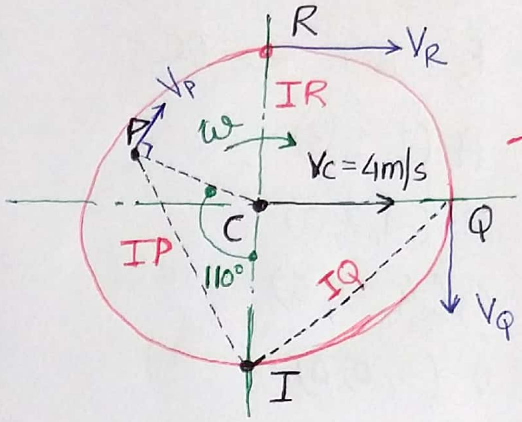
$\bar{R} = 63.359\,i + 74.832\,j + 133.274\,k$ ⟶ Ans — 1 —

c] Find: (i) $\omega$

(ii) $V_P$, $V_Q$, $V_R$

Given: $V_C = 4\ m/s$

$d = 2m$




— 1 —

Disc Rolls without slipping

Sol$^n$ :-

(i) $\omega$

$V_C = IC \times \omega$

$4 = 1 \times \omega$

$\omega = 4\ r/s$ ⟶ Ans — 1 —

(ii)

$V_P = IP \times \omega$

$V_P = 1.33 \times 4$

$V_P = 5.322\ m/s$ ⟶ Ans — 1 —

Use cosine Rule,

$IP^2 = IC^2 + CP^2 - 2(IC)(CP)\cos\theta$

$= 1^2 + 0.6^2 - 2(1)(0.6)\cos 110°$

$IP^2 = 1.77$

$IP = 1.33\,m$ — ½ —

$V_Q = IQ \times \omega$

$V_Q = 5.6568\ m/s$ ⟶ Ans — 1 —

Use Pythagorus Theorem,

$IQ^2 = IC^2 + CQ^2$

$= 1^2 + 1^2$

$IQ^2 = 2$

$IQ = 1.4142\,m$ — ½ —

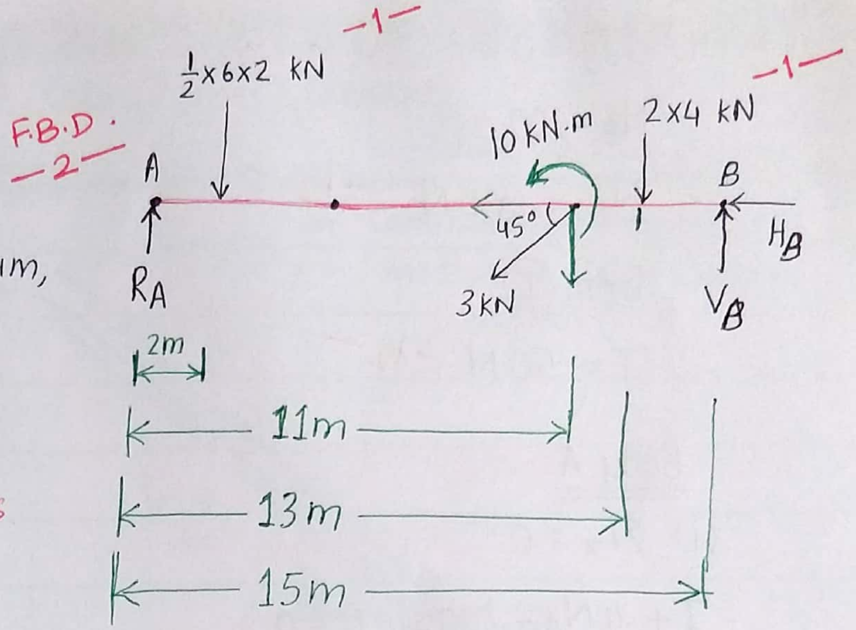
$V_R = IR \times \omega$

$= 2 \times 4$

$V_R = 8\ m/s$ ⟶ Ans — 1 —

Q.3]

a] Find: $R_A$, $V_B$, $H_B$




Sol$^n$:

According to Conditions of Equilibrium,

(i) $\Sigma F_x = 0$

$-3\cos45° - H_B = 0$ —1—

$H_B = -2.1213$ kN $\longrightarrow$ Ans

(ii) $\Sigma F_y = 0$

$R_A - 6 - 3\sin45° - 8 + V_B = 0$

$R_A + V_B = 16.1213$ kN $\longrightarrow$ (I) —1—

(iii) $\Sigma M_A^F = 0$

$-6(2) - 3\sin45°(11) - 8(13) + V_B(15) + 10 = 0$

$V_B = 8.6223$ kN $\longrightarrow$ Ans —1—

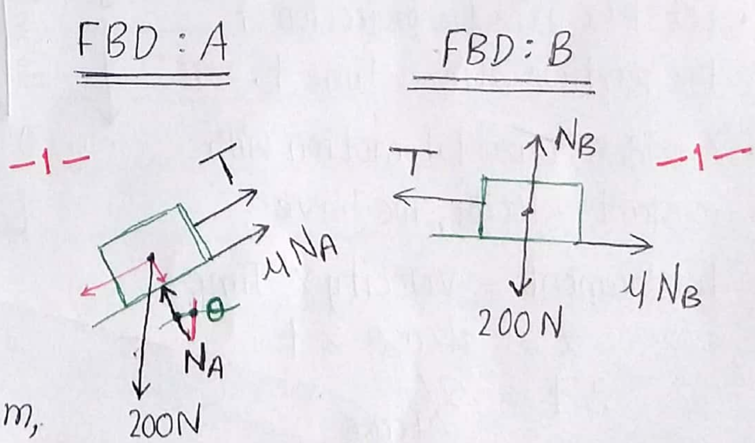
from (I) $R_A = 7.499$ kN $\longrightarrow$ Ans —1—

b] Find: $\theta$

Given: $W_A = 200$ N

$W_B = 200$ N

$\mu = 0.25$




Sol$^n$:

