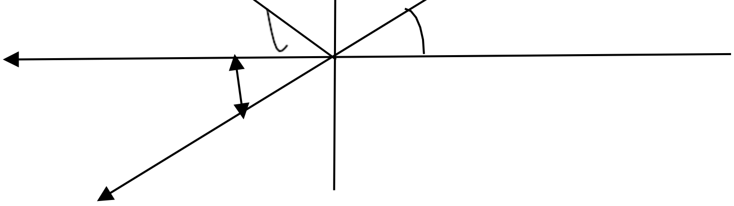
ROHININ COLLEGE OF ENGINEERING AND TECHNOLOGY
Approved by AICTE & Affliated to anna university
Accredited with A^+ grade by NAAC
DEPARTMENT OF MECHANICAL ENGINEERING

NAME OF THE SUBJECT: ENGINEERING MECHANICS

SUBJECT CODE : ME3351

REGULATION 2021

UNIT I: BASIC & STATICS OF PARTICLES



Equilibrium of Particles in Two Dimensions

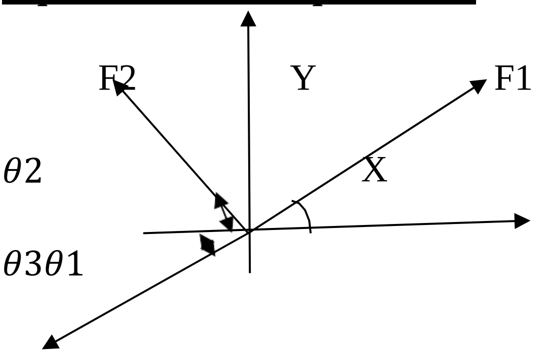
Equilibrium:

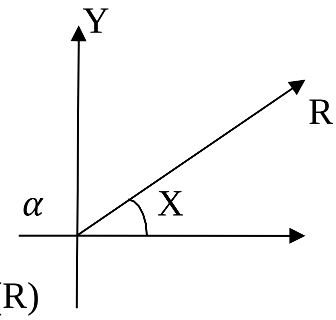
A body is said to be in a state of equilibrium, if the body is either at rest or moving at a constant velocity.

Equilibrium Force:

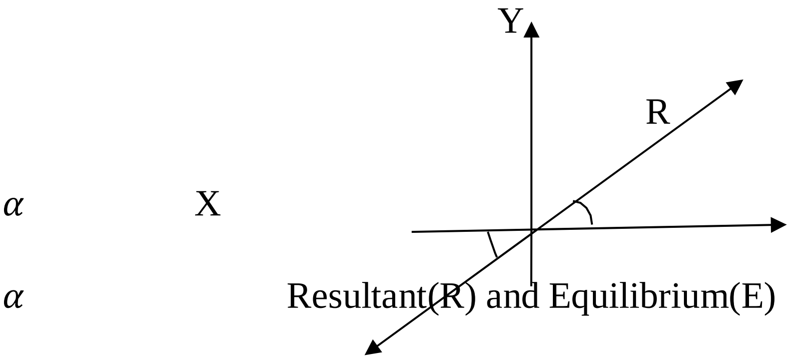
The set of forces where resultant is zero is called “Equilibrium Force”.

Equilibrium and Equilibrant:





Resultant(R)



Resultant(R) and Equilibrium(E)

Consider a particle subjected to three coplanar concurrent forces as shown in fig(1)

Let the resultant force of the force system R as shown in fig(2) with direction of α with horizontal. Due to this resultant force, the particle may starts moving in the direction of resultant force.

But if we apply an additional force of same magnitude and direction as that of resultant force, on the same line of action, but in opposite direction, then the movement of the particle will be arrested or the particle to said to be in Equilibrium.

The force E, which brings the particle (or set of force) to equilibrium, is called equilibrant.

Hence, Equilibrant (E) is Equal to the resultant force(R) in magnitude and direction, collinear but opposite in nature.

Conditions of Equilibrium:

For equilibrium condition of force system, the resultant is Zero.

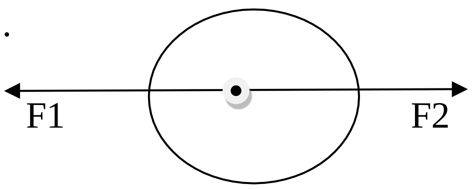
R=0

But R $= \sqrt{(\sum FH)^2 + (\sum FV)^2}$

$\sum FH=0 \qquad \sum FV=0$

Principle of Equilibrium:

Equilibrium principles are developed from the force Law of equilibrium ($\sum F = 0$).



