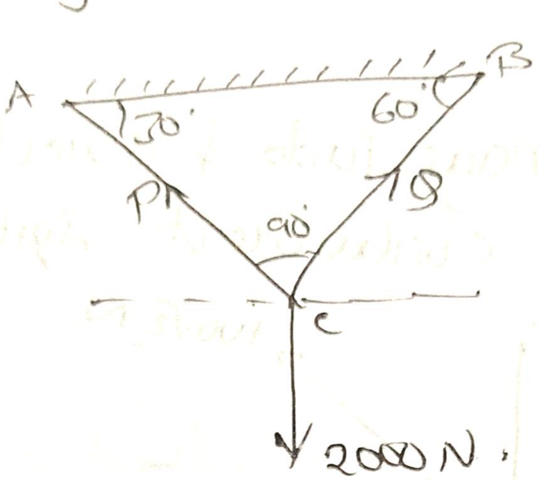
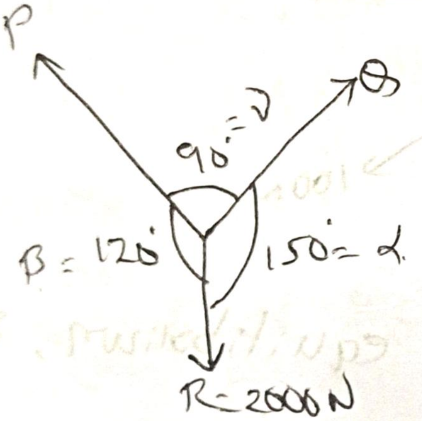
Problems on Lamis Theorem

1) A wt of 200N is supported by 2 chains AC & BC as shown in fig. Determine the tension in each chain



Sol:



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

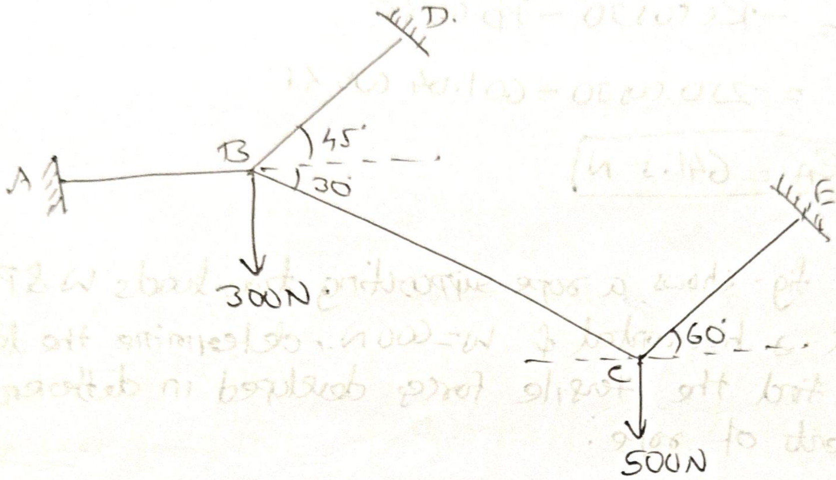
$$\frac{P}{\sin 150} = \frac{2000}{\sin 90}$$

$$P = 1000\,N$$

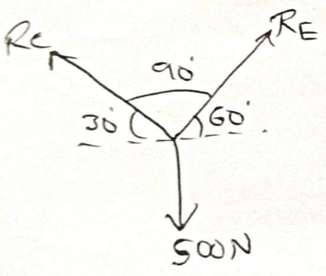
$$\frac{Q}{\sin 120} = \frac{2000}{\sin 90}$$

$$Q = 1732\,N$$

2) A System of cables in equilibrium condition under two vertical loads of 300 N & 500 N as shown in fig. Determine the forces developed in different segments



