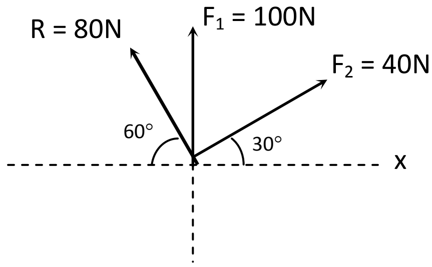
Model Paper Solution

Q1) Solve all questions. Each question is of five marks.

1. a) Rsultant of 3 forces F_1, F_2 and F_3 is 80 N as shown in the figure. of these. Find the magnitude and direction of F_3.



Since the direction and magnitude of F_3 is not known let us assume that the x-component of F_3 is rightward, i.e., F_{3X} ($\rightarrow$) and y – component of F_3 is upward, i.e. F_{3Y} ($\uparrow$)

The x – component of the resultant is given by

$$R_X = \sum F_X$$

$\therefore$ $-80 \cos 60° = 40 \cos30° + F_{3X}$

$\therefore$ $F_{3X} = -74.64$ N

$\therefore$ $F_{3X} = 74.64$ N ($\leftarrow$) negative sign indicates leftward direction

The y – component of the resultant is given by

$$R_Y = \sum F_Y$$

$\therefore$ $80 \sin 60° = 40 \sin30° + 100 + F_{3Y}$

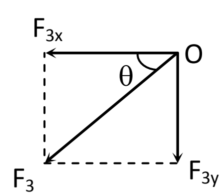
$\therefore$ $F_{3Y} = -50.72$ N

$\therefore$ $F_{3Y} = 50.72$ N ($\downarrow$) negative sign indicates downward direction

F_3 is the resultant of F_{3X} and F_{3Y}.

$$F_3 = \sqrt{F_{3X}^2 + F_{3Y}^2}$$

$= 90.24$ N,



The direction of the F_3 is given by

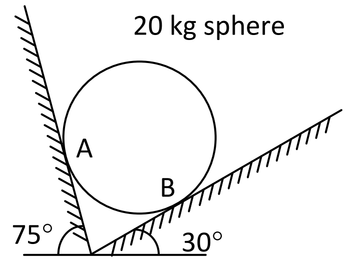
$\theta = \tan^{-1} (F_{3Y} / F_{3X})$

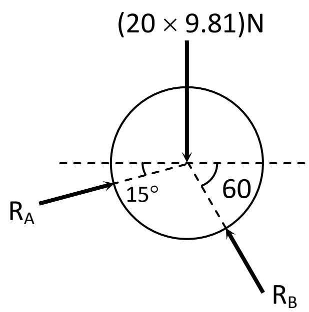
$= \tan^{-1}(50.72 / 74.64)$

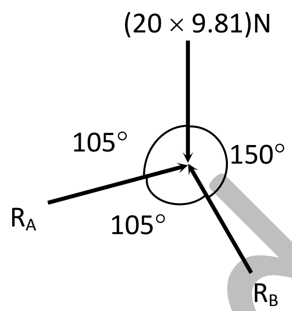
$= 34.2°$ (In 3rd quadrant)

Point of application of F_3 is point O.

b) A sphere of mass 20 kg is resting against two inclined planes with inclinations of 75° and 30° respectively. Calculate the reactions at A and B.







FBD of sphere

By Lami's theorem,

$$\frac{20 \times 9.81}{\sin 105°} = \frac{R_A}{\sin 150°} = \frac{R_B}{\sin 105°}$$

$\therefore \quad R_A = 101.6$ N, $R_B = 196.2$ N

c) A particle moving in the +ve x direction has an acceleration. $a = 100 - 4v^2$ m/s^2. Determine the time interval and displacement of a particle when speed changes from 1 m/s to 3 m/s.

Given : $a = 100 - 4v^2$

$$\therefore \quad \frac{dv}{dt} = 100 - 4v^2$$

$$\therefore \quad t = \int_1^3 \frac{dv}{100 - 4v^2}$$

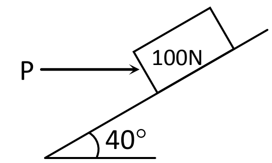
$$t = 0.025 \text{ sec}$$

$$v\frac{dv}{ds} = 100 - 4v^2$$

$$\therefore \quad S = \int_1^3 \frac{v\,dv}{100 - 4v^2}$$

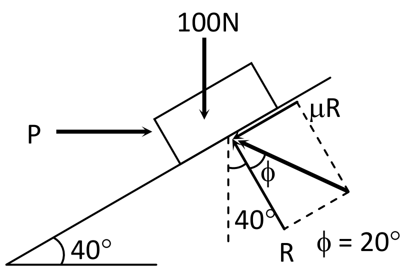
$$S = 0.051 \text{ m}$$

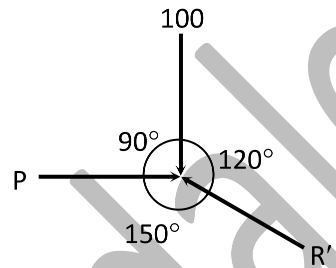
d) Find the horizontal force P required to push the 100 N block up the slope. Take the angle of friction between the slope and block as $\phi = 20^\circ$.



$\phi = 20^\circ$

using Lami's theorem.



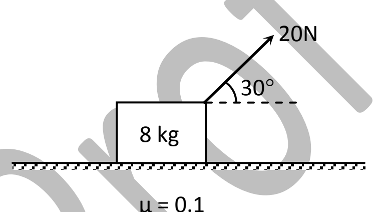


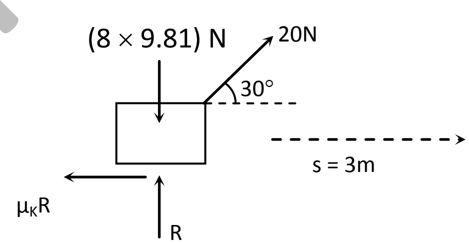
$$\frac{100}{\sin 150} = \frac{P}{\sin 120} = \frac{R'}{\sin 90}$$

Hence $P = 173.2$ N and $R' = 200$ N

Note : This problem may also be solved by writing equations $\Sigma F_X = 0$ and $\Sigma F_Y = 0$, and taking $\mu = \tan\phi = \tan 20^\circ = 0.364$

e) A block of mass 8 kg is lying at rest on a flat horizontal surface. A 20 N force pulls the block at a 30° angle as shown. Taking, $\mu_k = 0.1$, find the velocity of the block after it slides through a distance of 3m.