Body B

According to condition of Limiting Equilibrium,

(i) $\Sigma F_x = 0$

$\mu N_B - T = 0$

$0.25 N_B = T \longrightarrow$ (I) —½—

(ii) $\Sigma F_y = 0$

$N_B - 200 = 0$

$N_B = 200\,N$ — ½ —

from (I)

$T = 50\,N$ — ½ —

<u>Body A</u>

(i) $\Sigma F_x = 0$

$T + \mu N_A - 200\sin\theta = 0$

$50 + 0.25(200\cos\theta) - 200\sin\theta = 0 \longrightarrow$ (II) $\longrightarrow$ from (III) — 1 —

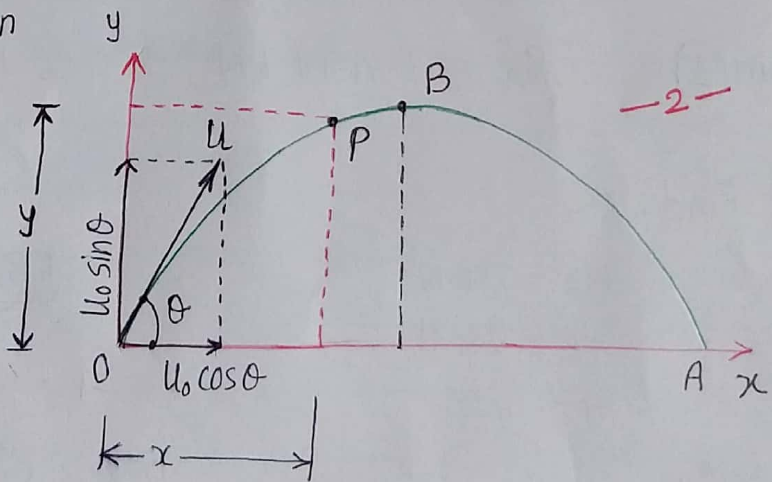
(ii) $\Sigma F_y = 0$

$N_A - 200\cos\theta = 0$

$N_A = 200\cos\theta \longrightarrow$ (III) — 1 —

from (II), $\theta = 28.07°$ $\longrightarrow$ Ans — ½ —

c] Path of Projectile Equation




- consider the particle to be freely thrown from point O at angle $\theta$ with velocity u.
- Let P(x, y) be the projection of the particle after a time t. — 1 —
- Consider horizontal motion with constant velocity, we have

Displacement = Velocity × Time

$x = u\cos\theta \times t$ — 1 —

$\therefore t = x/u\cos\theta$

- considering vertical motion under gravity, we have

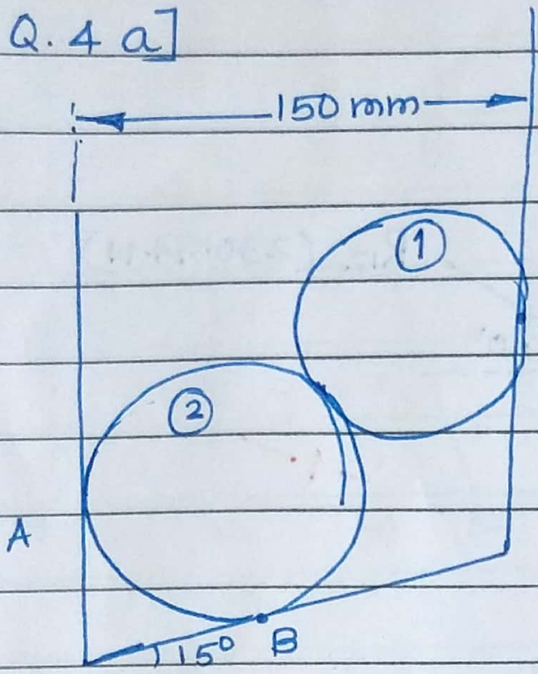
$h = ut - \frac{1}{2}gt^2$ — 1 —

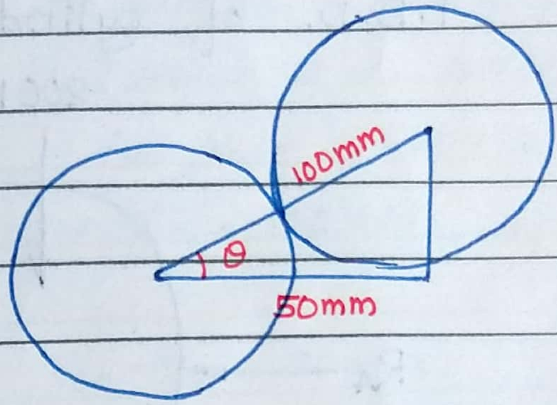
$y = u\sin\theta \times \frac{x}{u\cos\theta} - \frac{1}{2}g\left[\frac{x}{u\cos\theta}\right]^2$

$y = x\tan\theta - \frac{gx^2}{2u^2}(1+\tan^2\theta) \longrightarrow$ Equation of Parabola — 1 —

Thus, the path of projectile is a parabola and this equation is called the eqⁿ of Projectile motion.

