Module 2 — Equilibrium of System of Coplanar Forces :

(1) **For General force System :**

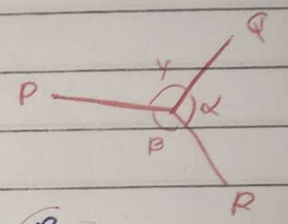
Conditions of Equilibrium

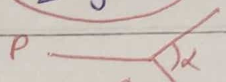
$\Sigma F_x = 0$; $\Sigma F_y = 0$; $\Sigma M = 0$

(2) **For concurrent force system :**

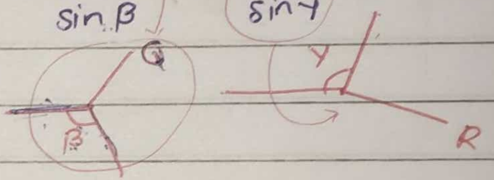
Conditions of Equilibrium

$\Sigma F_x = 0$, $\Sigma F_y = 0$





(3) theorem / law — **lami's theorem :** $\dfrac{P}{\sin\alpha} = \dfrac{Q}{\sin\beta} = \dfrac{R}{\sin\gamma}$



- If three concurrent forces are in equilibrium then their magnitude are proportional to the angle b/w the other two forces.

- [If a body is in equilibrium under the action of three non-collinear coplanar and concurrent forces

- then each force is proportional to the sine of the angle b/w the other two forces.]

definitions :

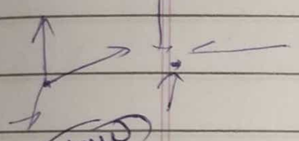
$R_f = 0$

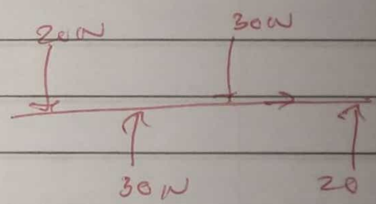
(1) **Equilibrium** : If the Resultant of the force system happen to be zero, the system is said to be in a state of equilibrium.

(2) **Equilibrant** : A Single force which when acting with all other force keeps the body at rest or in equilibrium

(3) **Free Body diagram** : A diagram formed by isolating the body from its surrounding and then showing all the forces acting on it.

(4) **reaction** : Whenever a body is supported, the support offer resistance, known as reaction.





law

law of equilibrium of two force :-

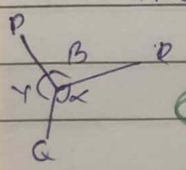
- Two Force can be equilibrium only if they are equal
  - in magnitude
  - opposite in direction
  - collinear in action

Imp

definitation

- It is applicable for only 3 concurrent force.

- If 3 concerrent forces are in equilibrium then the magnitude of each force is proportion to Sine of angle b/w other two forces in system



$$\frac{P}{\sin\alpha} = \frac{Q}{\sin\beta} = \frac{R}{\sin\gamma}$$

* **limitations** :

(1) Angle b/w two adjacent force should not exceed 180°

(2) It is applicable only when three force acting at a point are in equilibrium

(3) The three concurrent forces should either act toward the point of concurrence or away from it.

(4) If this is not the case, then using the principle of transmissibility they can be made in required form

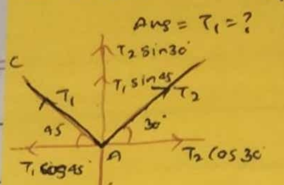
(P42)

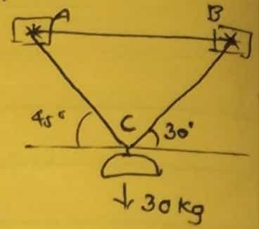
$\boxed{\text{lami's theorem}}$:

and also solved by lamis theorem

A 30 kg iron block is suspended using support A and B, what will be the tension in rope CA

Ans = T_1 = ?





30 kg = 30×9.8 N

$$\boxed{\frac{T_1}{\sqrt{2}} + \frac{T_2}{\sqrt{3}} = 30 \times 9.8}$$

$$\frac{1}{\sqrt{2}} + \frac{T_2}{T_1 \sqrt{3}} = \frac{30 \times 9.8}{T_1}$$

$$\frac{1}{\sqrt{2}} + \frac{1}{\sqrt{6}} = \frac{30 \times 9.8}{T_1}$$

$$0.7071 + \overset{0.408}{\cancel{2.4449}} = \frac{30 \times 9.8}{T_1}$$

$$T_1 \cos 45 = T_2 \cos 30°$$

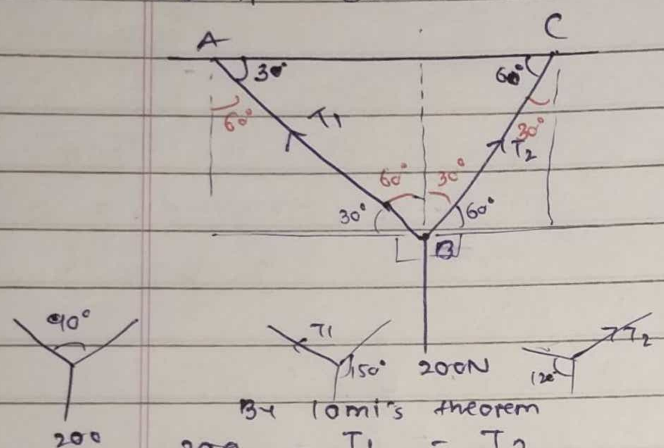
$$\frac{T_2}{T_1} = \frac{2}{\sqrt{3}\sqrt{2}}$$

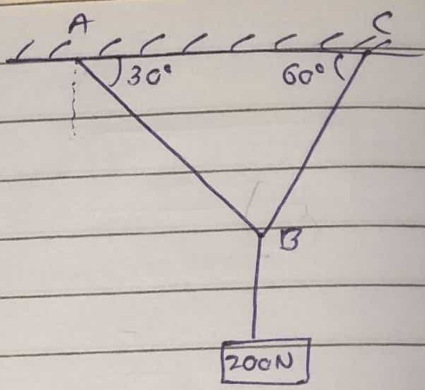
$$T_1 = \frac{30 \times 9.8}{1.115}$$

$$\boxed{T_1 = 263.67}$$

(1) Calculate the tension in the string AB and BC, if the weight of 200 N is attached by the two string as shown in fig

⇒ AB = T_1 BC = T_2





By lami's theorem

$$\frac{200}{\sin 90°} = \frac{T_1}{\sin(90+60°)} = \frac{T_2}{\sin(90+30°)}$$

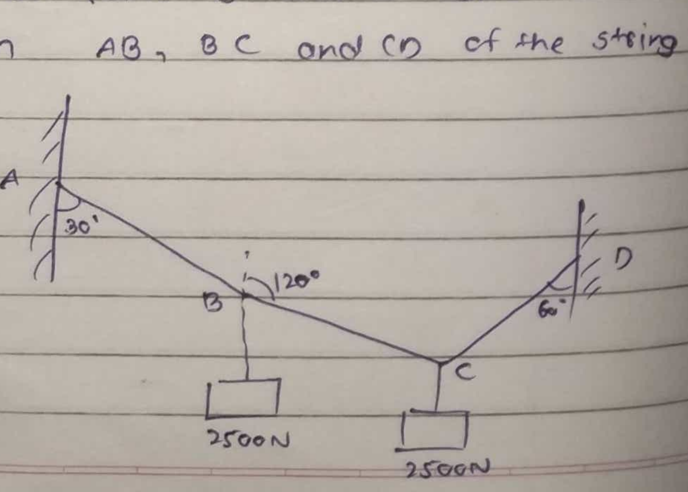
$$200 = \frac{T_1}{\cos 60°} = \frac{T_2}{\cos 30°}$$

$$\frac{T_1}{1/2} = 200 \qquad \frac{T_2}{\sqrt{3}/2} = 200$$

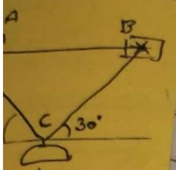
$$T_2 = 100 \times \sqrt{3}$$

$$\boxed{T_1 = 100N} \qquad \boxed{\cancel{T_2 = 57.735 N}} \quad \boxed{T_2 = 173.205 N}$$