$\sum F_y = 0$

$\therefore R - 8(9.81) + 20\sin 30^\circ = 0$

$\therefore R = 68.48$ N

Consider the work done by various forces acting on the block.

(i) Work done by 20 N force

$W_1 = (F\cos 30^\circ)(s)$

= (20cos30°) (3) = 51.96 Nm

(ii) Work done by friction

W_2 = $-(\mu_k R)(s)$

= $-(0.1 \times 68.48)(3)$

= $-$ 20.54Nm

(iii)Works done by 'Weight' and Normal reaction 'R' are zero, since these forces act in a direction perpendicular to displacement.

$\therefore$ Σ WD = 51.96 – 20.54 = 31.42

By work energy principle

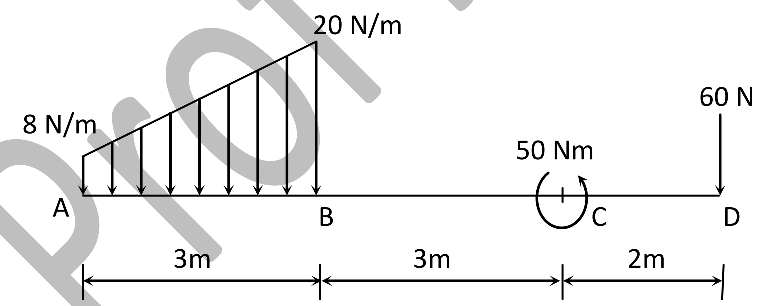
Σ work done = Change in KE

$$31.42 = \frac{1}{2}(8)\left(v_2^2 - v_1^2\right)$$

But $v_1 = 0$ $\therefore$ $v_2 = 2.8$ m/s

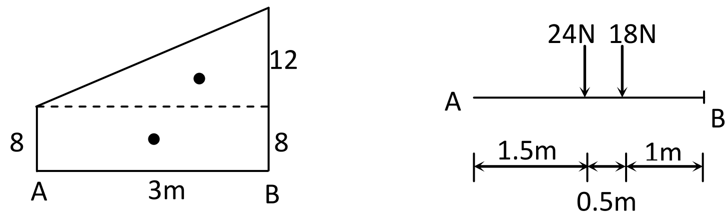
Note:- Question can be solved by D'Alemberts principle.

Q2.a) Find the resultant force and its point of application. **(06)**

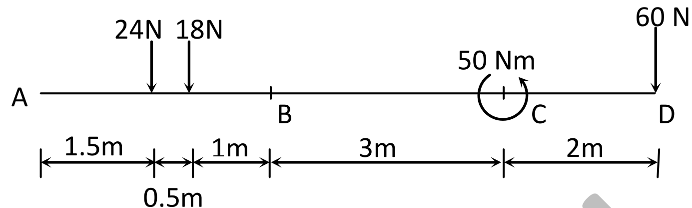


Convert the given distributed load into point loads as follows.
The trapezoidal load can be divided into :
A uniformly distributed load with intensity of 8 N/m
A triangular load with intensity of 12 N/m at right end.

Magnitude of the point load is equal to the area under the distributed load.
Point of application is through the centroid of the area.



Conversion of trapezoidal load into point loads



Simplified figure

Magnitude of resultant is given by

$$R = -24 - 18 - 60 = -102 \text{ N}$$

$\therefore$ $R = 102 \text{ N} (\downarrow)$ negative sign indicates downward direction

To find the point of application of the resultant we use Varignon's theorem, i.e. Moment of resultant about a point = sum of moments of all forces and couples about that point.

Select any convenient point.

Find the summation of moments of all forces and couples about that point.
Position of resultant must now be such that its moment about that point must be having same magnitude and sense.

Consider point A, (anticlockwise moments assumed positive)

$$\sum M_A = -24(1.5) - 18(2) - 60(8) + 50$$
$$= -502 \text{ Nm}$$
$$= 502 \text{ Nm } (\circlearrowright)$$

The resultant force R is downward.

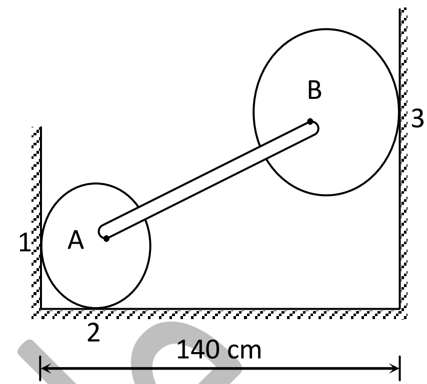
Moment of R about A has to be same as that of $\sum M_A$ i.e. clockwise.

Hence R has to be to the right of A. Let the distance of the point of application of R be 'd' to the right of A.

$$R(d) = \sum M_A$$
$$d = 502 / 102$$
$$= 4.92 \text{ m (to the right of A)}$$

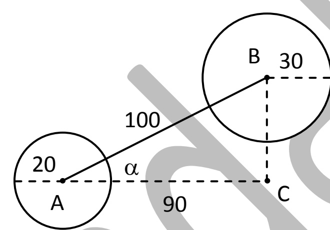
Hence, the resultant has a magnitude of R = 102 N. Direction is downward. Point of application of this force is 4.92 m to the right of A.