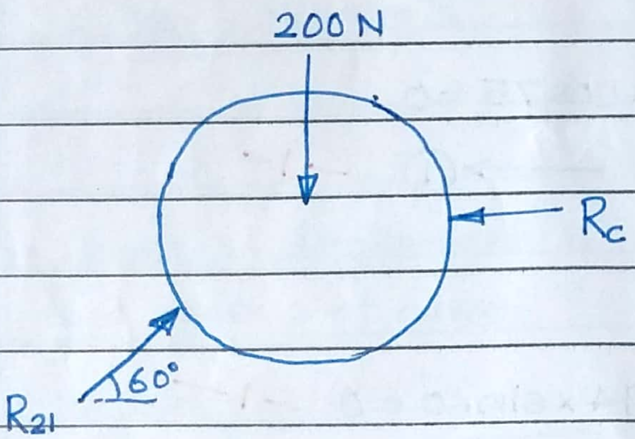
Q. 4 a]



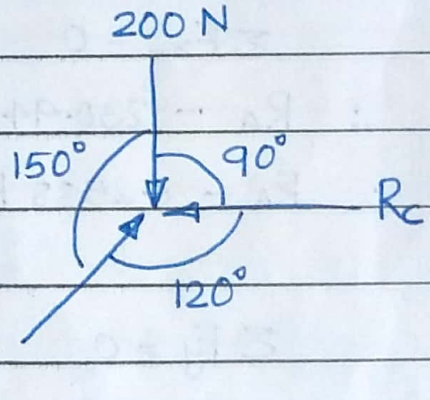




$\theta = \cos^{-1}\left(\frac{50}{100}\right) = 60°$ $-\frac{1}{2}$

F. B. D. of cylinder ①




$-1\frac{1}{2}$




Using Lami's theorem,

$$\frac{200}{\sin 120} = \frac{R_c}{\sin 150} = \frac{R_{21}}{\sin 90}$$

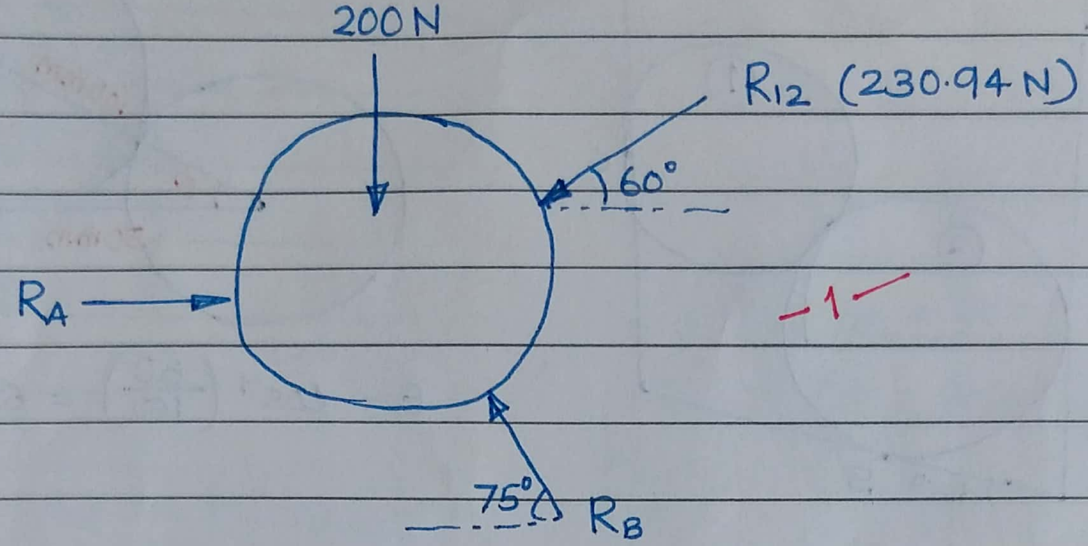
$\therefore\ R_c = \frac{200 \times \sin 150}{\sin 120}$

$\therefore\ R_c = 115.47\ N$ $-1$

$R_{21} = \frac{200 \times \sin 90}{\sin 120}$

$\therefore\ R_{21} = 230.94\ N$ $-1$

F.B.D. of cylinder 2




— 1 —

Using conditions of equilibrium,

$\Sigma F_x = 0$

$\therefore$ $R_A - 230.94 \times \cos 60 - R_B \times \cos 75 = 0$

$\therefore$ $R_A - 0.2588\, R_B = 115.47 \longrightarrow (1)$ — 1 —

$\Sigma F_y = 0$

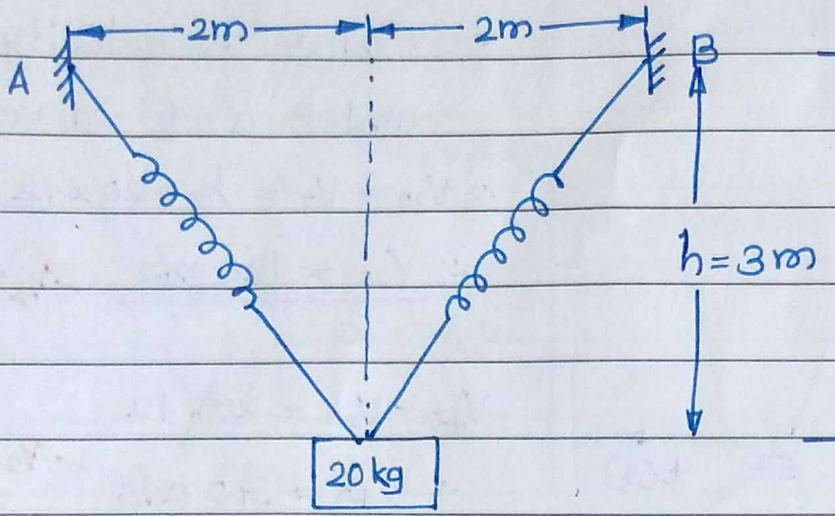
$\therefore$ $-200 + R_B \times \sin 75 - 230.94 \times \sin 60 = 0$ — 1 —