Soln:. FBD @ C

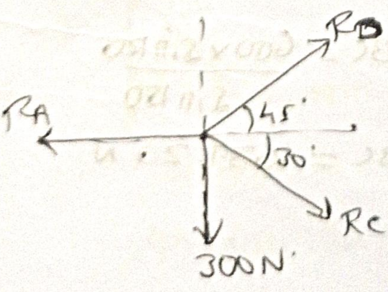


$$\frac{R_C}{\sin 150} = \frac{R_E}{\sin 120} = \frac{500}{\sin 90}$$

$$\boxed{R_C = 250\ N}$$

$$\boxed{R_E = 433\ N}$$

FBD @ B



$\Sigma F_x = 0$

$-R_A + R_C \cos 30 + R_D \cos 45 = 0$

$\Sigma F_y = 0$

$-R_C \sin 30 + R_D \sin 45 - 300 = 0$

$$R_D = \frac{300 + 250 \sin 30}{\sin 45}$$

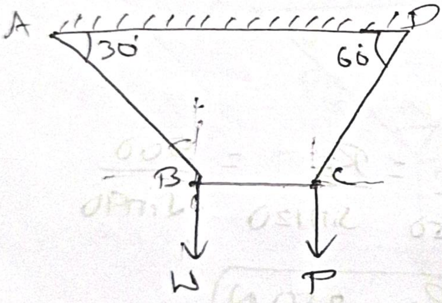
$$\boxed{R_D = 601.04\ N}$$

$$-R_A = -R_C \cos 30 - R_D \cos 45$$

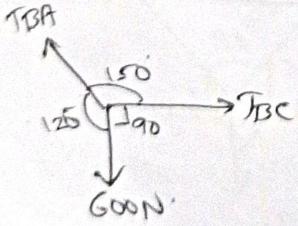
$$= -250 \cos 30 - 601.04 \cos 45$$

$$\boxed{R_A = 641.5\ N}$$

3) Below fig. shows a rope supporting two loads W & P. If BC is horizontal & W = 600 N., determine the load. Also find the tensile forces developed in different segments of rope.



Soln:- FBD @ B

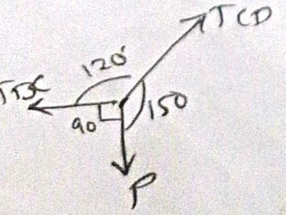


$$\frac{T_{BA}}{\sin 90} = \frac{T_{CB}}{\sin 120} = \frac{600}{\sin 150}$$

$$T_{BC} = \frac{600 \times \sin 120}{\sin 150}$$

$$T_{BC} = 1039.23\ N$$

FBD @ C



$$\frac{T_{CD}}{\sin 90} = \frac{1039.23}{\sin 150} = \frac{P}{\sin 120}$$

~~P = 1800~~ N.

~~TCD = 2078~~.46 N

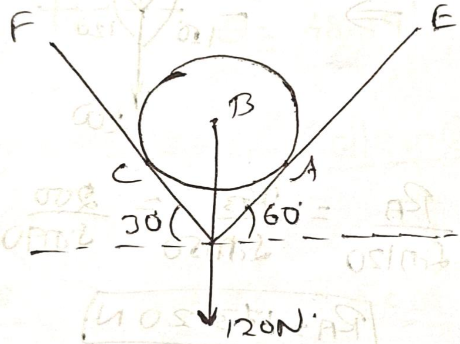
$P = \dfrac{1039.23 \times \sin 120}{\sin 150}$

$P = 1800\ N$

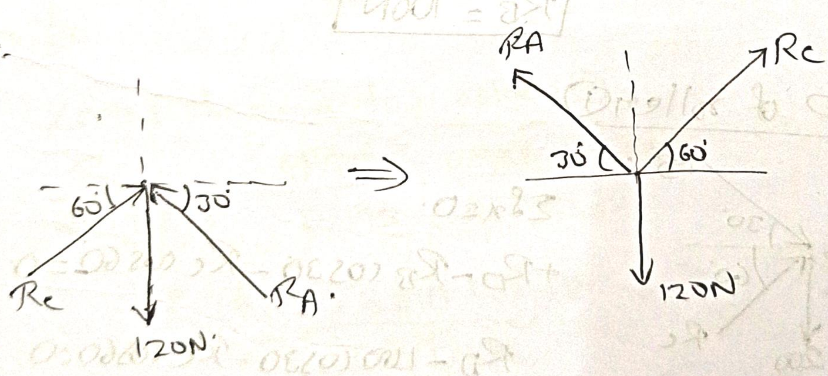
$T_{CD} = 2078.46\ N$

Problems on FBD/Equilibrium

1) A ball of weight 120N rests in a right angled groove as shown in fig. The sides of the groove are inclined to an angle of 30° & 60° to the horizontal. If all surfaces are smooth, determine the reactions at A & C