1. Two force Equilibrium principle:

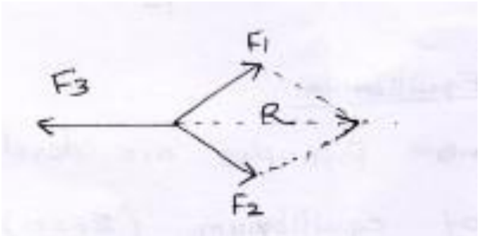
If a body is subjected to two forces, then the body will be in equilibrium if the two forces are collinear, equal and opposite.

2. Three force equilibrium principle:

If a body is subjected to three forces, then the body will be in equilibrium, if the resultant of any two forces is equal, opposite and collinear with the third force.

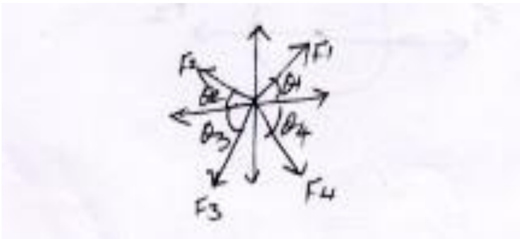
R is the resultant

F_1 and F_2 also $R=F_3$



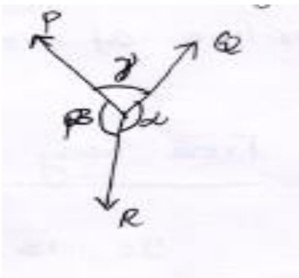
3. Four Force Equilibrium Principle:

If a body is in equilibrium , acted upon by four forces, then the resultant of any two equal must be equal, opposite and collinear with the resultant of the other two.



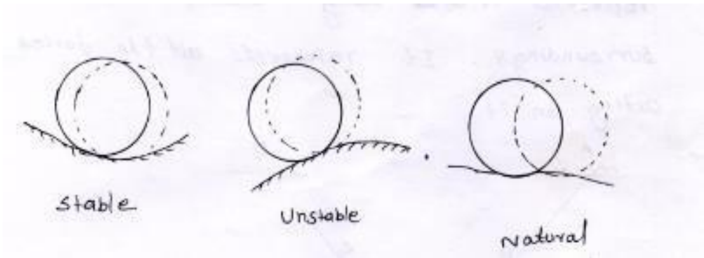
⇒Lami's Theorem:

If three coplanar forces acting at a point be in equilibrium, than each force is proportional to the sine of the angle b/w the other two.



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

Types of Equilibrium:



Stable Equilibrium:

A body is said to be in stable equilibrium, if it returns back to its original position atter it is slightly displaced from its position.

Unstable Equilibrium:

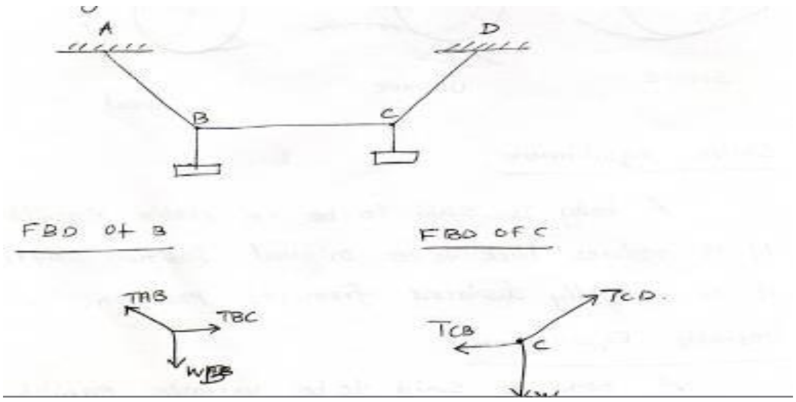
A body is said to be unstable equilibrium it does not return back to its original position and heals farther away after slightly displaced from its position of rest.