$\therefore$ $\underline{R_B = 399.99 \text{ N}}$

$\therefore$ $\underline{R_A = 218.987 \text{ N}}$

— 1 —

Q.4 b]




—— Position ①

—— Position ②

$k = 15\ N/cm$

$\therefore k = 15\ N/m$

Free length of spring $l_0 = 2m$
at ① length of spring $l_1 = 2m$
at ② length of spring $l_2 = \sqrt{2^2+3^2} = 3.606\ m$ } $-1\frac{1}{2}-$

$\therefore\ x_1 = l_1 - l_0 = 0\ m$ $-1-$

$x_2 = l_2 - l_0 = 3.606 - 2 = 1.606\ m.$ $-1-$

Using W-E-Principle,

Workdone in system = Change in K.E. $-1-$

$\therefore$ W.D. by wt. force + 2(W.D. by spring) = $(K.E.)_2 - (K.E.)_1$

$\therefore\ mgh + 2\left[\frac{1}{2} \times k \times (x_1^2 - x_2^2)\right] = \frac{1}{2} m V_2^2 - 0$

$\longrightarrow \because (K.E.)_1 = 0$ (rest) $-1/2-$

$\therefore\ (20 \times 9.81 \times 3) + 15\ (-1.606^2) = \frac{1}{2} \times 20 \times V_2^2$

$10 V_2^2 = 549.91$

$\underline{\underline{V_2 = 7.416\ m/s}}$ $(\downarrow)$ $-1-$

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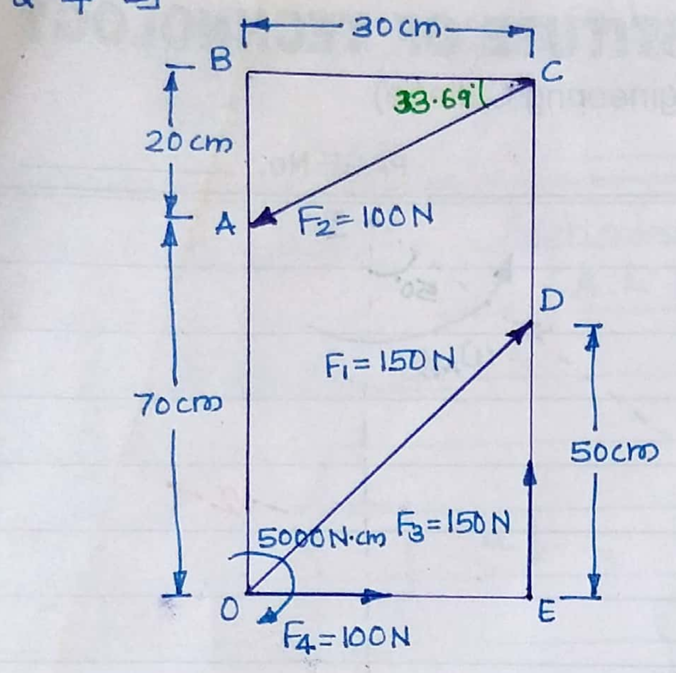
Q. 4 5]




$\angle BCA = \tan^{-1}\left(\frac{20}{30}\right) = 33.69°$

$\angle DOE = \tan^{-1}\left(\frac{50}{30}\right) = 59.04°$

$\Sigma F_x = 100 + 150 \times \cos 59.04 - 100 \times \cos 33.69$

$\therefore \Sigma F_x = 93.96 \text{ N} \quad (\rightarrow)$ -1-

$\Sigma F_y = 150 + 150 \times \sin 59.04 - 100 \times \sin 33.69$

$\therefore \Sigma F_y = 223.159 \text{ N} \quad (\uparrow)$ -1-

Resultant force $R = \sqrt{\Sigma F_x^2 + \Sigma F_y^2} = \sqrt{93.96^2 + 223.159^2}$

$\therefore R = 242.13 \text{ N}$ -1-

$\theta = \tan^{-1}\left[\frac{\Sigma F_y}{\Sigma F_x}\right] = \tan^{-1}\left[\frac{223.159}{93.96}\right] = 67.17°$ -1-

$\boxed{R = 242.13 \quad \angle 67.17}$

Moment about 'O', $M_o = 5000 - 150 \times 30 - (100 \times \cos 33.69 \times 90) + (100 \times \sin 33.69 \times 30)$

$\therefore M_o = -5324.36 \text{ N·cm}$

$\therefore M_o = 5324.36 \text{ N·cm}$ (Anticlockwise) -1-

Resultant force must produce same moment about 'O'