(2) Two equal loads of 2500 N are supported by a flexible string ABCD at point B and C and find the tension in the portion AB, BC and CD of the string



suspended
, what will be



$= T_2 \cos 30$

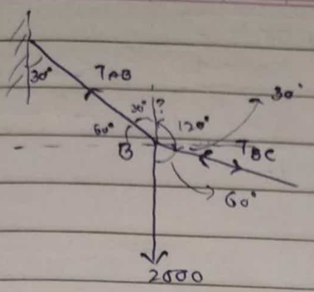
$\frac{2}{\sqrt{3}\sqrt{2}}$

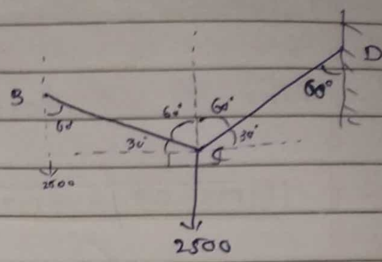
30×9.8

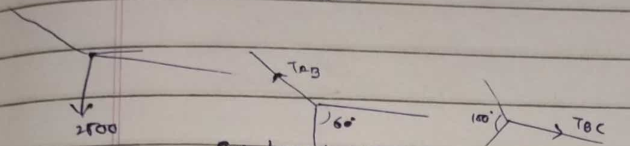
1.15

$\boxed{263.67}$

Date
Page







By lomis theorem

$$\frac{2500}{\sin(150^\circ)} = \frac{T_{AB}}{\sin 60^\circ} = \frac{T_{BC}}{\sin(150^\circ)}$$

$\sin(90+60^\circ)$

$\cos 60$

$$\frac{2500}{\cancel{\sin(150^\circ)}} = \frac{T_{BC}}{\cancel{\sin(150^\circ)}}$$

$$\boxed{T_{BC} = 2500N}$$

$$T_{AB} = \frac{2500}{\frac{1}{2}} \cdot \frac{\sqrt{3}}{2}$$

$$\boxed{T_{AB} = 4330.12N}$$

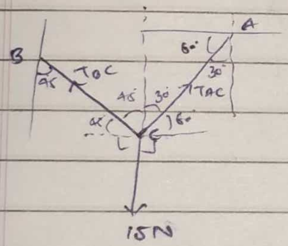
By lomis theorem

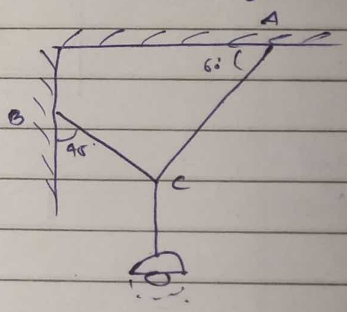
$$\frac{2500}{\sin(120^\circ)} = \frac{T_{BC}}{\sin 120^\circ} = \frac{T_{CD}}{\sin 120^\circ}$$

$$\boxed{T_{BC} = 2500N}$$

$$\boxed{T_{CD} = 2500N}$$

(3) An electric bulb weight 15N hangs from C by two string AC and BC. The string AC is inclined at 60° degree to the horizontal and BC at 45° to the vertical as shown in fig. using lomis theorem determine the force in the string AC and BC





By using lomi's theorem

$$\frac{15}{\sin(75^\circ)} = \frac{T_{BC}}{\sin(90+60^\circ)} = \frac{T_{AC}}{\sin(90+45^\circ)}$$

$$\frac{15}{0.9659} = \frac{T_{BC}}{1/2} = \frac{T_{AC}}{\frac{1}{\sqrt{2}}}$$

$$T_{BC} = \frac{1}{2} \times \frac{15}{0.9659}$$

$$\boxed{T_{BC} = 7.764N}$$

$$T_{AC} = \frac{1}{\sqrt{2}} \times \frac{15}{0.9659}$$

$$= \frac{10.6}{0.9659}$$

$$\boxed{T_{AC} = 11.77N}$$

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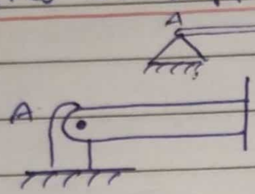
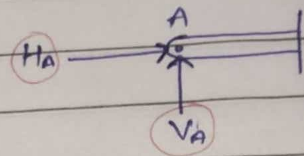
Reaction of different support, Types of load, type of beams :

Type of support and reaction

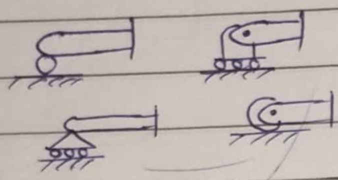
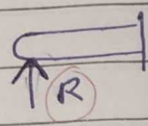
Types of support | **Reaction and FBD**

(1) Hinge support

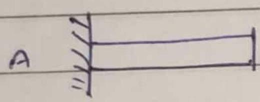


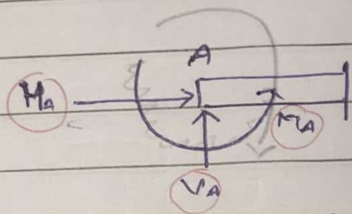


(2) Roller support

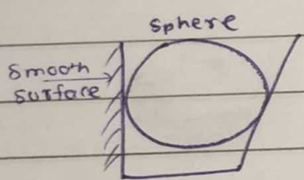



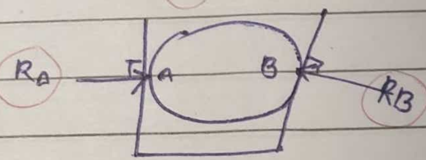
(3) Fixed support



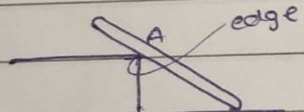


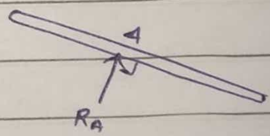
(4) Smooth support



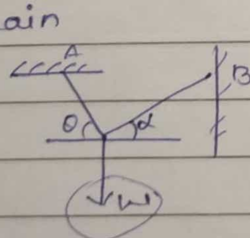


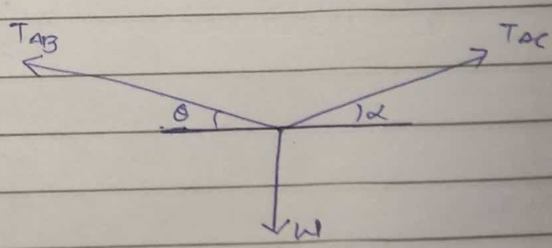
(5) Edge support





(6) Rope / String / cable / chain support

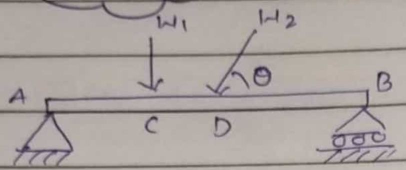




Imp content for numerical

Types of beams:

(1) Simply supported beam :- A beam that has hinged connected at one end and roller connected in other end.



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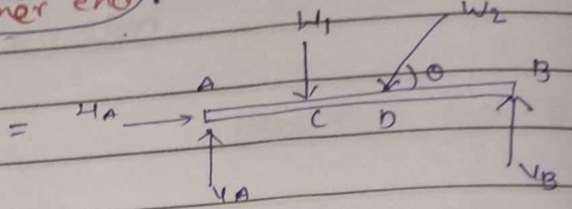
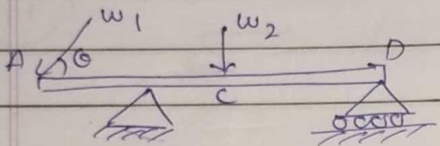
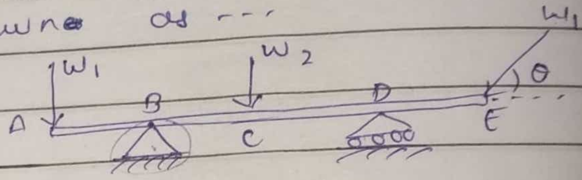
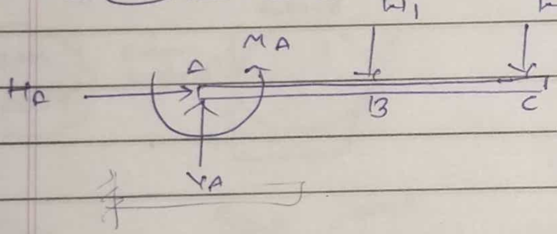


(2) Over hanging beam :- A beam which beyond the support is known as ---





(3) Cantilever beam : A beam fixed at one end and free at other end is called ---



At fixed support

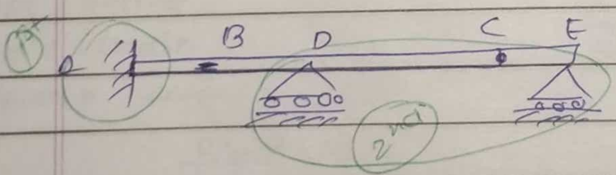
there are three reaction

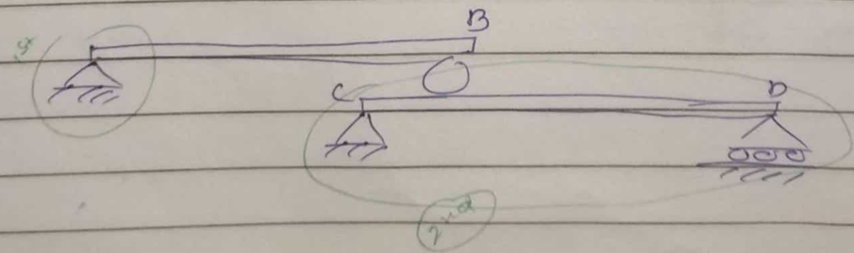
(a) horizontal reaction

(b) vertical reaction

(c) moment.