2b) Two cylinders A & B have weights 400N and 800N and have radii 20 cm and 30 cm respectively. Weightless Rod AB has length 100cm. Calculate the reactions at points 1, 2, and 3. **(08)**

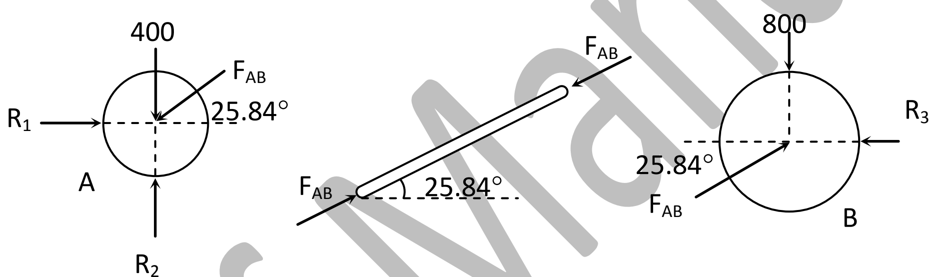


AC = 140 – 20 –30 = 90 cm

$\alpha \quad = \cos^{-1}\left(\frac{90}{100}\right) = 25.84°$



Rod AB is a 2 force member subjected to equal and opposite forces F_{AB}.



Consider cylinder B :

Using Lami's theorem :

$$\frac{800}{\sin 154.16°} = \frac{F_{AB}}{\sin 90°} = \frac{R_3}{\sin 115.84°}$$

$\therefore \quad F_{AB} = 1835.4$ N

$R_3 = 1651.9$ N ($\leftarrow$)

Consider cylinder A :

$\sum F_X = 0, \quad R_1 - F_{AB} \cos 25.84° = 0$

$\therefore \quad R_1 = 1651.9$ N ($\rightarrow$)

$\sum F_Y = 0, \quad R_2 - 400 - F_{AB} \sin 25.84° = 0$

$\therefore \quad R_2 = 1200\text{ N } (\uparrow)$

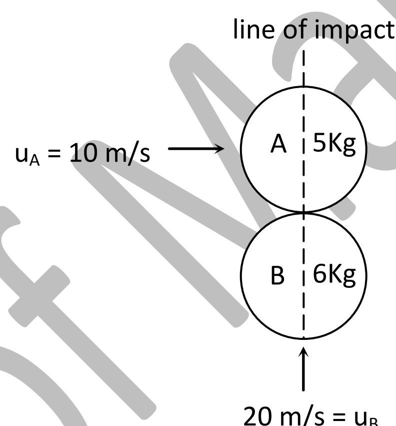
$\therefore \quad R_C = \sqrt{H_C^2 + V_C^2} = 1154.7\text{ N}$

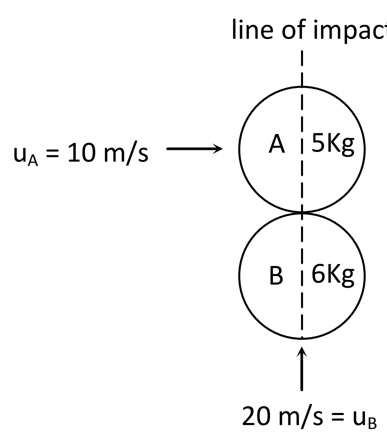
$\theta_C = \tan^{-1}\left(\frac{V_C}{H_C}\right) = 60^\circ$ (↘)

Hence, $R_A = F_{AB} = 1154.7\text{ N}$

$\theta_A = 60^\circ$ (↗)

2c) A smooth spherical ball A of mass 5 Kg is moving in a horizontal plane from left to right with a velocity of 10 m/s. Another ball B of mass 6 Kg traveling in a perpendicular direction with a velocity of 20 m/s collides with A in such a way that the line of impact is in the direction of motion of ball B. Assuming e = 0.7, determine the velocities of balls A and B after impact. **(06)**





Along line of impact, momentum is conserved

$\therefore \quad 5(0) + 6(20) = 5(V_{Ay}) + 6(V_{By})$

$\therefore \quad 120 = 5(V_{Ay}) + 6(V_{By}) \quad \ldots \text{(i)}$

$$e = \frac{V_{Ay} - V_{By}}{u_{By} - u_{Ay}}$$

$$\therefore \quad 0.7 = \frac{V_{Ay} - V_{By}}{20 - 0}$$

$\therefore \quad 14 = V_{Ay} - V_{By} \quad \ldots$ (ii)

From (i) and (ii),

$$V_{Ay} = 18.54 \text{ m/s}$$

$$V_{By} = 4.54$$

Velocity components, perpendicular to line of impact will not change.

$$V_A = \sqrt{10^2 + 18.54^2}$$

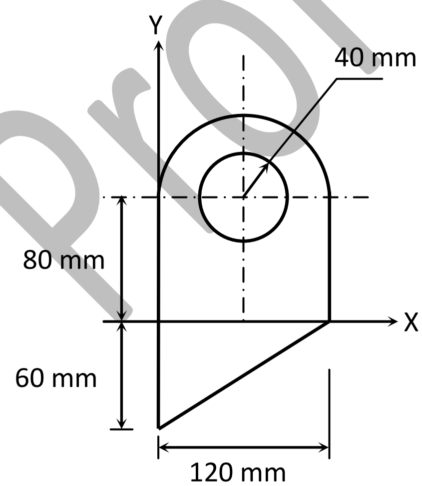
$$= 21.06 \text{ m/s}$$

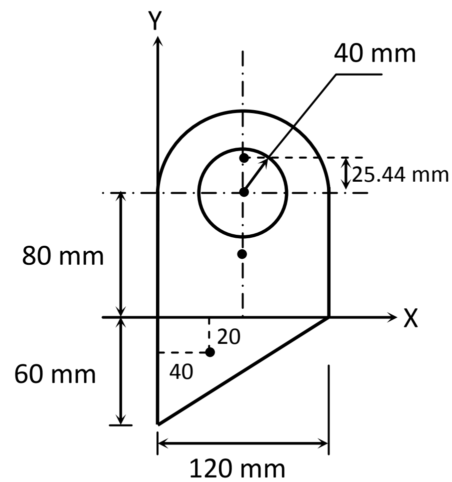
$$\theta_A = \tan^{-1}\left(\frac{18.54}{10}\right)$$

$$= 61.66° (\measuredangle)$$

$$V_B = 4.54 \text{ m/s}(\uparrow)$$

Q3a) For the composite area shown in the figure, locate the centroid with reference to the coordinate axes shown in the figure. **(08)**