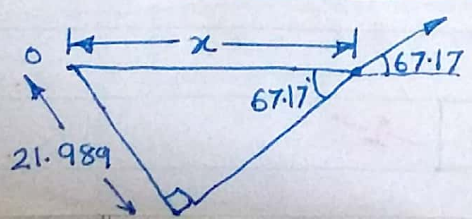
$\therefore M_o = R \times d$

$\therefore 5324.36 = 242.13 \times d$

$\therefore d = 21.989 \text{ cm}$

$x = 21.989 / \sin 67.17$

$\therefore x = 23.858 \text{ cm}$ -1-




OR

$x = \frac{M_o}{\Sigma F_y} = \frac{5324.36}{223.159}$

$x = 23.859 \text{ cm}$

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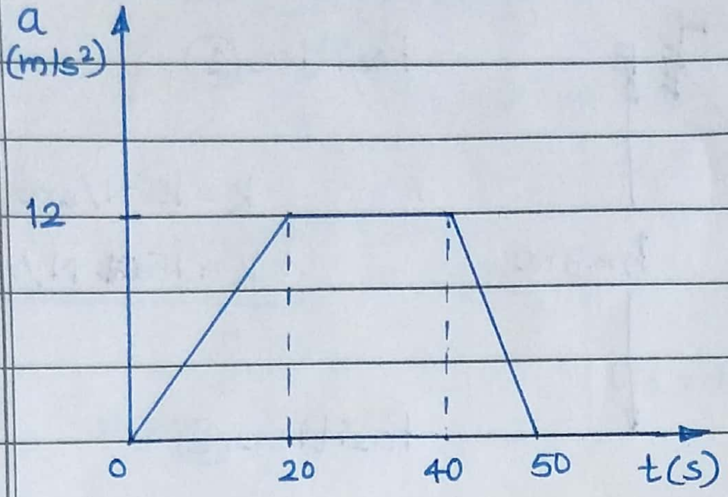
Q.5 a]




• Change in velocity is area under a-t curve.

$\therefore V_{20} - V_0 = \frac{1}{2} \times 20 \times 12$ $\boxed{V_0 = 0}$

$\therefore \underline{V_{20} = 120 \text{ m/s}}$ — ½ —

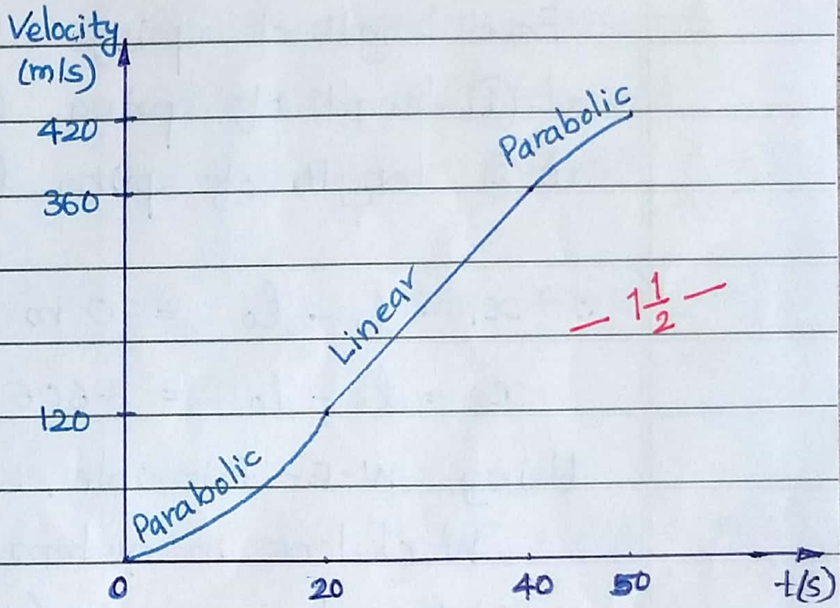
$V_{40} - V_{20} = 20 \times 12$

$\therefore \underline{V_{40} = 360 \text{ m/s}}$ — ½ —

$V_{50} - V_{40} = \frac{1}{2} \times 10 \times 12$

$\therefore V_{50} = 60 + 360$

$\therefore \underline{V_{50} = 420 \text{ m/s}}$ — ½ —




— $1\frac{1}{2}$ —

• Change in displacement is area under V-t curve.