(4) Compound beam : when two or more beams are joined together by internal hinge and internal roller, the combination is called

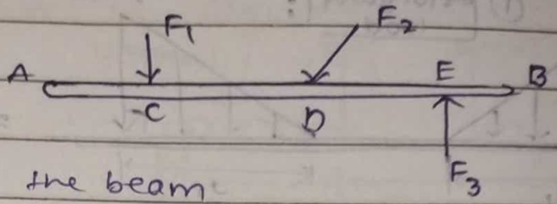




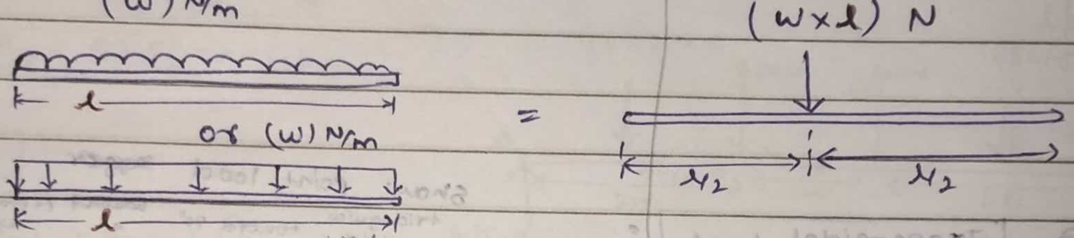
Type of load on the beam :

(1) Point load or Concentrated load

↳ load acting at a single point on the beam

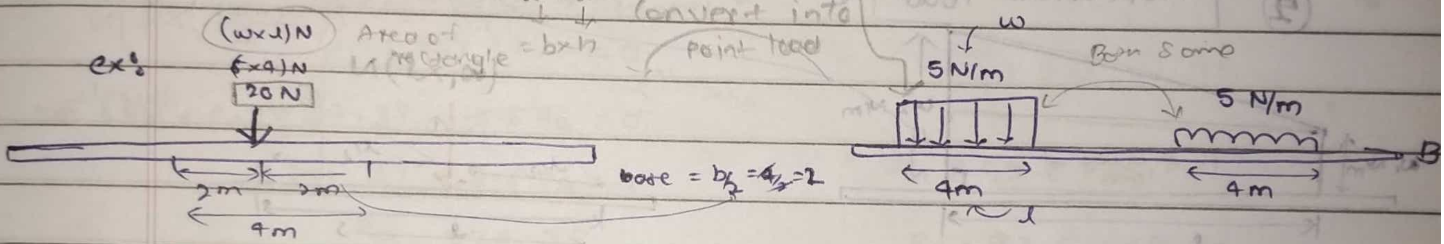


(2) Uniformly distributed (UDL) load or Rectangular (UDL) load :



w × l ↓ convert into point load

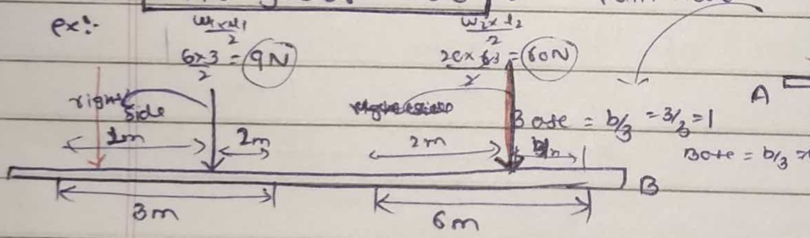
ex:

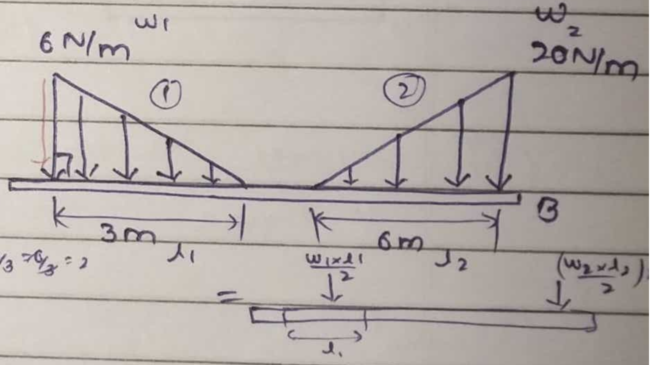


(3) Uniformly varying (UVL) load : [show right side]

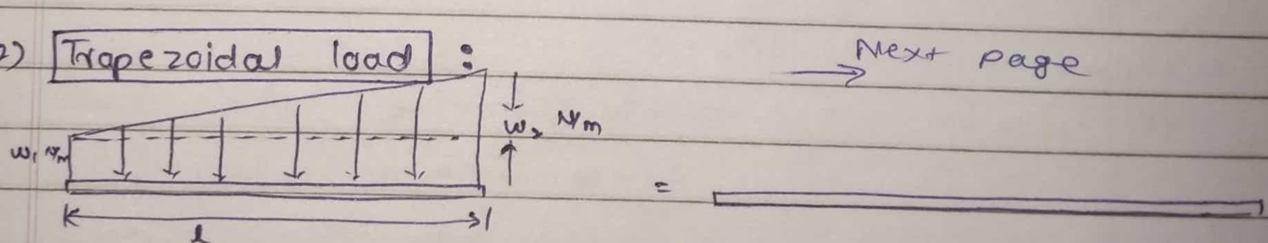
(1) triangular load :

ex:-





(2) Trapezoidal load :



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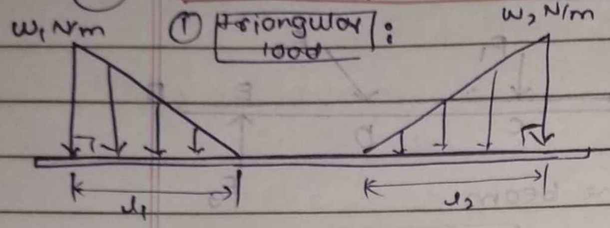
Base [Shown in Point side] 1st ne right me / pass me

(5) [uniformly varying load] :-

(1) [triangular load] :



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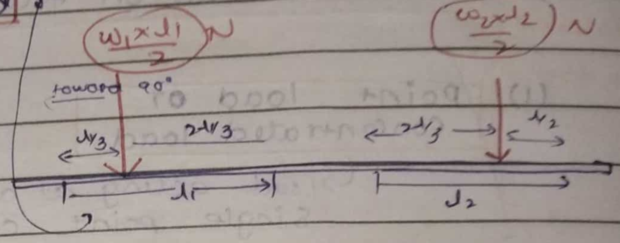
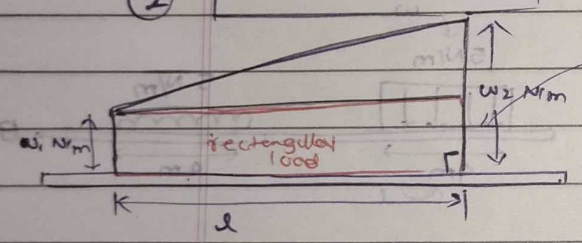
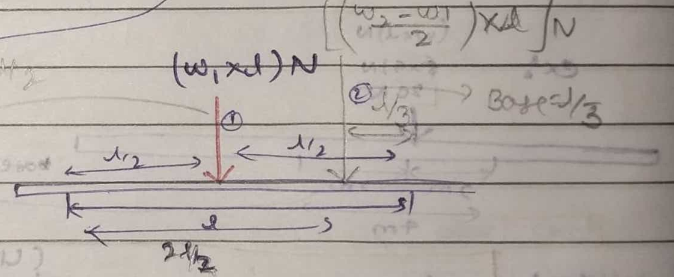