Natural Equilibrium:

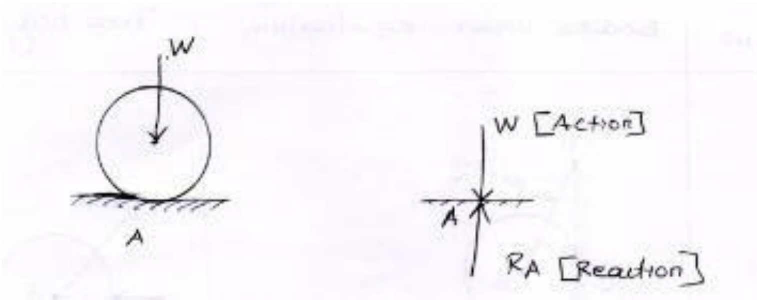
A body is said to be in natural equilibrium it in occupies a new position (also remain at rest) atter slightly displaced from its position of rest.

⇒**Free body Diagram:**

It is a sketch of the particle which represents it as being isolated from its surroundings. It represents all the forces acting on it.



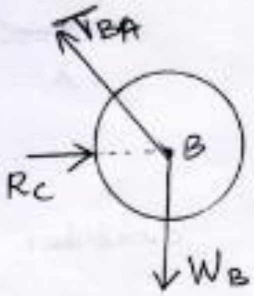
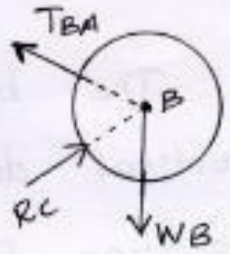
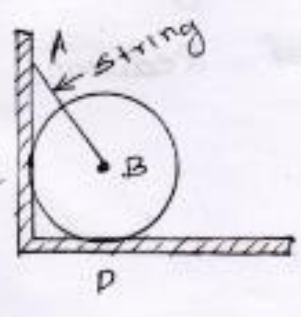
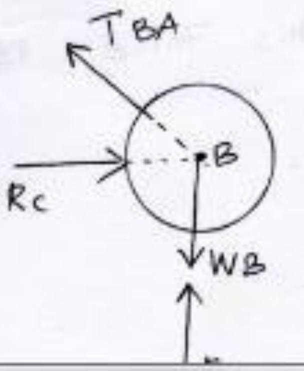
⇒**Action and Reaction:**

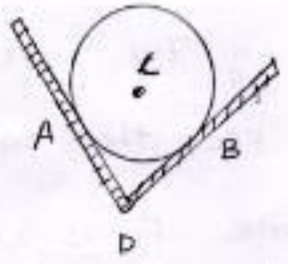
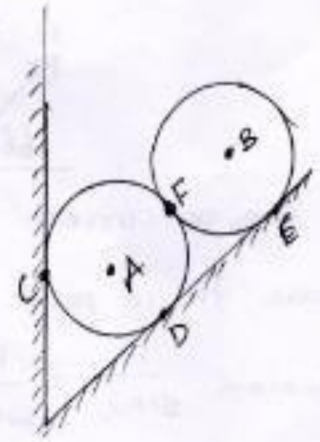
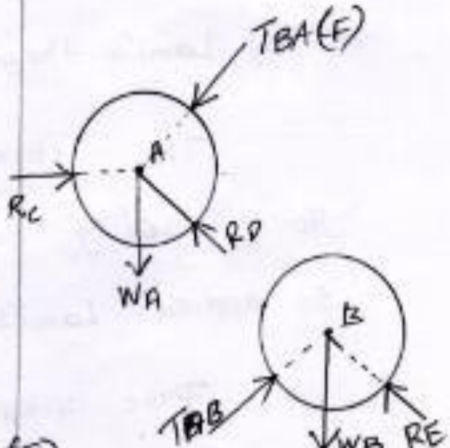
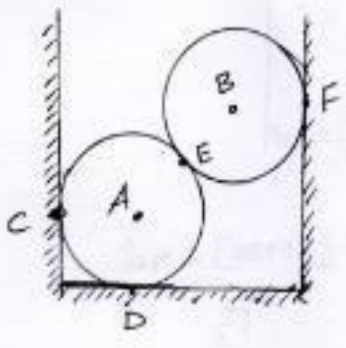
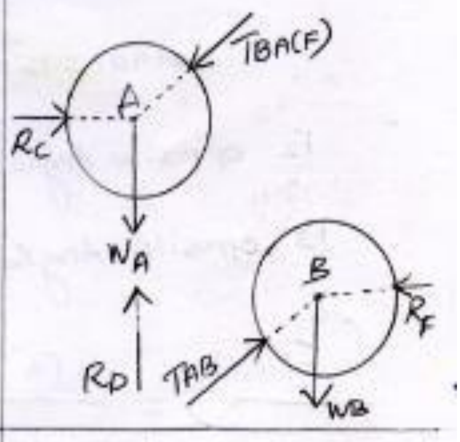
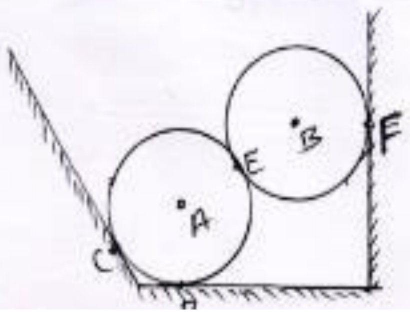
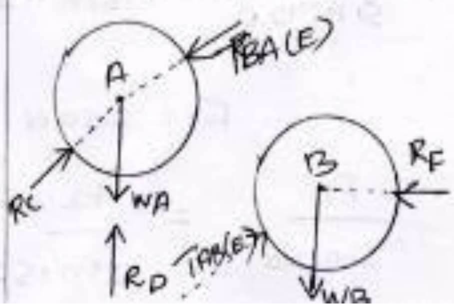