For rectangle:

A_1 = 80×120 = $9600\ mm^2$

x_1 = $120 / 2$ = 60 mm

y_1 = $80 / 2$ = 40 mm

For triangle:

A_2 = $1/2 \times 60 \times 120$ = $3600\ mm^2$

x_2 = $120 / 3$ = 40 mm

y_2 = $-60 / 3$ = -20 mm

For semicircle:

A_3 = $\pi(60)^2 / 2$ = $5654.87\ mm^2$

x_3 = 60 mm

For circle:

A_4 = $-\pi(40)^2$ = $-5026.55\ mm^2$

[Since it is a removed circular hole, the area is taken as negative]

x_4 = 60 mm

y_4 = 80 mm

A summary of these calculations are given in the table below.

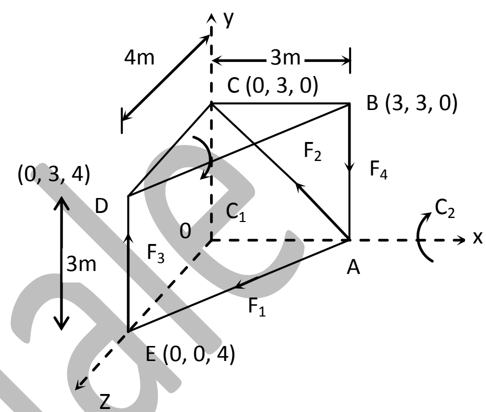
Part	A_i	x_i	y_i	$A_i x_i$	$A_i y_i$
Rectangle	9600	60	40	576000	384000
Triangle	3600	40	–20	144000	–72000
Semicircle	5654.87	60	105.44	339292.2	596249.49
Circle	–5026.55	60	80	–301593	–402124
	$\sum A_i$ =13828.32			**$\sum A_i x_i$ =757699.2**	**$\sum A_i y_i$ = 506125.5**

$$\bar{x} = \frac{\sum A_i x_i}{\sum A_i} = 54.79 \text{ mm}$$

$$\bar{y} = \frac{\sum A_i y_i}{\sum A_i} = 36.6 \text{ mm}$$

Hence the coordinates of centroid are (54.79, 36.6) in mm.

3b) Determine the resultant force and the resultant couple of the force system shown below, when F_1 = 100 N, F_2 = 20 $\sqrt{2}$ N, F_3 = 40 N, F_4 = 40 N, C_1 = 250 Nm & C_2 = 100 Nm. **(06)**



$$\bar{C}_1 = 250 \times \lambda_{DB}$$

$$= 250 \times \frac{3\hat{i} - 4\hat{k}}{\sqrt{3^2 + 4^2}}$$

$$= 150\,\hat{i} - 200\,\hat{k} \text{ Nm}$$

$$\bar{C}_2 = -100\,\hat{i} \text{ Nm}$$

$$\bar{F}_1 = 100 \times \lambda_{AE}$$

$$= 100 \times \frac{-3\hat{i} + 4k}{\sqrt{3^2 + 4^2}}$$

$$= -60\,\hat{i} + 80\,\hat{k} \text{ N}$$

$$\bar{F}_2 = 20\sqrt{2} \times \lambda_{AC}$$

$$= 20\sqrt{2} \times \frac{-3\,\hat{i} + 3\hat{j}}{\sqrt{3^2 + 3^2}}$$

$$= -20\,\hat{i} + 20\,\hat{j} \text{ N}$$

$$\bar{F}_3 = 40\,\hat{j} \text{ N}$$

and $\bar{F}_4 = -40\,\hat{j}$ N

$$\bar{R} = (-60 - 20)\,\hat{i} + (20 + 40 - 40)\,\hat{j} + (80)\,\hat{k}$$

$$\bar{R} = -80\,\hat{i} + 20\,\hat{j} + 80\,\hat{k} \text{ N}$$

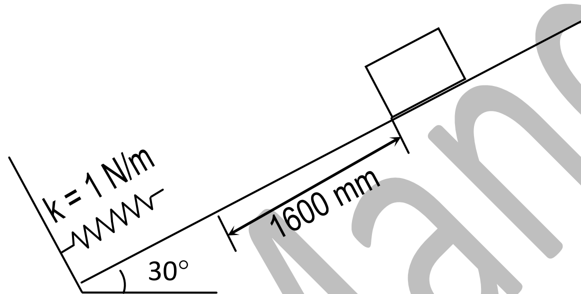
and $\Sigma\overline{M_0} = \overline{OA}\times\overline{F_1}+\overline{OA}\times\overline{F_2}+\overline{OA}\times\overline{F_4}+\overline{OB}\times\overline{F_3}+\overline{C_1}+\overline{C_2}$

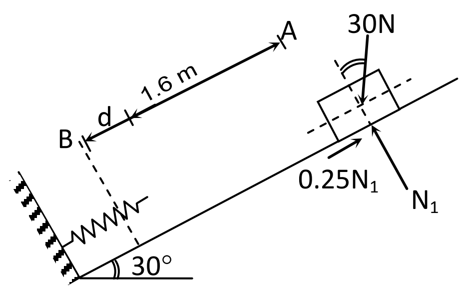
$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 0 & 0 \\ -60 & 0 & 80 \end{vmatrix} + \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 0 & 0 \\ -20 & 20 & 0 \end{vmatrix} + (120\,\hat{k}) + (-160\,\hat{i}) + \overline{C_1} + \overline{C_2}$$

$$= -\hat{j}\,(240) + \hat{k}(60) - 120\,\hat{k} - 160\,\hat{i} + 150\,\hat{i} - 200\,\hat{k} - 100\,\hat{i}$$

$$\Sigma\overline{M}_0 = -110\,\hat{i} - 240\,\hat{j} - 260\,\hat{k}\ \text{Nm}$$