Show point load bigger
triangular wala toward 90°
rectangular wala middle me

(2) [Trapezoidal load] :

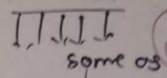




used to solve question by equilibrium condition

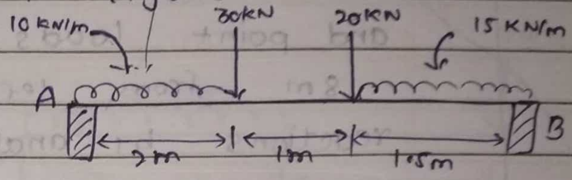
$\Sigma F_x = 0$
$\Sigma F_y = 0$
$\Sigma M = 0$

(UDL)



Simply support beam wala

(1) Find out the support reaction of the simply support beam shown in figure



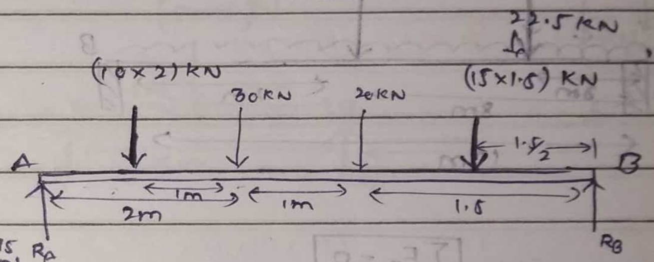
$\boxed{\Sigma F_x = 0}$

$\boxed{\Sigma F_y = 0}$

$R_A + R_B - 20 - 30 - 20 - 22.5 = 0$

$\boxed{R_A + R_B = 92.5}$ ...(1)

FBD



$\boxed{\Sigma M_A = 0}$

$(R_A \times 0) + (10\times2)\times1 + (30\times2) + (20\times3) + (22.5\times3.75)$
$(-R_B \times 3.5) = 0$

$20 + 60 + 60 + 84.37 - 3.5 R_B = 0$

$224.37 - 3.5 R_B = 0$

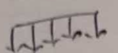
$R_B = \dfrac{224.37}{4.5}$

$\boxed{R_B = 49.86 \text{ kN}}$

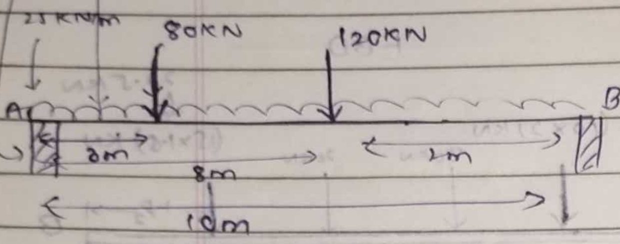
$R_A = 92.5 - R_B$

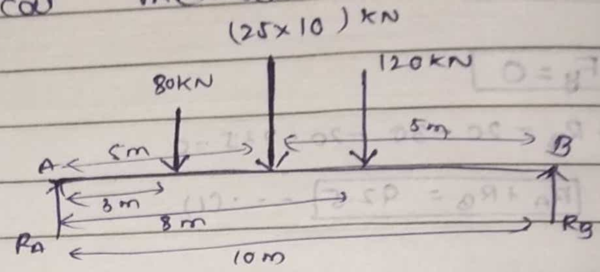
$R_A = 92.5 - 49.86$

$\boxed{R_A = 42.64}$

Same as  Date = 2/7

(2) A simply supported beam is of 10m span. It has UDL of $25^{kN}/m$ throughout its length and point loads 80kN and 120 kN at 3m and 8m from left support. Calculate support reactions by analytical method.





$\boxed{\Sigma F_x = 0}$

$\boxed{\Sigma F_y = 0}$ ↓ Down −ve ↑ up +ve

$+R_A + R_B - 80 - 250 - 120 = 0$

$\boxed{R_A + R_B = 450}$

$R_A + R_B = 450$

$\boxed{R_A = 450 - R_B}$

$\boxed{R_A = 205\ kN}$

$\Sigma M_A = 0$

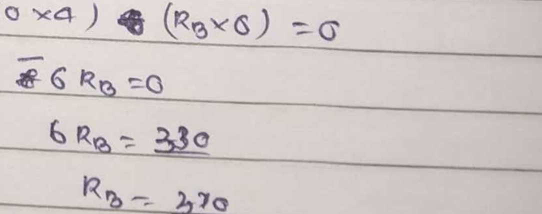
$-(R_A \times 0) + (80 \times 3) + (250 \times 5) + (120 \times 8) - (R_B \times 10) = 0$

$240 + 1250 + 960 - 10 R_B = 0$

$R_B = \frac{2450}{10}$

$\boxed{R_B = 245\ KN}$

(3) Calculate the reaction of the beam loaded as shown in figure



$\boxed{\Sigma F_x = 0}$

$\boxed{\Sigma F_y = 0}$

$R_A + R_B - 60 = 0$

$\boxed{R_A + R_B = 60}$

$\Sigma M_A = 0$

$-(R_A \times 0) + 90 + (60 \times 4) - (R_B \times 6) = 0$

$90 + 240 - 6 R_B = 0$

$6 R_B = 330$

$R_B = \frac{330}{6}$

$\boxed{R_B = 55}$

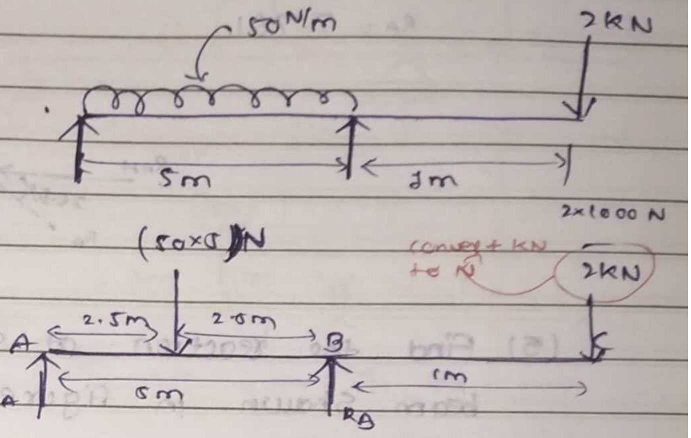
$R_A + R_B = 60$

$R_A = 60 - R_B$

$\boxed{R_A = 05}$

over hanging beam wala

(3) Calculate the reaction of the beam loaded as shown in fig by analytical method.



$\boxed{\Sigma f_x = 0}$

$\boxed{\Sigma f_y = 0}$

$R_A + R_B - 50 \times 5 - 2000 = 0$

$R_A + R_B - 250 - 2000 = 0$

$\boxed{R_A + R_B = 2250}$

$\boxed{\Sigma M_A = 0}$

$(R_A \times 0) + [(50 \times 5) \times 2.5] - (R_B \times 5) + (2000 \times 6) = 0$

$250 \times 2.5 - 5R_B + 12000 = 0$

625

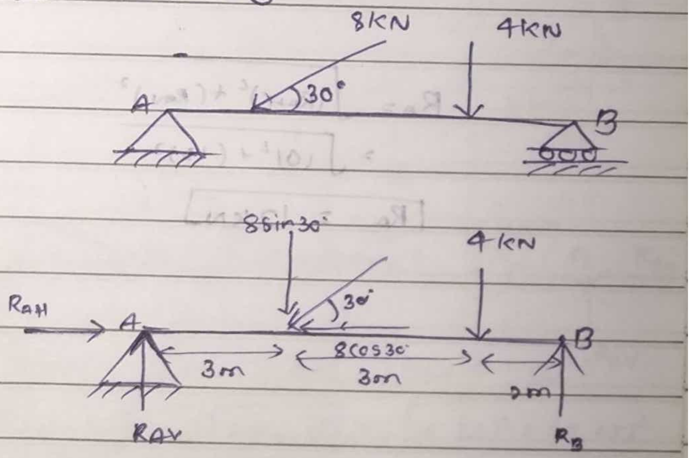
$5R_B = 12625$

$\boxed{R_B = 2525 N}$ (↑) $\quad R_A + R_B = 2250$

$\boxed{R_A = -275 N}$ (↓)

$\boxed{R_A = 275 N \ (\downarrow)}$

(4) Find the reaction Support A and B



$\Sigma F_x = 0$

$R_{AH} - 8\cos 30° = 0 \quad R_{AH} = \frac{8\sqrt{3}}{2} = 4\sqrt{3}$

$\boxed{R_{AH} = 6.928}$

$\Sigma f_y = 0$

$-8\sin 30° + R_{AV} + R_B - 4 = 0$

$-4 + R_{AV} + R_B - 4$

$\boxed{R_{AV} + R_B = 8}$ --(1)