Consider a Ball placed on a horizontal surface shown in fig. The self weight of the ball (w) is acting vertically downwards through its centre of gravity. This force is called Action.

The ball can move horizontally, but its vertical downward motion is resisted due to resisting force developed at support (here, at the point of contact A) Acting vertically upwards. This force is called reaction.

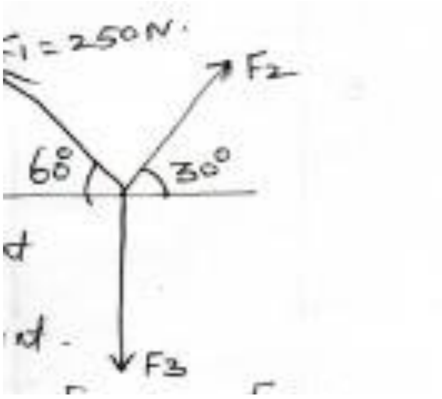
⇒Free body diagram:

<table>
<tr><th>Sl NO</th><th>Bodies under equilibrium</th><th>Free body diagram.</th></tr>
<tr><td>1.</td><td>
</td><td>
</td></tr>
<tr><td>2</td><td>
</td><td>
</td></tr>
<tr><td>3</td><td>
</td><td>
</td></tr>
</table>

4.		
5		 TBA(E)=TAB(F)
6		
7		

Problems:

1. The force shown in fig. is acting on a particle and keeps the particle in equilibrium. Then magnitude of force F1 is 250 N. Find the magnitude of forces F2 and F3.



Soln:

1. By Lami's theorem

The three concurrent force acting outwards from a point. So applied Lami's theorem. $\frac{F1}{sin\alpha} = \frac{F2}{sin\beta} = \frac{F3}{sin\gamma}$