$\therefore S_{20} - S_0 = \frac{1}{3} \times 20 \times 120$

$\therefore \underline{S_{20} = 800 \text{ m}}$ $\boxed{S_0 = 0}$ — ½ —

$S_{40} - S_{20} = (20 \times 120) + \frac{1}{2}(20 \times 240)$

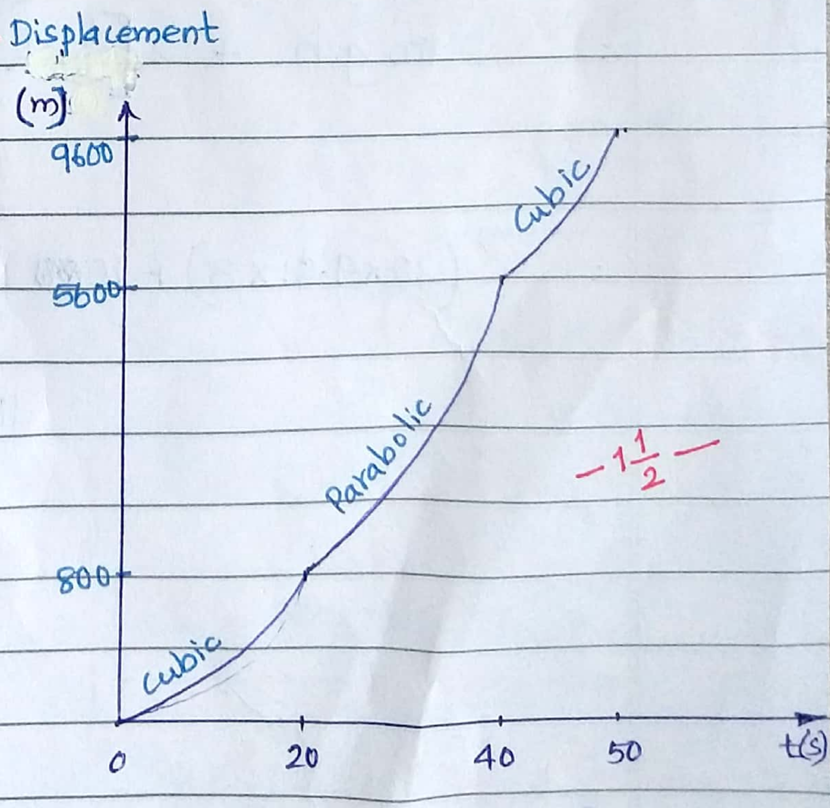
$\therefore S_{40} = 2400 + 2400 + 800$

$\therefore \underline{S_{40} = 5600 \text{ m}}$ — ½ —

$S_{50} - S_{40} = (10 \times 360) + \frac{2}{3} \times 10 \times 60$

$\therefore S_{50} = 3600 + 400 + 5600$

$\therefore \underline{S_{50} = 9600 \text{ m}}$ — ½ —




— $1\frac{1}{2}$ —

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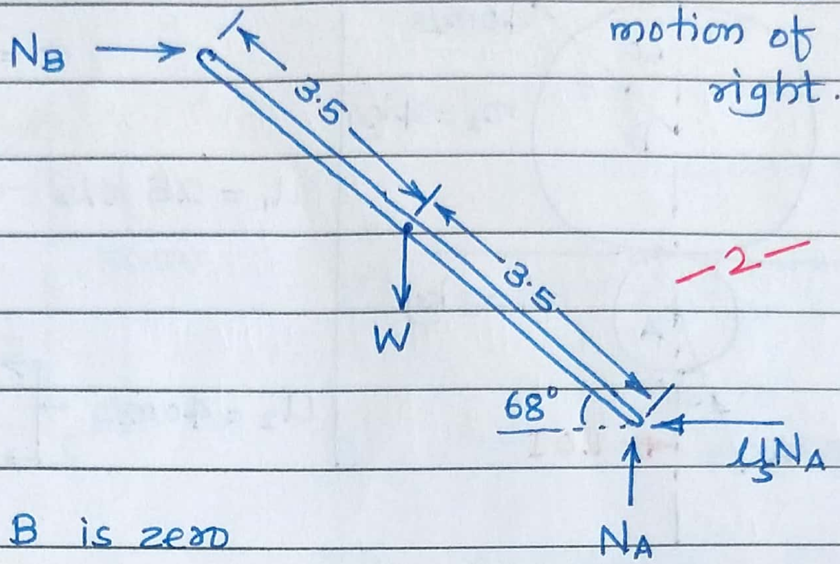
Q.5 b]

F.B.D.

* Considering impending motion of 'A' towards right.




• Friction force @ B is zero

Applying conditions of equilibrium,

$\Sigma F_x = 0$ $\quad\quad$ $\Sigma F_y = 0$

$\therefore -\mu_s N_A + N_B = 0$ $\quad\quad$ $N_A - W = 0$

$\boxed{\therefore N_B = \mu W}$ -1- $\quad\quad$ $\therefore N_A = W$ -1-

$\Sigma M_A = 0$

$N_B \times 7 \times \sin 68 - W \times 3.5 \times \cos 68 = 0$ -1-

$\therefore \mu_s \times \cancel{W} \times 7 \times \sin 68 = \cancel{W} \times 3.5 \times \cos 68$

$$\therefore \mu_s = \frac{3.5 \times \cos 68}{7 \times \sin 68}$$

$\therefore \mu_s = 0.202$ -1-

$\therefore$ Coefficient of static friction at A is 0.202

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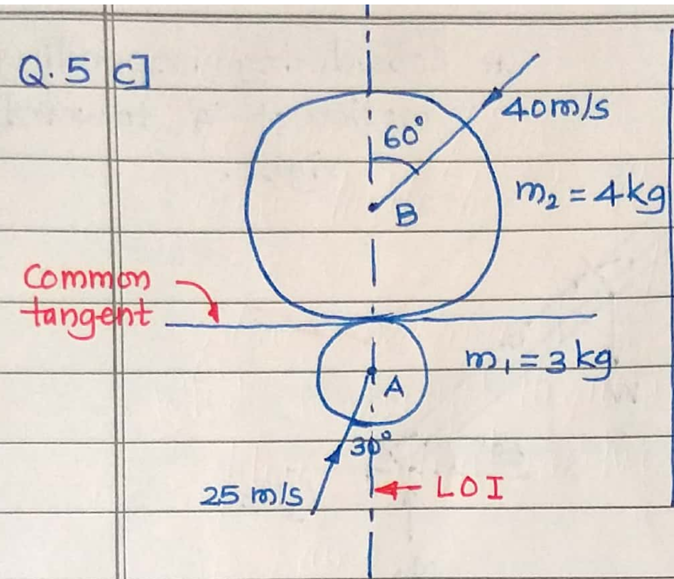
Q.5 c]




Given data :

$e = 0.8$

$u_1 = 25$ m/s → $u_{1x} = 25 \sin 30 = 12.5$ m/s (→) ; $u_{1y} = 25 \cdot \cos 30 = 21.65$ m/s (↑)

$u_2 = 40$ m/s → $u_{2x} = 40 \sin 60 = 34.64$ m/s (←) ; $u_{2y} = 40 \cdot \cos 60 = 20$ m/s (↓)

• Along Line of impact

i) Conservation of momentum.

$$m_1 u_{1y} + m_2 u_{2y} = m_1 V_{1y} + m_2 V_{2y}$$

$$\therefore 3(21.65) + 4(-20) = 3V_{1y} + 4V_{2y}$$

$$\therefore 3V_{1y} + 4V_{2y} = -15.05 \longrightarrow (1) \quad -1-$$

ii) Coefficient of restitution.

$$e = \frac{V_{2y} - V_{1y}}{u_{1y} - u_{2y}}$$

$$\therefore 0.8 = \frac{V_{2y} - V_{1y}}{21.65 - (-20)}$$

$$\therefore V_{2y} - V_{1y} = 33.32 \longrightarrow (2) \quad -1-$$

Solving eqn (1) & (2)

$V_{1y} = -21.19$ m/s $= 21.19$ m/s (↓) -1-

$V_{2y} = 12.13$ m/s (↑) -1-

• Along common tangent.