$\boxed{\Sigma M_A = 0}$

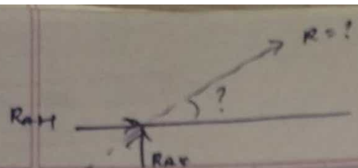
$(R_{AH} \times 0) + (R_{AV} \times 0) + (8\sin 30° \times 3) + (8\cos 30° \times 0) + (4 \times 6) - (R_B \times 8) = 0$

$0 + 0 + 12 + 0 + 24 - 8R_B = 0$

$R_{AV} = 8 - R_B \quad R_{AV} = 8 - 4.5 \quad 8R_B = 36 \quad \boxed{R_B = \frac{36}{8}} \quad \boxed{R_B = 4.5}$

$\boxed{R_{AV} = 3.5}$

→ Next page



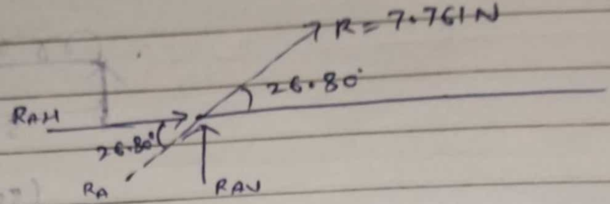
$R_A = \sqrt{(R_{AH})^2 + (R_{AV})^2}$

$= \sqrt{(6.928)^2 + (3.5)^2}$

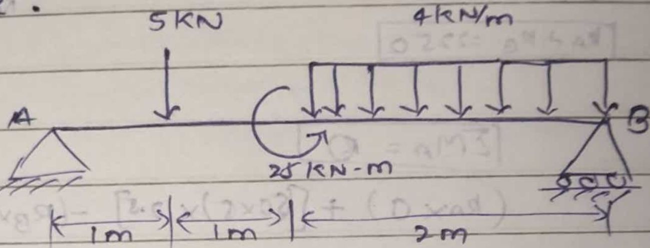
$R_A = 7.761$

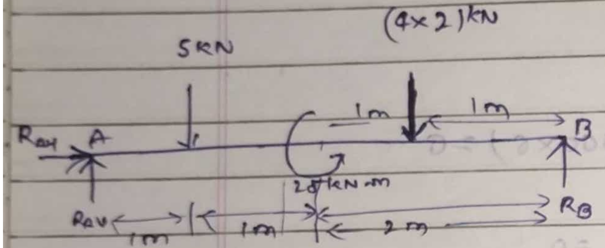
$\theta = \tan^{-1}\left(\frac{R_{AV}}{R_{AH}}\right) = \tan^{-1}\left(\frac{3.5}{6.928}\right)$

$\boxed{\theta = 26.80^\circ}$



(5) Find the reaction at supports A and B for the beam shown in figure.





$\Sigma F_x = 0 \quad \boxed{R_{AH} = 0}$

$\Sigma F_y = 0 \quad R_{AV} + R_B - 5 - 8 = 0$

$\boxed{R_{AV} + R_B = 13}$

$\Sigma M_A = 0$

$(R_{AH} \times 0) + (R_{AV} \times 0) + (5 \times 1) + (8 \times 3) - 25 - (R_B \times 4) = 0$

$0 + 0 + 5 + 24 - 25 - 4R_B = 0$

$4 = 4R_B \quad \boxed{R_B = 1\,kN}$

$\boxed{R_{AV} = 12\,kN}$

$R_A = \sqrt{(R_{AH})^2 + (R_{AV})^2}$

$= \sqrt{(0)^2 + (12)^2}$

$\boxed{R_A = 12\,kN}$

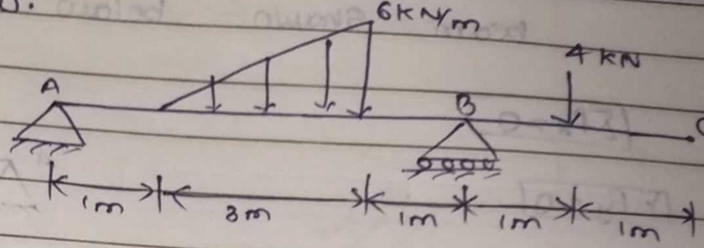
$\theta = \tan^{-1}\left(\frac{R_{AV}}{R_{AH}}\right)$

$= \tan^{-1}\left(\frac{0}{12}\right)$

$\boxed{\theta = 0^\circ}$

over hanging beam

(6) Find the reaction at supports A and B for the beam shown below.



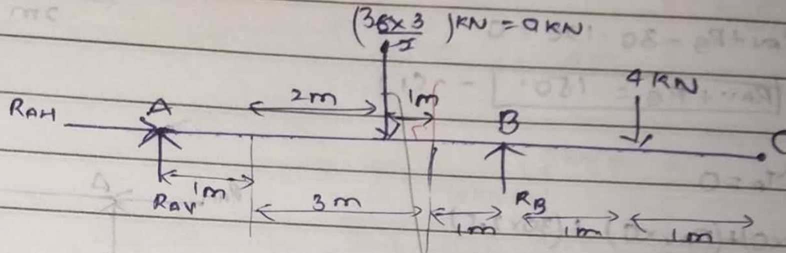
$\Sigma F_x = 0$

$\boxed{R_{AH} = 0}$

$\Sigma F_y = 0$

$R_{AV} + R_B - 9 - 4 = 0$

$\boxed{R_{AV} + R_B = 13}$ --- (1)



$\Sigma M_A = 0$

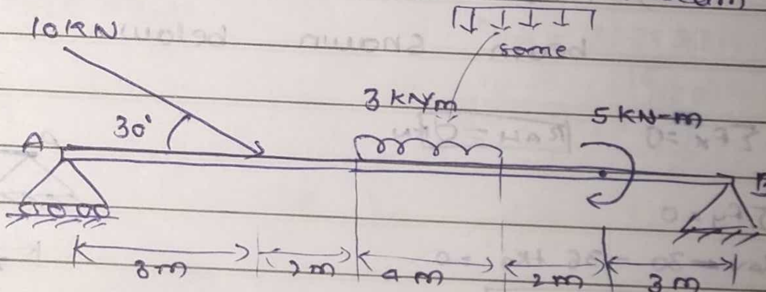
$(R_{AH} \times 0) + (R_{AV} \times 0) + (9 \times 3) - (R_B \times 5) + (4 \times 6) = 0$

$0 + 0 + 27 - 5R_B + 24 =$

$R_B = \frac{51}{5}$ $\boxed{R_B = 10.2 \text{ KN}}$

$\boxed{R_{AV} = 2.8 \text{ KN}}$ from (1)

(7) Find the reaction at supports A and B for the beam shown in figure



$\Sigma F_x = 0$

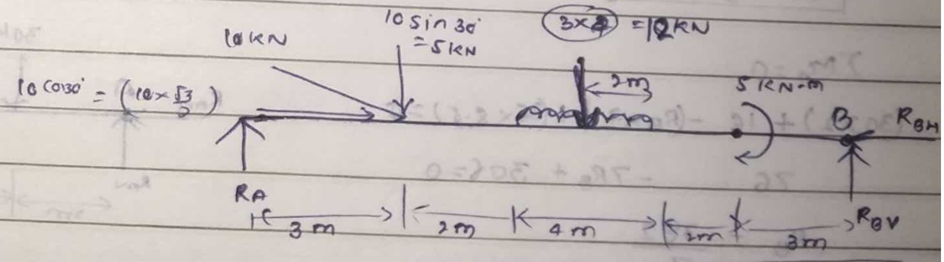
$-R_{BH} + 5 \times \sqrt{3} = 0$

$\boxed{R_{BH} = 8.66 \text{KN}}$

$\Sigma F_y = 0$

$R_A + R_{BV} - 5 - 12 = 0$

$\boxed{R_A + R_{BV} = 17}$ - (1)



$\Sigma M_A = 0$

$(R_A \times 0) + (10\cos 30° \times 0) + (R_{BH} \times 0)$
$+ (5 \times 3) + (12 \times 7) + 5 - 14(R_{BV}) = 0$