First find the opposite angle of F1& F2&f3

F1 opposite angle

30+90=120°

F2 opposite angle (90+60)=150°

F3 opposite angle (180-[60+30]=90°

$$\frac{F1}{sin120} = \frac{F2}{sin150} = \frac{F3}{sin90}$$

F1=250 N

$$\frac{F1}{sin120} = \frac{F2}{sin150}$$

$$\frac{250}{sin120} = \frac{F2}{sin150}$$

F2=144.33 N

$$\frac{F1}{sin120} = \frac{F3}{sin90}$$

F3=288.67 N

2) By Equations of Equilibrium

∑FH=0 ∑FV=0 F3 is No horizontal force

1) ∑FH= F2 cos30-F1 cos60=0

F2 cos30-250 cos60=0

$F2=\frac{250cos60}{cos30}$

F2=144.33N

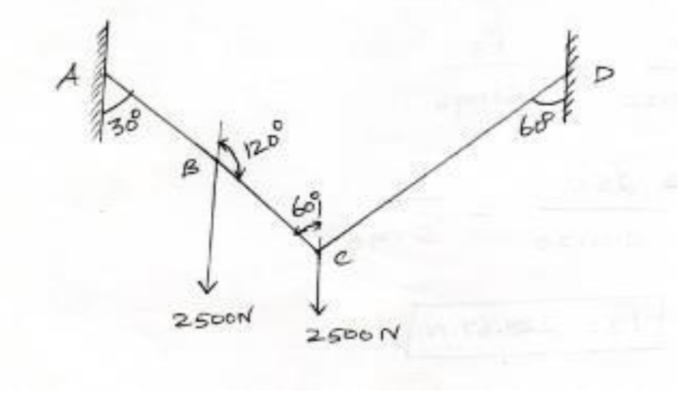
∑FH= F1 sin 30+ F2 sin 60-F3=0

250sin30+144.33 sin 60-F3=0

250 sin30+144.33 sin 60=F3

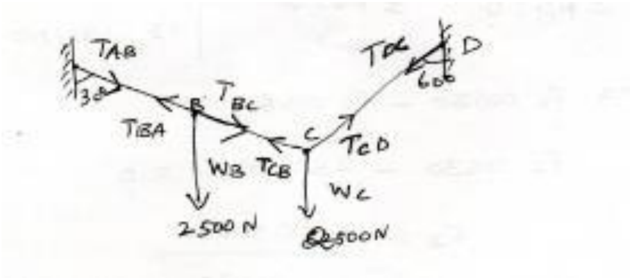
F3=228.67N

2. Two equal loads of 2500N are supported by a flexible string ABCD at points A &D. Find the tension in the portions AB,BC & CD of string.



Soln:

Free body diagram



$T_{AB} = T_{BA}$

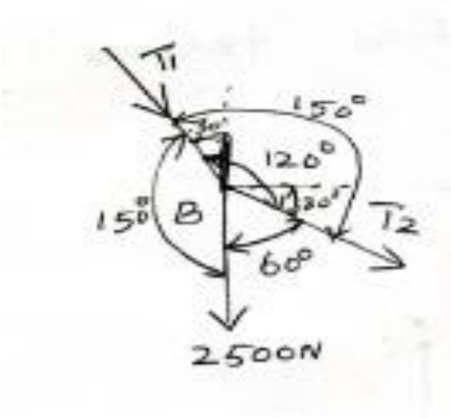
III ly$T_{BC} = T_{CB}$&$T_{CD} = T_{DC}$

⇒Let the tension in AB/BC &CD be T_1, T_2 & T_3 respectively

⇒ Let us split up the string

ABCD into two parts.

Consider A and B



By Lami's Theorem

$$\frac{TBA}{sin60} = \frac{TBC}{sin150} = \frac{Z500}{sin150}$$

$\frac{TBA}{sin60} = \frac{2500}{sin150}$

$T_{BA} = \frac{2500}{sin150} \times sin60$

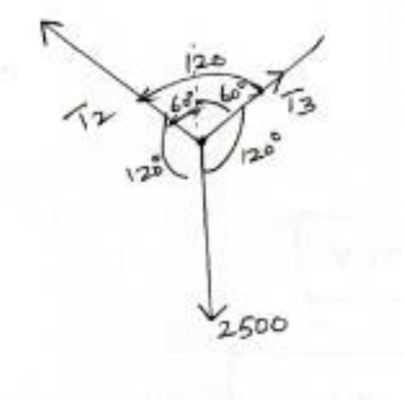
$T1 = 4330.13\ N$

$\frac{T_{CB}}{sin150} = \frac{2500}{sin150}$

$$T2 = \frac{2500}{sin150} \times sin150$$

$$T2 = 2500\ N$$

Consider a point c

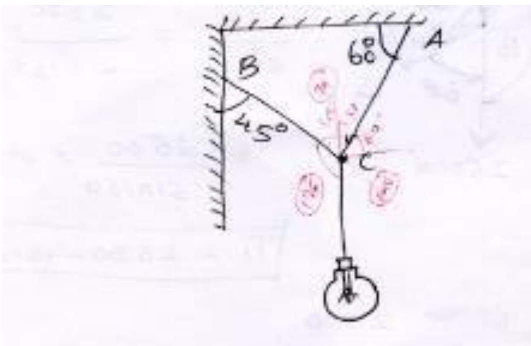


$$\frac{T2}{sin120} = \frac{T3}{sin120} = \frac{Z500}{sin120}$$

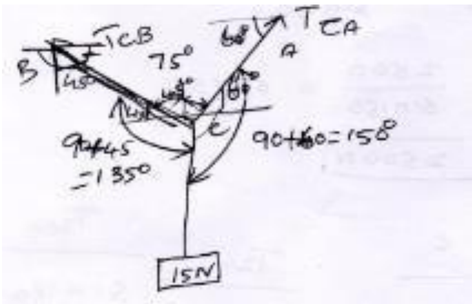
$$\frac{T3}{sin120} = \frac{2500}{sin120}$$

$$T3 = 2500\ N$$

3. An electric lamp weighting 15 N hangs from a point c, by $ two strings AC and Bc as shown in fig. find tensions in string Ac & BC