3c) A 30N block is released from rest. It slides down a rough incline having coefficient of friction 0.25. Determine the maximum compression of the spring. **(06)**





From FBD $\Sigma F_y = 0$ (↖ +ve)

$N_1 - 30\cos 30 = 0$

$N_1 = 25.98$ N

For maximum compression the block will stop (v =0) and let the compression be 'd' m

Data : From (A) to (B)

$$m = \frac{30}{g}\ \text{kg},\ u = 0,\ V = 0$$

For the spring : k = 1 N/m, $x_1 = 0$ and $x_2 = d$

By work Energy principle between (A) to (B)

Σ wD = ΔkE

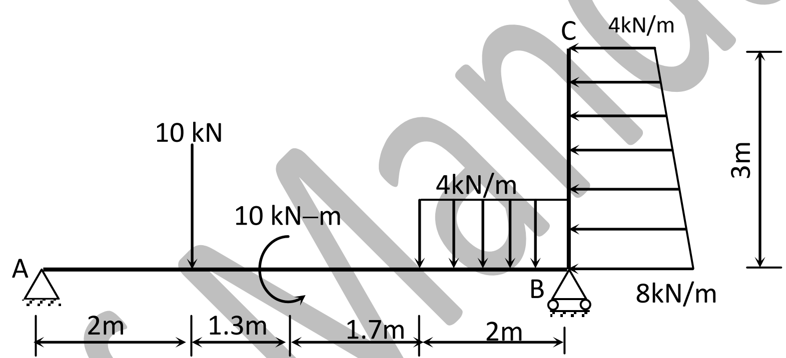
$\therefore \quad [wD]_F + [wD]_{\mu N} + [wD]_{mg} + [wD]_{spring} = \frac{1}{2}\ m(v^2 - u^2)$

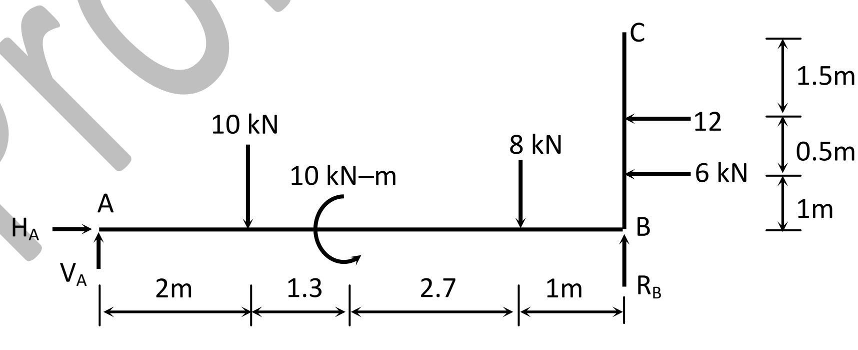
$\therefore \quad [30 \sin 30 \times (1.6 + d)]_{mg} + [-0.25\ N_1 \times (1.6 + d)]_{\mu N}$

$+ \left[\frac{1}{2} \times k(x_1^2 - x_2^2)\right]_{spring} = \frac{1}{2}\left(\frac{30}{g}\right)(O^2 - O^2)$

d = 18.48 m

4.a) Find the reactions at A and B for a bent beam ABC loaded as shown in figure. **(08)**





We first convert all the distributed loads into point loads as shown in figure.

$\Sigma M_A = 0, \quad -10(2) + 10 - 8(6) + 6(1) + 12(1.5) + R_B(7) = 0$

$\therefore \quad R_B = 4.857\ N\ (\uparrow)$

$\Sigma F_X = 0, \quad H_A - 12 - 6 = 0$

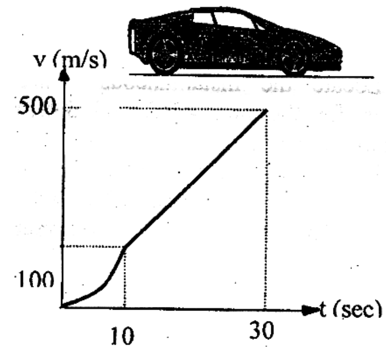
$\therefore \quad H_A = 18\ N\ (\rightarrow)$

$\sum F_Y = 0,$ $\quad V_A - 10 - 8 + 4.857 = 0$

$\therefore \quad V_A = 13.142$ N (↑)

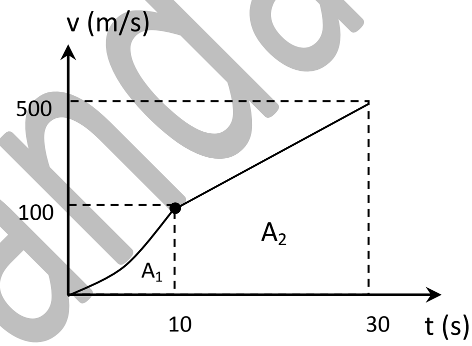
4b) A car moves along a straight road such that its velocity is described by the graph shown in figure.For the first 10 seconds the velocity variation is parabolic and between 10 seconds to 30 seconds the variation is linear. Construct the s-t and a-t graphs for the time period $0 \le t \le 30$s.