$15 + 84 + 5 - R_{BV}(14) = 0$

$R_{BV} = \frac{104}{14}$

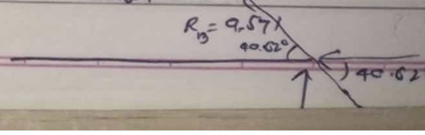
$\boxed{R_{BV} = 7.42 \text{KN}}$

$\boxed{R_A = 9.571 \text{ KN}}$

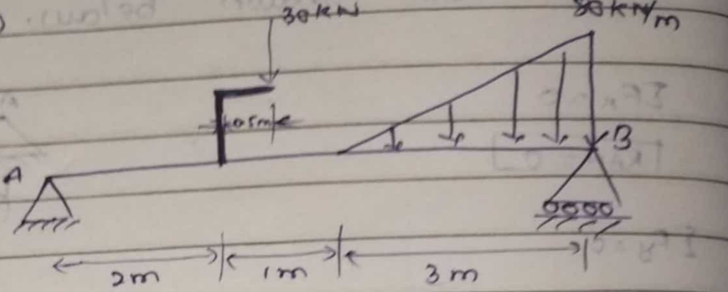
$R_B = \sqrt{(R_{BH})^2 + (R_{BV})^2} = \sqrt{(8.66)^2 + (7.42)^2}$

$= \sqrt{74.99 + 55.05}$ $\boxed{R_B = 11.15 \text{ KN}}$

$\theta = \tan^{-1}\left(\frac{R_{BV}}{R_{BH}}\right)$, $\theta = 40.62°$

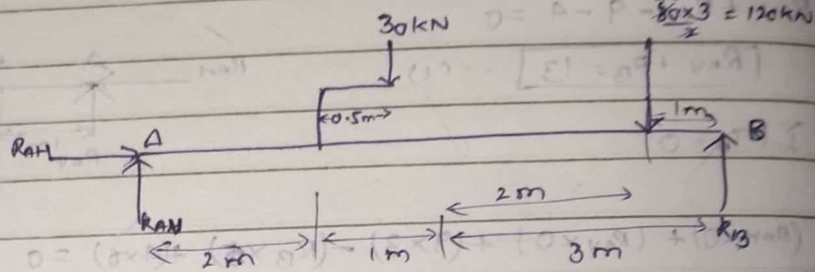


(8) Find the reaction at support A and B for the beam shown below



$\boxed{\Sigma F_x = 0}$

$\boxed{\Sigma F_y = 0}$



$R_{AV} + R_B - 30 - 120 = 0$

$\boxed{R_{AV} + R_B = 150}$ --- (1)

$\Sigma M_A = 0$

$(R_{AH} \times 0) + (R_{AV} \times 0) + (30 \times 2.5) + (20 \times 5) - (R_B\, 6) = 0$

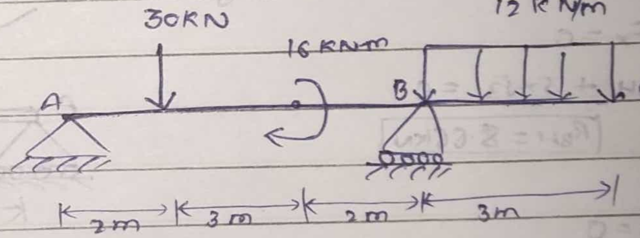
$0 + 0 + 75 + 600 - 6R_B = 0$

$6R_B = 675$

$R_B = \frac{675}{6}$ $\boxed{R_B = 112.5\ \text{kN}}$

$\boxed{R_{AV} = 37.5\ \text{KN}}$

(9) Find the reaction at support A and B for the beam shown below.

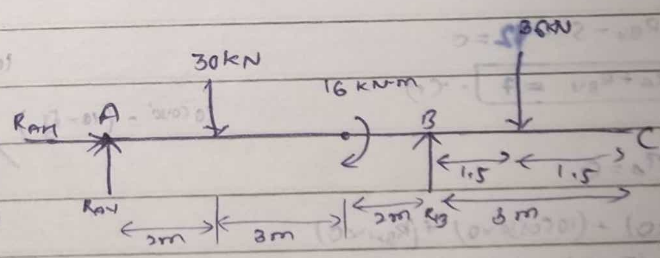


$\Sigma F_x = 0$ $\boxed{R_{AH} = 0\ \text{kN}}$

$\Sigma F_y = 0$

$R_{AV} - 30 - 36 + R_B = 0$

$\boxed{R_{AV} + R_B = 66}$



$\Sigma M_A = 0$

$(30 \times 2) + 16 - (R_B \times 7) + (36 \times 8.5) = 0$

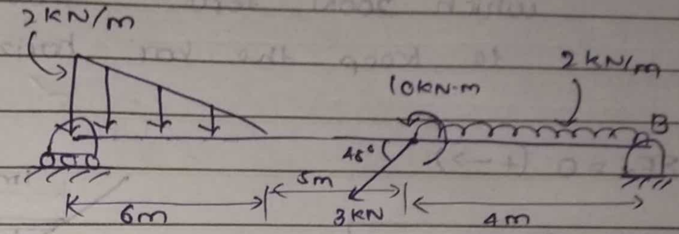
$76 - 7R_B + 306 = 0$

$R_B = \frac{382}{7}$

$\boxed{R_B = 54.571\ \text{kN}}$

$\boxed{R_{AV} = 11.428\ \text{KN}}$

(18) Find the reaction at support of the Beam AB loaded as shown in the f.g



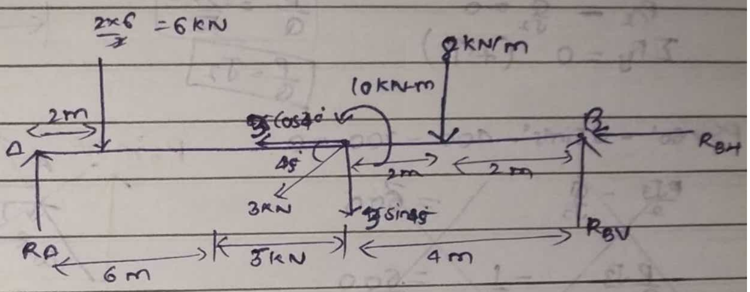
$\Sigma F_x = 0 \; (+\rightarrow)$

$-R_{BH} - 3\cos 45° = 0$

$R_{BH} = -\frac{3\times 1}{\sqrt{2}}$

$\boxed{R_{BH} = -2.121 \text{ kN}}$

$\boxed{R_{BH} = 2.121 \text{ kN} (\leftarrow)}$



$\boxed{\Sigma F_y = 0} \; (+\uparrow)$

$+R_A + R_{BV} - \frac{3}{\sqrt{2}} - 6 - 8 = 0$

$R_A + R_{BV} \quad -2.12 - 14 = 0$

$\boxed{R_A + R_{BV} = 16.12} \quad --(1)$

$\boxed{\Sigma M_A = 0} (6\times 2) - 10 + \left(\frac{3}{\sqrt{2}} \times 11\right) + (8\times 13) - (R_{BV}\times 15) = 0$