Soln:



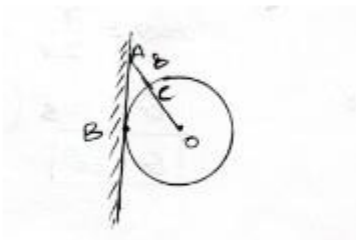
By Lami's theorem

$$\frac{TCB}{sin150} = \frac{TCA}{sin135} = \frac{15}{sin75}$$

$$\frac{TCB}{sin150} = \frac{15}{sin75} = TCB = 7.76\ N$$

$$\frac{TCA}{sin135} = \frac{15}{sin75} = TCA = 7.76N$$

4. A smooth sphere w is supported by a string fastened to a point A on the smooth vertical wall, the other end is in contact with point b, on the wall as shown in fig. If the length of the string AC is equal to the radius of the sphere, find the tension in the string & reaction of the wall.



<u>Given:</u>

Radius of sphere OB=OC=radius length of string, AC= radius of sphere=r , weight of sphere =w

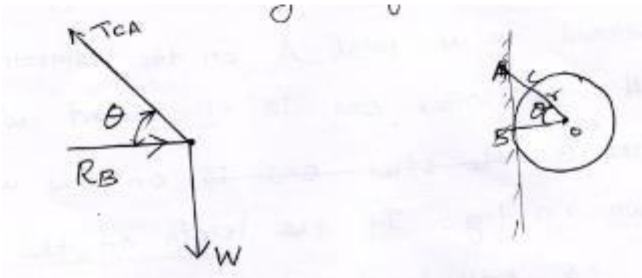
<u>To find :</u>

1. Tension in string

2. Reaction of the wall

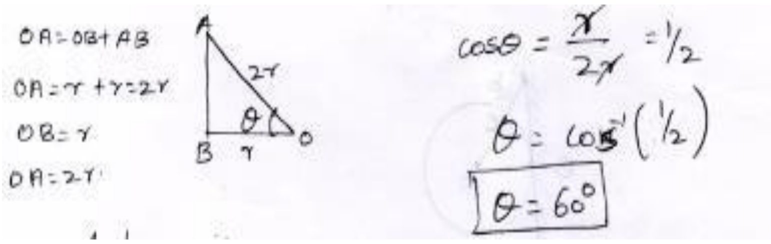
Soln:

Free body diagram



Find the angle b/w T_{CA}& R_B

From right angle triangle AOB



Apply $\sum FH=0$

R_B-T_{CA} cos 60 = 0 --------------(1)

$\sum FV=0$

T_{CA} sin 60- w=0 --------------(2)

T_{CA} sin60=w

$T_{CA}=\frac{w}{sin60}$

T_{CA}= 1.155w

T_{CA} value sub in Eqn (1)

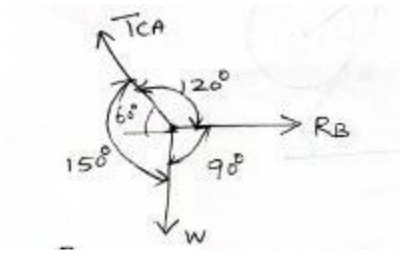
R_B-T_{CA} cos 60 = 0---------------(1)

R_B-1.155w cos60=0

R_B=0.577w

Other method

By Lami's theorem

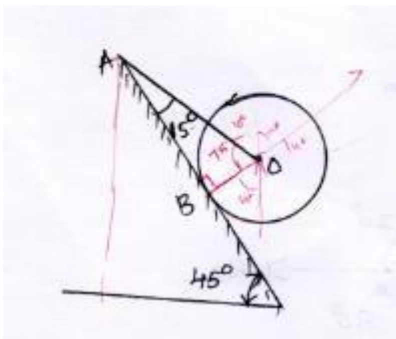


$$\frac{TCA}{sin90} = \frac{RB}{sin150} = \frac{w}{sin120}$$

$\frac{TCA}{sin90} = \frac{w}{sin120} \Rightarrow R_B = \frac{w}{sin120} \times sin150$

R_B=0.577 W

5. String AO holds a smooth sphere on an inclined plane ABC as shown in fig. the weight of the sphere is 1000 N and the plane is smooth. Calculate the tension in the string and the reaction at the point of contact B.