Sol:-



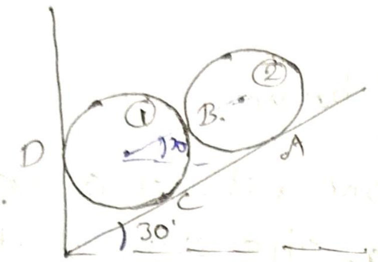
Applying lami's theorem

$$\frac{R_A}{\sin 150} = \frac{R_C}{\sin 120} = \frac{120}{\sin 90}$$

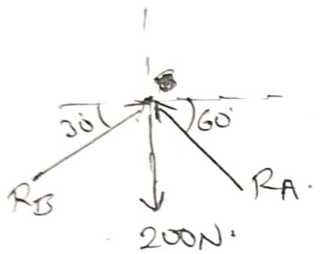
$\boxed{R_C = 103.2\ N}$

$\boxed{R_A = 60\ N}$

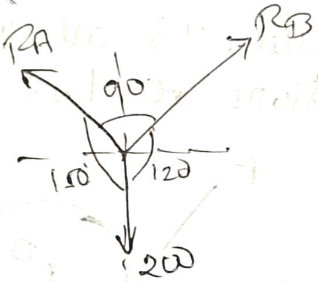
2) Two identical rollers each weighing 200N are placed in a trough as shown in fig. Assuming all contact surfaces are smooth, find the reactions developed at contact surface A, B, C & D.



Soln :- FBD of roller ②.



$\Rightarrow$

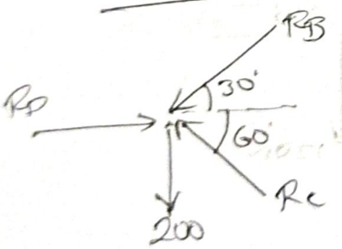


$$\frac{R_A}{\sin 120} = \frac{R_B}{\sin 150} = \frac{200}{\sin 90}$$

$$\boxed{R_A = 173.20\ N}$$

$$\boxed{R_B = 100N}$$

FBD of roller ①



$\Sigma f_x = 0$

$+R_D - R_B \cos 30° - R_C \cos 60° = 0$

$R_D - 100 \cos 30 - R_C \cos 60 = 0 \rightarrow ①$

$\Sigma f_y = 0$

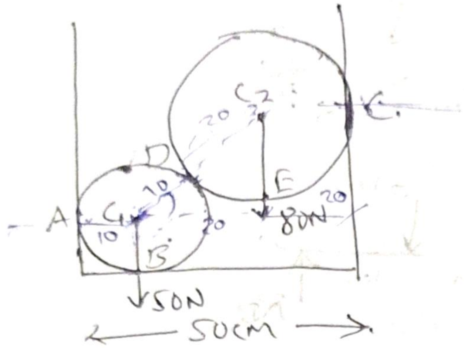
$-200 - R_B \sin 30° + R_C \sin 60 = 0$

$R_C \sin 60 =$

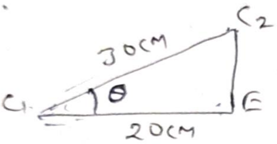
$$\boxed{R_C = 288.67\ N}$$

$$\boxed{R_D = 230.6\ N}$$

3) Two spheres having weight 50N & 80N & radius 10cm & 20cm are piled in a cylindrical channel of 50cm diameter as shown in fig. Find the reactions to the walls & base of the channel.