$\cancel{-10 + 23.33 + 26 - 15R_{BV}}$

$\cancel{16 + 23.33 = 15R_{BV}}$

$\cancel{R_{BV} = \frac{39.33}{15}}$

$12 - 10 + 23.33 + 104 - 15R_{BV} = 0$

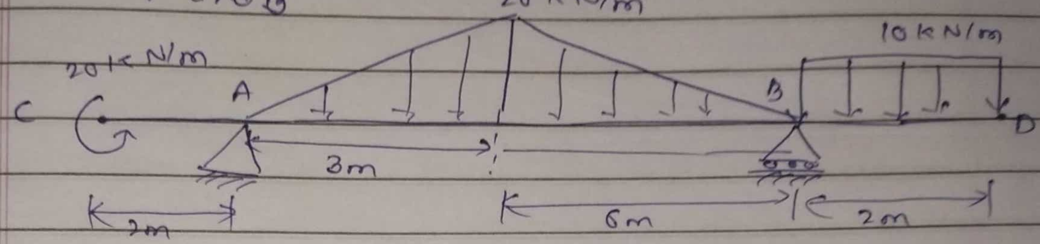
$94 + 23.33 = 15R_{BV}$

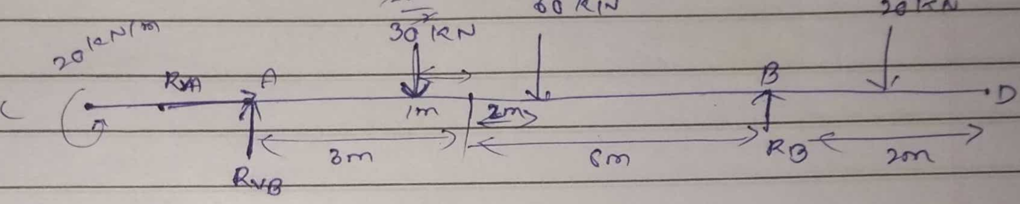
$R_{BV} = \frac{117.33}{15}$

$\boxed{R_{BV} = 7.822}$

$\boxed{R_A = 8.298}$

(12) Find the reaction for the loaded beam A and B





$\Sigma F_x = 0\ (+\rightarrow)$ $\boxed{R_{HA} = 0}$

$\Sigma F_y = 0\ (+\uparrow)$

$R_{VB} + R_B - 30 - 60 - 20 = 0$

$\boxed{R_{VB} + R_B = 110}$

$+\circlearrowleft M_A = 0$

$-20 + 30\times 2 + (60\times 5) - (R_B \times 9) + (10\times 20) = 0$

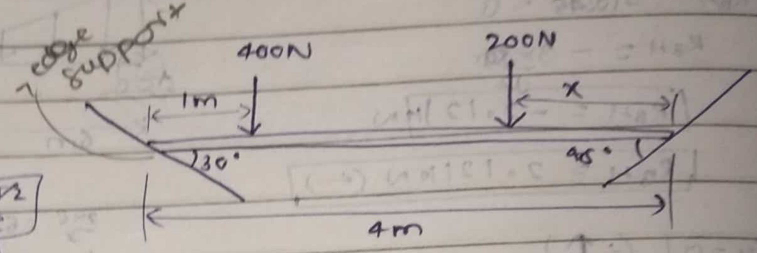
$-20 + 60 + 300 + 200$

$\frac{540}{9} = R_B$

$\uparrow \boxed{60 = R_B}$

$\boxed{R_{VB} = 50\ kN \uparrow}$

(11) A weightless bar is placed in a horizontal position on the smooth inclines as shown in fig. Find x at which 200N force should be placed from point B to keep the bar horizontal



$\Sigma F_x = 0 \ (+\rightarrow)$

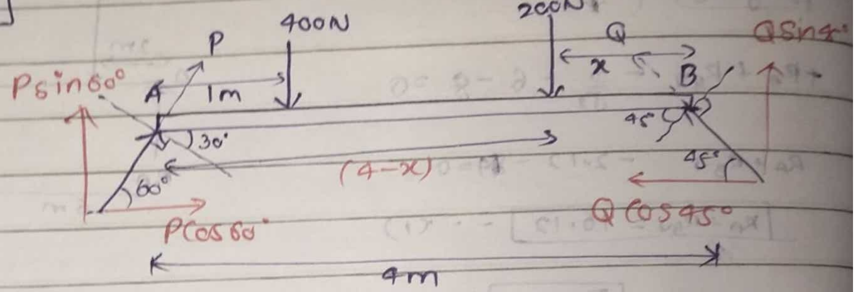
$\boxed{P\cos 60^\circ - Q\cos 45^\circ = 0}$

$\frac{P}{2} - \frac{Q}{\sqrt{2}} = 0$

$\boxed{\frac{P}{Q} = \frac{\sqrt{2}\cdot 2}{\sqrt{2}}}$

$\boxed{\frac{P}{Q} = \sqrt{2}}$

$\Sigma F_y = 0 \ (+\uparrow)$



$P\sin 60^\circ - Q\sin 45^\circ - 400 - 200 = 0$

$\cancel{\frac{P\sqrt{3}}{2} - \frac{Q}{\sqrt{2}} = 600}$

$\cancel{\frac{P}{Q}\frac{\sqrt{3}}{2} - \frac{1}{\sqrt{2}} = \frac{600}{Q}}$

$\cancel{\frac{\sqrt{2}\sqrt{3}}{2} - \frac{1}{\sqrt{2}} = \frac{600}{Q}}$

$\cancel{\frac{\sqrt{3}}{\sqrt{2}} - \frac{1}{\sqrt{2}} = \frac{600}{Q}}$ $\cancel{\frac{\sqrt{3}-1}{\sqrt{2}} = \frac{600}{Q}}$ $\cancel{Q = \frac{600\times\sqrt{2}}{\sqrt{3}-1}}$ $\cancel{= \frac{848.5}{0.732}}$

$P(0.5) - Q(0.71) = 0 \qquad \times\frac{\sqrt{3}}{2}$

$P(0.866) + Q(0.71) = 600 \qquad \times\frac{1}{\sqrt{2}}$

$(1.366)P = 600$

$P = \frac{600}{1.366}$ $\boxed{P = 439.2\,N}$ $\boxed{Q = 309.3\,N}$

$\Sigma M_0 = 0 \ (+\circlearrowright)$

$(400\times 1) + [200\times(4-x)] - (Q\sin 45^\circ \times 4) = 0$

$400 + 800 - 200x - \frac{309.3\times 4}{\sqrt{2}} = 0$

$400 + 800 - 200x - 874.83$

$400 + 74.83 = 200x$

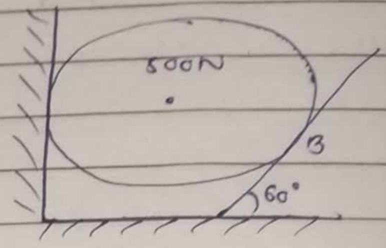
$\cancel{474.83}\ 325.17 = 200x$

$x = \frac{\cancel{474.83}\ 325.17}{200}$

$\boxed{x = 1.625\,m}$

Sphere wala and cylinder

(1) Find the reaction at the point of contact A and B for the ~~shape~~ sphere of weight 500N shown below.



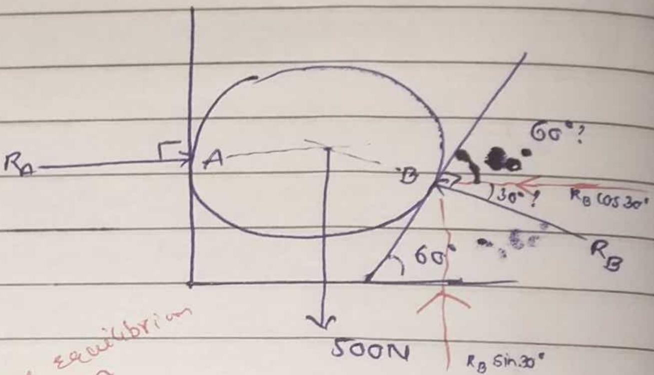
⇒

$\Sigma F_x = 0 \;(+\rightarrow)$

$R_A - R_B \cos 30° = 0$

$R_A = R_B \frac{\sqrt{3}}{2}$ $\boxed{\frac{R_A}{R_B} = \frac{\sqrt{3}}{2}}$

$\Sigma F_y = 0 \;(+\uparrow)$



$-500 + R_B \sin 30° = 0$

$+\frac{R_B}{2} = 500$

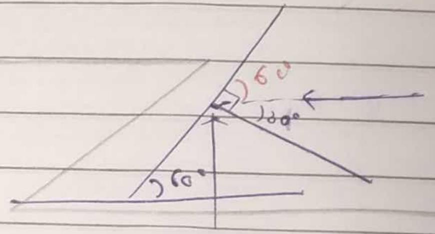
$\boxed{R_B = 1000\,N}$

$R_A = \frac{\sqrt{3} \times \cancel{1000}^{500}}{\cancel{2}}$

$R_A = 500 \times \sqrt{3}$

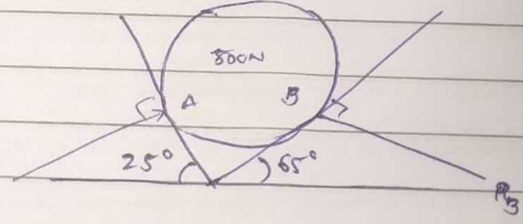
$\boxed{R_A = 866.025\,N}$

Apply equilibrium condition



(2) Find the reaction at the point of contact A and B for the sphere of weight 500N shown below.