(06)



$A_1 = \frac{1}{3}(10 \times 100)$

$= 333.33$



$A_2 = \left(\frac{100+500}{2}\right)(20)$

$= 6000$

$S_0 = 0$ (given)

$S_{10} = S_0 + 333.33 = 333.33$ m

$S_{30} = S_{10} + 6000 = 6333.33$ m

Assume equation of parabola as $v = kt^2$

at t = 10 s, v = 100 m/s

$\therefore \quad 100 = k(10)^2$

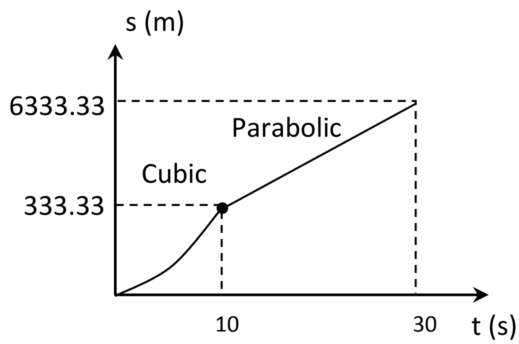
$\therefore \quad k = 1$

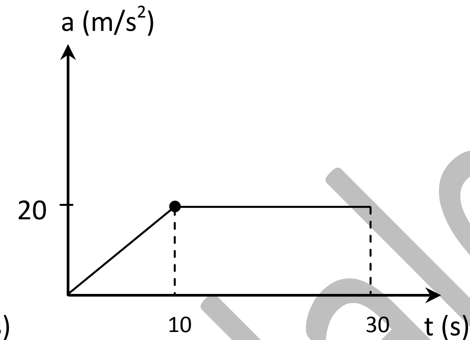
$\therefore$ Equation of parabolic curve is $v = t^2$

$\therefore \quad a = \frac{dv}{dt} = 2t, \ 0 \le t \le 10$ s

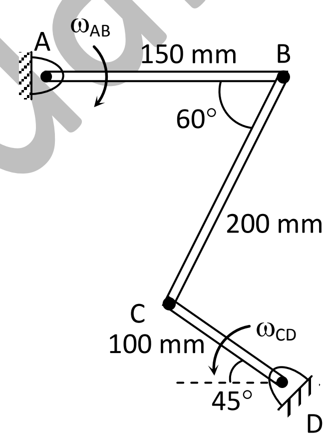
For $10 \le t \le 30$, $a = \frac{500-100}{30-10}$

$= 20\ m/s^2$





4c) If link CD is rotating at W_{CD} = 5 rad/sec, anticlockwise determine the angular velocity of link AB at the instant shown. **(06)**



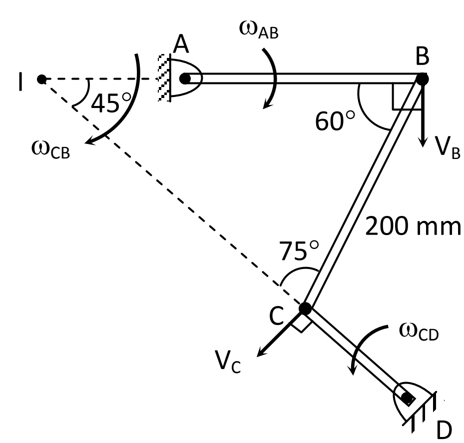
The rods DC and AB are performing fixed axis rotation around the points D and A respectively.

Hence we have,

$V_C = DC \times \omega_{DC}$

$= 100 \times 5$

$= 500$ mm/s



The rod BC is performing general plane motion and its ICR is located by drawing perpendiculars to the directions of V_C and V_B as shown in the figure.

In triangle BCI, using sine rule, we have

$$\frac{200}{\sin 45^o} = \frac{IB}{\sin 75^o} = \frac{IC}{\sin 60^o}$$

$\therefore$ IB = 273.2 mm

and IC = 244.9 mm

We see from the figure that the angular velocity of rod CB, ω_{CB} is in the clockwise direction.

$V_C = IC \times \omega_{CB}$

$\therefore$ $500 = (244.9) \times \omega_{CB}$

$\therefore$ $\omega_{CB} = 2.04$ rad/s (clockwise)

$V_B = IB \times \omega_{CB}$

$= 273.2 \times 2.04$

$= 557.7$ mm/s (↓)

$V_B = AB \times \omega_{AB}$

$557.7 = 150 \times \omega_{AB}$

$\therefore$ $\omega_{AB} = 3.71$ rad/s (clockwise)

Q5a)A particle moves in x – y plane and its position is given by r = (3t) i + (4t – 3t^2) j where r is the position vector of the particle measured in meters at time ‘t’ seconds. Find the radius of curvature of its path and normal and tangential components of acceleration when it crosses x–axis again. **(06)**

$r = (3t)\,i + (4t - 3t^2)\,j$

when the particle crosses the x–axis,

$y = 0$

$\therefore$ $4t - 3t^2 = 0$

$\therefore$ $t(4 - 3t) = 0$

$\therefore$ $t = 0, 4/3$ sec.

$v = \frac{d}{dt}(r) = (3)i + (4 - 6t)j$

$a = \frac{d}{dt}(\mathbf{v}) = (0)i + (-6)j$

∴ at t = 4/3 sec

$v = 3i - 4j$ … (1)

$a = 0i - 6j$ … (2)

∴ $v_x = 3$ m/s, $v_y = -4$ m/s

$a_x = 0$, $a_y = -6$ m/s^2

∴ $$\rho = \frac{\left(v_x^2 + v_y^2\right)^{3/2}}{\left|v_x a_y - v_y a_x\right|} = 6.94 \text{ m}$$

From (1), $v = \sqrt{3^2 + 4^2} = 5$ m/s

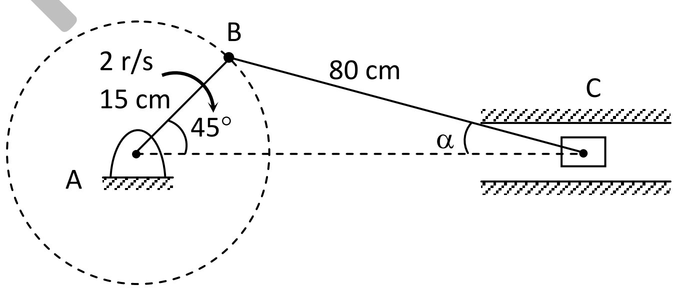
From (2), $a = \sqrt{0^2 + 6^2} = 6$ m/s^2