Velocities are conserved.

$\therefore V_{1x} = u_{1x} = 12.5$ m/s (→) -1-

$V_{2x} = u_{2x} = 34.64$ m/s (←) -1-

Now,

$V_1 = \sqrt{V_{1x}^2 + V_{1y}^2} = 24.6$ m/s -½-

$\theta_1 = \tan^{-1}\left[\frac{V_{1y}}{V_{1x}}\right] = 59.46°$ -½-

$$\boxed{\therefore V_1 = 24.6 \text{ m/s} \quad 59.46°}$$

$V_2 = \sqrt{V_{2x}^2 + V_{2y}^2} = 36.7$ m/s -½-

$\theta_2 = 19.298°$ -½-

$$\boxed{\therefore V_2 = 36.7 \text{ m/s} \quad 19.298°}$$

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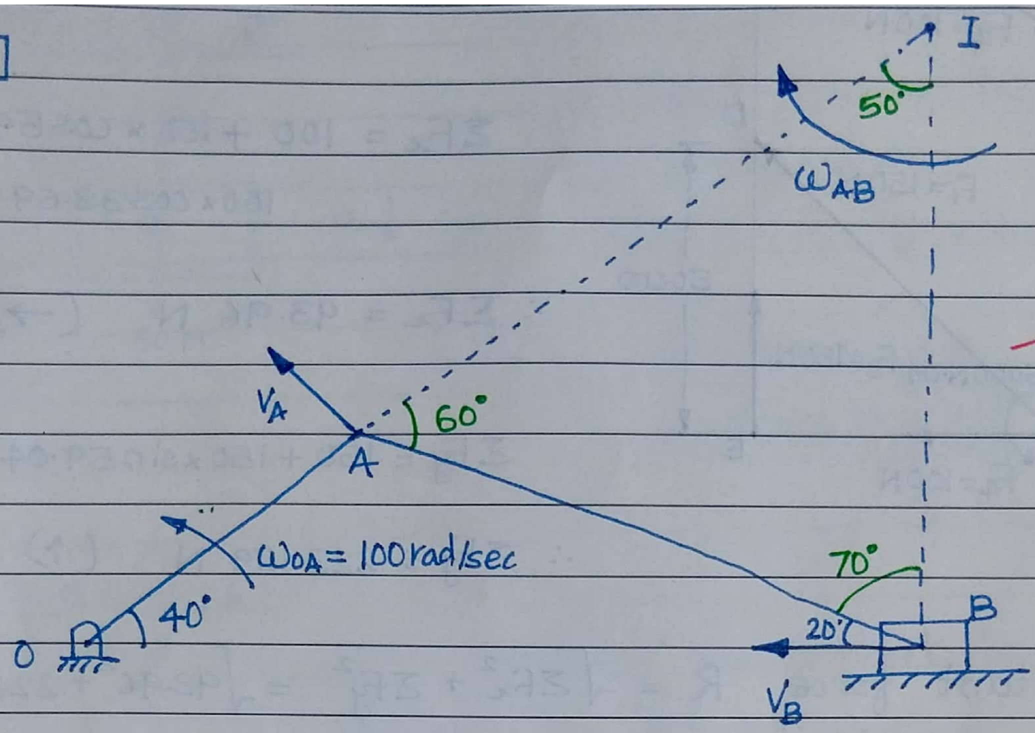
Q.6 a]




-2-

OA = 200 mm

In $\Delta$ OAB

$$\frac{AB}{\sin 40} = \frac{OA}{\sin 20}$$

$$\therefore AB = \frac{200 \times \sin 40}{\sin 20}$$

$$\therefore AB = 375.877 \text{ mm}$$ -1-

In $\Delta$ IAB

$$\frac{IA}{\sin 70} = \frac{IB}{\sin 60} = \frac{AB}{\sin 50}$$

$$\therefore IA = \frac{375.877 \times \sin 70}{\sin 50}$$

$$\therefore IA = 461.081 \text{ mm}$$

$$\& \ IB = 424.935 \text{ mm}$$ -1-

$$V_A = (OA) \cdot \omega_{OA}$$

$$\therefore V_A = 0.2 \times 100$$

$$\therefore V_A = 20 \text{ m/s} \quad (50°)$$

Also $V_A = (IA) \cdot \omega_{AB}$

$$\therefore \omega_{AB} = \frac{20}{0.461081}$$

$$\boxed{\therefore \omega_{AB} = 43.376 \text{ rad/se (clockwise)}}$$ -1-

$$V_B = (IB) \cdot \omega_{AB}$$

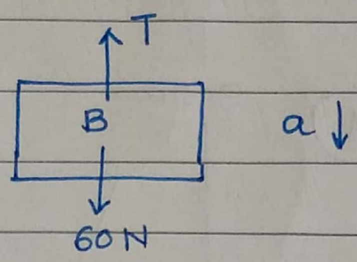
$$\therefore V_B = (0.4249) \times 43.376$$

-1-

$$\boxed{\therefore V_B = 18.432 \text{ m/s } (\leftarrow)}$$

Q. 6 b] Frictionless pulley - hence acceleration of block A & B will be same.

F.B.D. of 'B'




-1-

Using Di alembert principle.