⇒ $\Sigma F_x = 0 \;(+\rightarrow)$

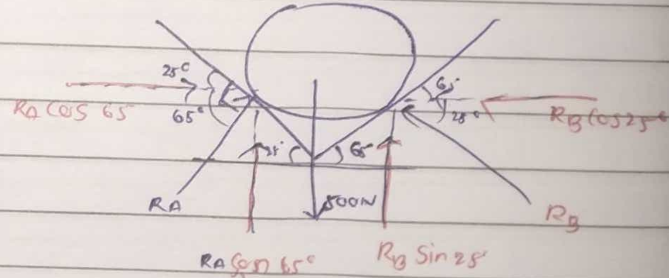


$\boxed{R_A \times \cos 65° - R_B \cos 25° = 0}$

$(0.422) R_A - (0.90) R_B = 0$ $\frac{R_A}{R_B} = \frac{0.9}{0.422}$

$\Sigma F_y = 0 \;(+\uparrow)$ $\boxed{\frac{R_A}{R_B} = 2.132}$

$\boxed{R_A \sin 65° + R_B \sin 25° = 500}$



$R_A(0.9) + (0.422) R_B = 500$

$\frac{R_A}{R_B} 0.9 + 0.422 = \frac{500}{R_B}$

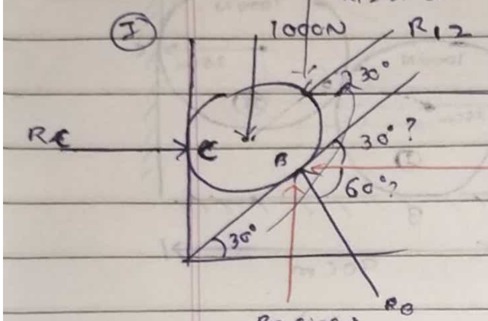
$2.132 \times 0.9 + 0.422 = \frac{500}{R_B}$

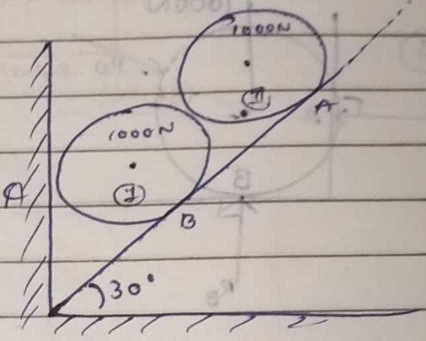
$1.917 + 0.422 = \frac{500}{R_B}$

$R_B = \frac{500}{\cancel{1.4914}\; 2.339}$

$\boxed{R_B = 215.57\,N}$ $\boxed{R_A = 451.06724}$

(3) Two identical rollers each of weight W = 1000N are supported by an inclined plane and a vertical wall as shown in figure. Find the reaction at the point of contact A, B and C. Assume all surfaces to be smooth





$\sum F_y = 0\ (+\uparrow)$

$R_B \sin 60^\circ = 1000$

$\boxed{R_B = \frac{2000}{\sqrt{3}} = 1154.7N}$

$\sum F_x = 0\ (+\rightarrow)$

$R_C - R_B \cos 60^\circ = 0$

$\boxed{R_C = \frac{R_B}{2}}$ $\quad R_C = \frac{1154.7}{2}$

$\boxed{R_C = 577.35 N}$

$\sum F_x = 0\ (+\rightarrow)$

$R_C + R_{12}\cos 30^\circ + R_B \cos 60^\circ = 0$

$R_C - \frac{\cancel{R_{12}}}{2} 324 - \frac{R_B}{2}$

$\boxed{R_C - \frac{R_B}{2} = 324.96}$

$\sum F_y = 0\ (+\uparrow)$

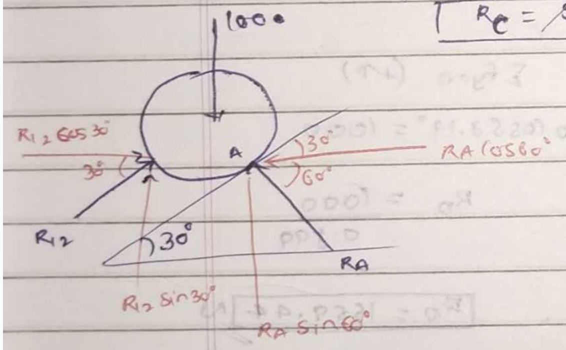
$R_B \sin 60^\circ + 1000 - \frac{R_{12}}{2} = 0$

$R_B \frac{\sqrt{3}}{2} = 1187.618$

$\boxed{R_B = 1371.33 N}$

$R_C - 685.66 = 324.96$

$\boxed{R_C = 1010.62 N}$



$\sum f_x = 0\ (+\rightarrow)$

$R_{12}\cos 30^\circ - R_A \cos 60^\circ = 0$

$\frac{R_{12}\sqrt{3}}{\sqrt{2}} = \frac{R_A}{2} \quad \frac{R_{12}}{R_A} = \sqrt{\frac{2}{3}} \times \frac{1}{2} = 0.4$

$\sum f_y = 0\ (+\uparrow)$

$R_{12}\sin 30^\circ + R_A \sin 60^\circ - 1000 = 0$

$0.4\ \frac{1}{2} + \frac{\sqrt{3}}{2} = \frac{1000}{R_A}$

$0.2 + 0.866 = \frac{1000}{R_A}$

$R_A = \frac{1000}{1.066}$ $\quad \boxed{R_A = 938.08}$

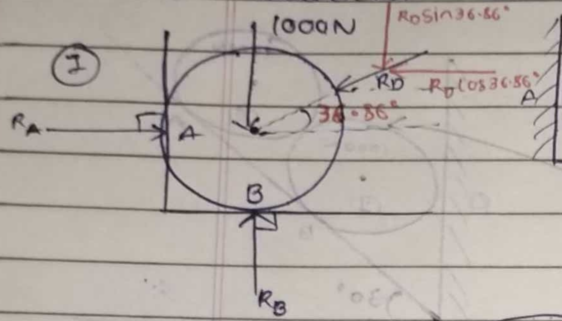
$\boxed{R_{12} = 375.23 N}$

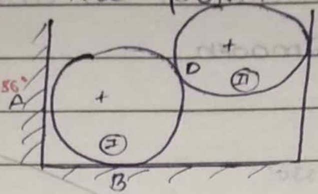
$R_A - R_B(0.5) = (500)\cos 30^\circ$

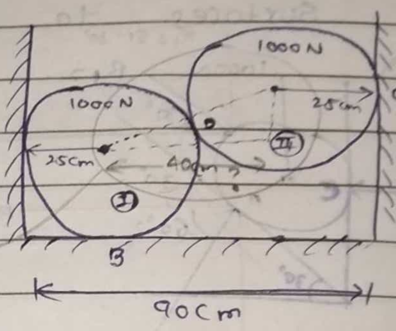
?

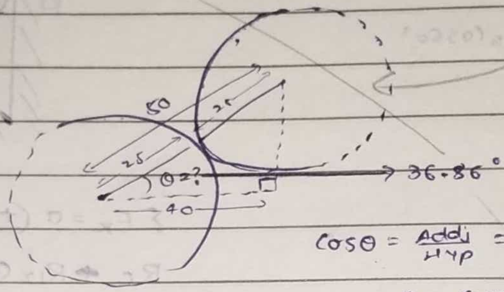
$R_C - R_B 0.5 = 433.01$

(4) Two sphere each of weight 1000N and of radius 25cm rest in a horizontal channel of width 90cm as shown in figure. Find the reaction at the point of contact A, B and C





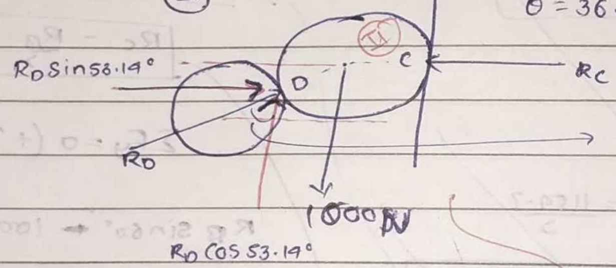




$\cos\theta = \frac{Adj}{Hyp} = \frac{40}{50}$

$\theta = \cos^{-1}(4/5)$

$\theta = 36.86°$



$90° - 36.86° = 53.14°$

I

$\Sigma F_x = 0 \quad (+\rightarrow)$

$\boxed{R_A - R_D \cos 36.86° = 0}$

put value R_D

$R_A = R_D \times \cos 36.86°$ $\quad R_A = (1669.44 \times 0.8001)$

$\boxed{R_A = 1336.1 N}$

$\Sigma F_y = 0 \quad (+\uparrow)$

$\boxed{R_B - R_D \sin 36.86° = 1000}$

put value R_D

$R_B = 1000 + 1669.44 \times 0.599$

$= 1000 + 1001.43$

$\boxed{R_B = 2001.43 N}$

II

$\Sigma F_y = 0 \quad (+\uparrow)$

$R_D \cos 53.14° = 1000$

$R_D = \frac{1000}{0.599}$

$\boxed{R_D = 1669.44} N$

$\Sigma F_x = 0 \quad (+\rightarrow)$

$-R_C + R_D \sin 53.14° = 0$

$R_C = R_D \sin 53.14°$

$R_C = 1669.44 \times 0.8001$

$\boxed{R_C = 1335.72 N}$