Normal acceleration, $$a_n = \frac{v^2}{\rho} = \frac{5^2}{6.94} = 3.6 \text{m}/\text{s}^2$$

Tangential acceleration, $$a_t = \sqrt{a^2 - a_n^2} = \sqrt{6^2 - 3.6^2} = 4.8 \text{m}/\text{s}^2$$

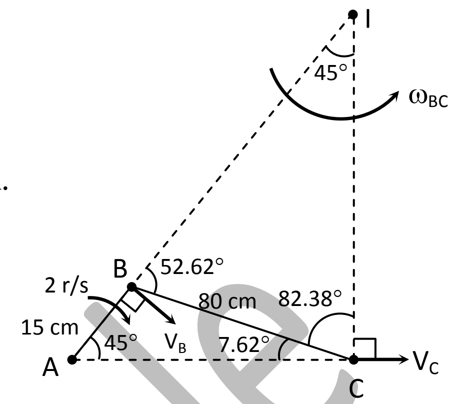
Q5b) In the slider crack mechanism shown in the figure, the crank AB of length 15 cm rotates clockwise at an angular velocity of 2 rad/sec. The connecting rod BC is 80 cm in length and the slider at C is constrained to move along a horizontal line. At the instant shown, find the angular velocity of rod BC and the velocity of the slider at C.

(06)



Given : ω_{AB} = 2 r/s (clockwise)

To find : ω_{BC} and V_C



For the mechanism shown in the figure,

The rod AB performs fixed axis rotation about point A.

$\therefore \quad V_B = AB \times \omega_{AB}$

$= 15 \times 2$

$= 30$ cm/s

The rod BC performs general plane motion. Hence we can locate its ICR. Drawing perpendiculars to the velocity directions of points B and C we locate its ICR at point I. The ICR is I and its angular velocity ω_{BC} is anticlockwise as shown in figure.

In triangle ABC using sine rule

$$\frac{80}{\sin 45^o} = \frac{15}{\sin\alpha}$$

$\therefore \quad \alpha = 7.62°$

In triangle IBC using sine rule

$$\frac{IB}{\sin 82.38^o} = \frac{IC}{\sin 52.62^o} = \frac{80}{\sin 45^o}$$

$\therefore \quad IB = 112.1$cm

and $\quad IC = 89.9$ cm

$V_B = IB \times \omega_{BC}$

$\therefore \quad 30 = 112.1 \times \omega_{BC}$

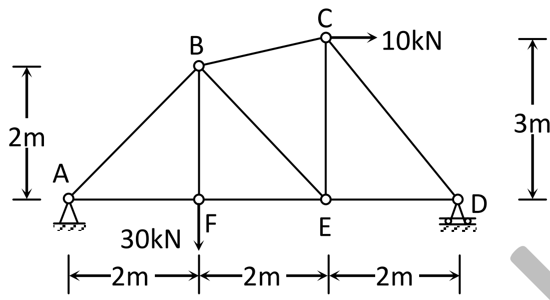
$\therefore \quad \omega_{BC} = 0.2676$ rad /s (anticlockwise)

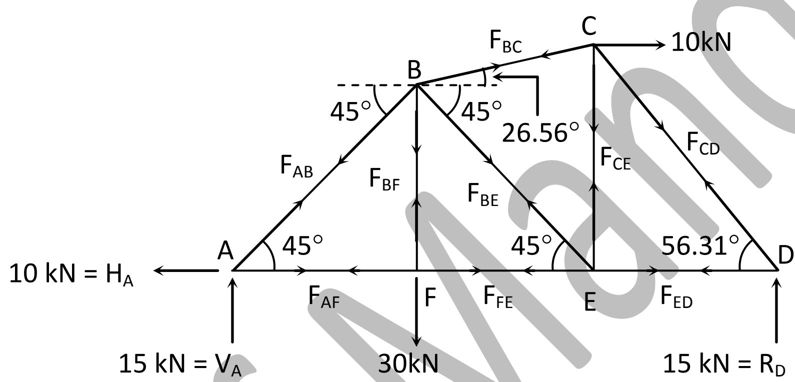
$V_C = IC \times \omega_{BC}$

$\therefore \quad V_C = 89.9 \times 0.2676$

∴ V_C = 24.06 m/s (→)

Q5c) A simply supported pin jointed truss is loaded and supported as shown in the following figure. Identify the members carrying zero force and find forces in members by method of joints. **(08)**





To find support reactions :

$\Sigma M_A = 0, -30(2) - 10(3) + R_D(6) = 0$

∴ $R_D = 15$ kN (↑)

$\Sigma F_x = 0, -H_A + 10 = 0$

∴ $H_A = 10$ kN (←)

$\Sigma F_y = 0, V_A - 30 + R_D = 0$

∴ $V_A = 15$ kN (↑)

Method of joints :

Joint A:

$\Sigma F_y = 0, 15 + F_{AB} \sin 45° = 0$

$\therefore \quad F_{AB} = -21.21$ kN

$\Sigma F_x = 0, -10 + F_{AF} + F_{AB} \cos 45° = 0$

$\therefore \quad F_{AF} = 25$ kN

Joint F :

$\Sigma F_y = 0, F_{BF} - 30 = 0$

$\therefore \quad F_{BF} = 30$ kN

$\Sigma F_x = 0, -F_{AF} + F_{FE} = 0$

$\therefore \quad F_{FE} = 25$ kN

Joint D :

$\Sigma F_y = 0, 15 + F_{CD} \sin 56.31° = 0$

$\therefore \quad F_{CD} = -18.03$ kN

$\Sigma F_x = 0, -F_{ED} - F_{CD} \cos 56.31° = 0$

$\therefore \quad F_{ED} = 10$ kN

Joint E :