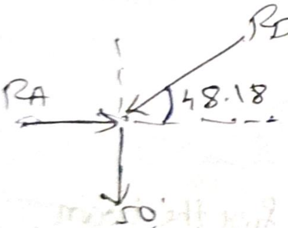
Soln:



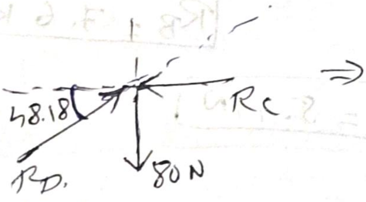
$\cos\theta = \frac{20}{30}$

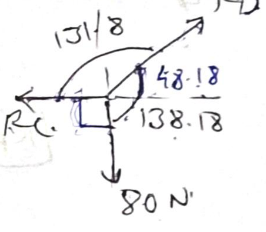
$\theta = 48.19°$

Roller ①



Roller ②





Lami's theorem for roller ②

$$\frac{R_C}{\sin 138.18} = \frac{R_D}{\sin 90} = \frac{80}{\sin 131.82}$$

$$R_C = \frac{80 \times \sin 138.18}{\sin 131.82} = 71.57\text{ N}$$

$R_D = 107.34$ N.

for roller ①

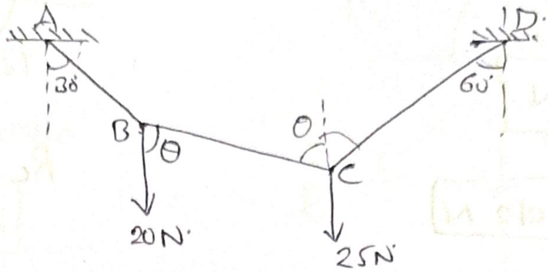
$\Sigma f_x = 0 \Rightarrow R_A - R_D \cos 48.18 = 0$

$R_A = 71.57$ N

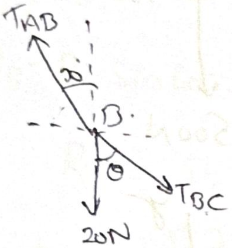
$\Sigma f_y = 0 \Rightarrow R_B - R_D \sin 48.18 - 50 = 0$

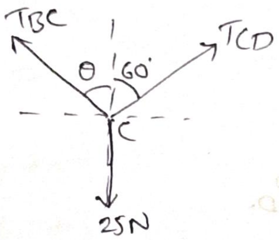
$R_B = 130$ N.

* Determine angle θ for the system of strings ABCD in equilibrium as shown in fig. Also find the tensions in the strings AB, BC & CD.



Sol: The free body diagram of B & C are shown below





$\Sigma F_x = 0$ for B.

$T_{BC} \sin\theta - T_{AB} \sin 30 = 0$

$T_{BC} \sin\theta = T_{AB} \sin 30$ --- ①

$\Sigma F_x = 0$ for C

$-T_{BC} \sin\theta + T_{CD} \sin 60 = 0$

$T_{BC} \sin\theta = T_{CD} \sin 60$ .... ②

∴ From ① & ② $T_{AB} \sin 30 = T_{CD} \sin 60$ --- ③

$\Sigma F_y = 0$ for B.

$T_{AB} \cos 30 - T_{BC} \cos\theta - 20 = 0$

$T_{BC} \cos\theta = T_{AB} \cos 30 - 20$ --- ④

$\Sigma F_y = 0$ for C

$T_{BC} \cos\theta + T_{CD} \cos 60 - 25 = 0$

$T_{BC} \cos\theta = 25 - T_{CD} \cos 60$ --- ⑤

∴ From ④ & ⑤

$T_{AB} \cos 30 - 20 = 25 - T_{CD} \cos 60$

$T_{AB} \cos 30 = 45 - T_{CD} \cos 60$

Substituting T_{CD} from eq ③

$T_{AB} \cos 30 = 45 - T_{AB} \dfrac{\sin 30}{\sin 60} \times \cos 60$

$\boxed{T_{AB} = 38.97\ N}$ ✓

From eq ①

$T_{BC} \sin\theta = 19.485$ — ⑥

From eq ⑤

$T_{BC} \cos\theta = 13.749$ → ⑦

Dividing ⑥ by ⑦

$\tan\theta = 1.417$

$\boxed{\theta = 54.8^\circ}$

$\boxed{T_{BC} = 23.84\ N}$

$\boxed{T_{CD} = 22.49\ N}$