$\Sigma F = ma$

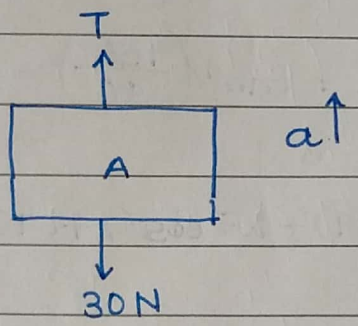
$\therefore 60 - T = \frac{60}{9.81} \times a$

$\therefore 60 - T = 6.116\,a$

$\therefore 6.116\,a + T = 60 \longrightarrow (1)$

-1-

F.B.D. of 'A'




-1-

Using De'alembert Principle,

$\Sigma F = ma$

$\therefore T - 30 = \frac{30}{9.81} \times a$

$\therefore T - 30 = 3.058\,a$

$\therefore T - 3.058\,a = 30 \longrightarrow (2)$

-1-

Solving equ$^n$ (1) & (2)

$a = 3.27\ m/s^2$ & $T = 40\ N$

-½-  -½-

Block 'B' is traveling '2m' downwards with $a = 3.27\ m/s^2$

$u = 0$ , $s = 2m$

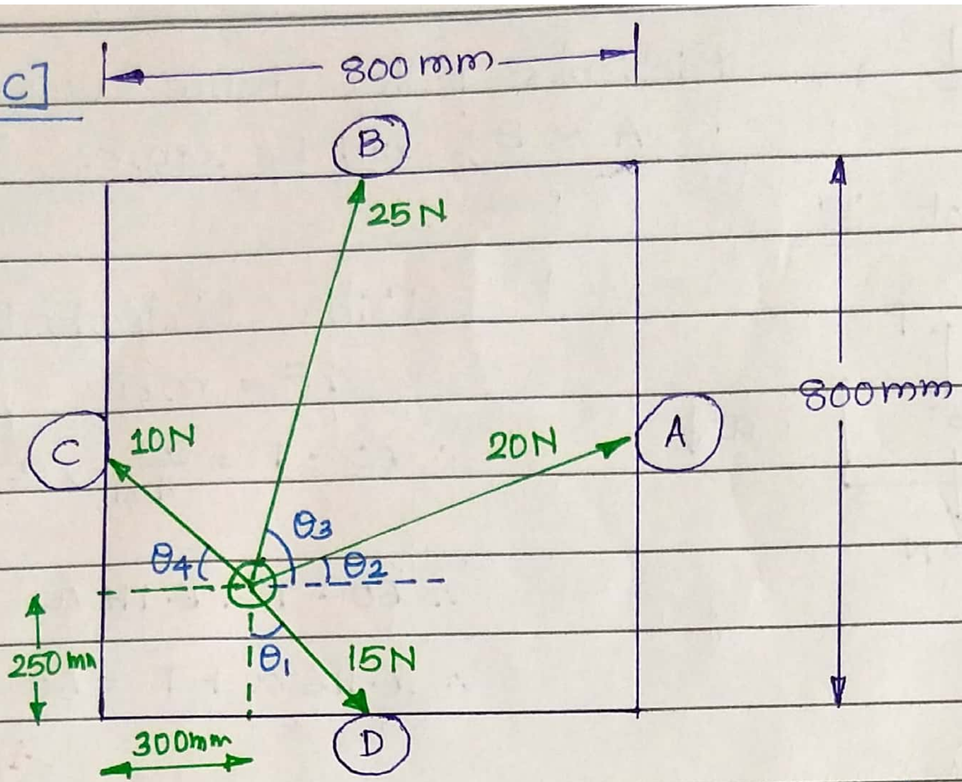
$\therefore v^2 = u^2 + 2as$

$\therefore v = \sqrt{2a \cdot s}$

$\therefore v = \sqrt{2 \times 3.27 \times 2}$

$\boxed{\therefore v = 3.616\ m/s (\downarrow)}$ -1-

Q. 6 C]




—1— $\theta_1 = \tan^{-1}\left(\frac{100}{250}\right) = 21.801°$ , $\theta_2 = \tan^{-1}\left(\frac{150}{500}\right) = 16.699°$ —1—

—1— $\theta_3 = \tan^{-1}\left(\frac{550}{100}\right) = 79.695°$ , $\theta_4 = \tan^{-1}\left(\frac{150}{300}\right) = 26.565°$ —1—

$\Sigma F_x = 15\sin(21.801) + 20\cos(16.699) + 25\cos(79.695) - 10\cos(26.565)$

$\therefore \Sigma F_x = 20.255$ N $(\rightarrow)$ —1—

$\Sigma F_y = -15\cos(21.801) + 20\sin(16.699) + 25\sin(79.695) + 10\sin(26.565)$

$\therefore \Sigma F_y = 20.889$ N $(\uparrow)$ —1—

$\therefore R = \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2} = \sqrt{(20.255)^2 + (20.889)^2} = \underline{\underline{29.096 \text{ N}}}$ —1—

$\theta = \tan^{-1}\left(\frac{\Sigma F_y}{\Sigma F_x}\right) = \tan^{-1}\left(\frac{20.889}{20.255}\right) = \underline{\underline{45.883°}}$ —1—

$\boxed{R = 29.096 \text{ N} \quad (\angle 45.883)}$