$\Sigma F_x = 0, -F_{FE} - F_{BE} \cos 45° + F_{ED} = 0$

$\therefore \quad F_{BE} = -21.21$ kN

$\Sigma F_y = 0, F_{CE} = F_{BE} \sin 45° = 0$

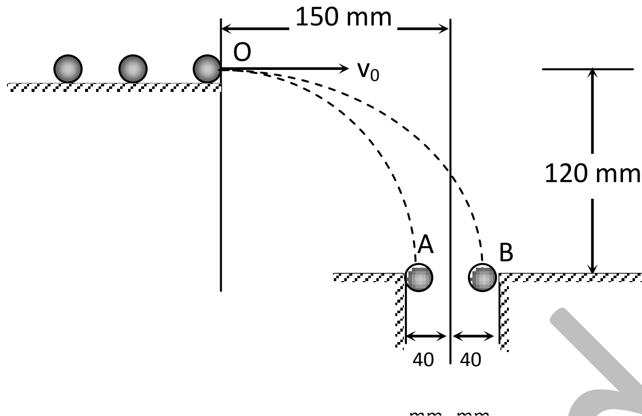
$\therefore \quad F_{CE} = 15$ kN

Joint C :

$\Sigma F_x = 0, -F_{BC} \cos 26.56° + 10 + F_{CD} \cos 56.31° = 0$

$\therefore \quad F_{BC} = 0$

Q6a) Balls of 10 mm diameter (of ball bearings) leave the horizontal trough with an initial horizontal velocity v_0 to fall through a gap of 80 mm size as shown in figure. Calculate the permissible range of velocity v_0 that will enable the balls to enter the gap. Take g = 9.81 m/s^2. **(06)**



(A) From the figure, considering O as origin.

$$O \equiv (0, 0)$$

$$A \equiv (115, -125)\text{mm} \equiv (0.115, -0.125)\text{m}$$

$$B \equiv (185, -125)\text{mm} \equiv (0.185, -0.175)\text{m}$$

Angle of projection $\alpha = 0$

Using equation of path,

$$y = x \tan\alpha - \frac{gx^2}{2u^2\cos^2\alpha}$$

For projectile OA :

$$-0.125 = 0.115 \tan 0^\circ - \frac{(9.81)(0.115)^2}{2(v_0)\cos^2 0^\circ}$$

$\therefore$ $v_0 = 0.72$ m/s

For projectile OB :

$$-0.125 = 0.185 \tan 0^\circ - \frac{(9.81)(0.185)^2}{2(v_0)^2\cos^2 0^\circ}$$

$\therefore$ $v_0 = 1.16$ m/s

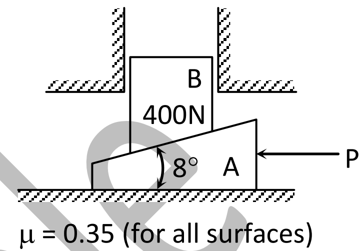
If the initial velocity $v_0 > 1.16$ m/s, the ball will land beyond the gap.

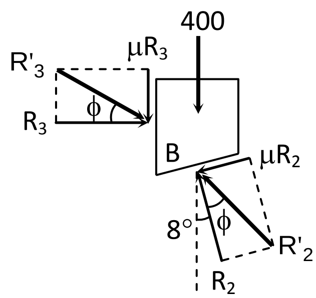
If the initial velocity $v_0 < 0.72$ m/s, the ball will land before the gap.

Hence, to fall through the gap,

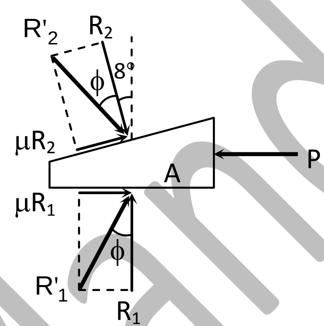
$$0.72 \text{ m/s} < v_0 < 1.16 \text{ m/s}$$

Q6b) An 8° wedge A is used to raise a block B having weight 400 N. A force having magnitude P is applied horizontally on the wedge A. Find the magnitude of force P required to raise the block B if μ between all surfaces is 0.35. Neglect the weight of the wedge. **(08)**



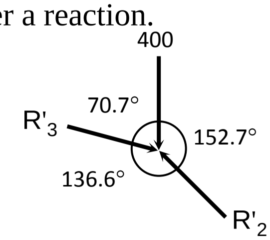


FBD of B



FBD of A

For block B, only the left side wall would offer a reaction.
Angle of friction, $\phi = \tan^{-1}(0.35) = 19.3°$
From FBD of block B, using Lami's theorem,

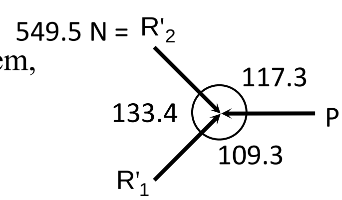


$$\frac{400}{\sin 136.6°} = \frac{R'_2}{\sin 70.7°} = \frac{R'_3}{\sin 152.7°}$$

$\therefore \quad R'_2 = 549.5$ N

$\therefore \quad R'_3 = 267$ N

From FBD of wedge A, using Lami's theorem,



$$\frac{549.5}{\sin 109.3°} = \frac{P}{\sin 133.4°} = \frac{R'_1}{\sin 117.3°}$$

$\therefore \quad P = 423$ N

$R'_1 = 517.4$ N

Q6c) Three blocks A, B, C are connected as shown in figure. Find acceleration of the masses and the tension T_1 & T_2 in the strings. Block A is 5Kg and B is of 10Kg.

(06)

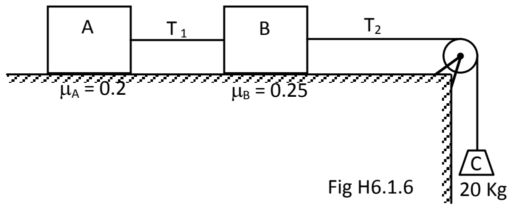


Fig H6.1.6

(Hint A and B are connected by same cable hence $a_A = a_{B.}$ But B and C is also connected by same cable $a_C = a_B$

Hence $a_A = a_{B.} = a_C = a_B = a$ [Ans: $T_1 = 32.22$ N, $T_2 = 103.7$ N, $a = 4.625$ m/s^2]