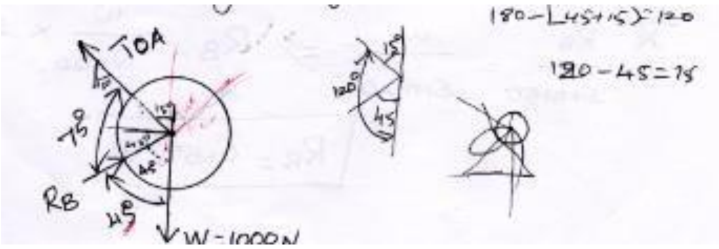
<u>Given:</u>

Weight of sphere W=1000N

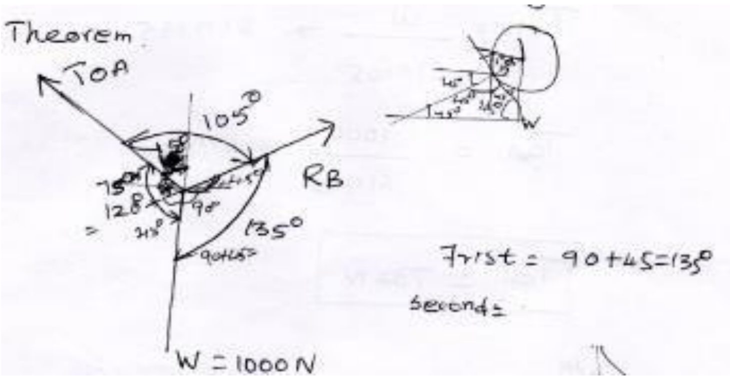
<u>To find</u>: Tension in string 7 Reaction

Soln:

Free body diagram



No of force is 3, so by using Lami's theorem



In right angled triangle OAB

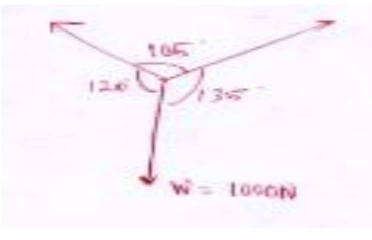
$\measuredangle$OAB+$\measuredangle ABO + \measuredangle BOA = 180°$ $\measuredangle OAB = 15°$

15+90+$\measuredangle BOA = 180°$ $\measuredangle ABO = 90°$

BOA=180-(15+90)

$\measuredangle BOA = 75°$

Apply Lami's Eqn



$$\frac{TOA}{sin135} = \frac{RB}{sin120} = \frac{w}{sin105}$$

$$\therefore \frac{TOA}{sin135} = \frac{w}{sin105}$$

$T_{OA} = \frac{w}{sin105} \times sin135$

$T_{OA} = \frac{1000}{sin105} \times sin135$

$T_{OA} = 732N$

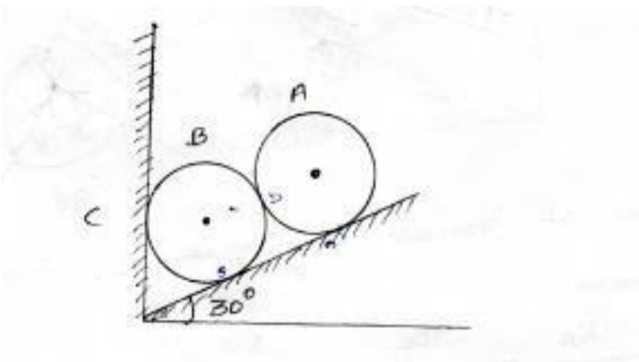
III ly $\frac{RB}{sin120} = \frac{w}{sin105}$

$\frac{R_B}{sin120} = \frac{1000}{sin105}$

$R_B = \frac{1000}{sin105} \times sin120$

$R_B = 896.57N$

6. Two identical rollers, each of weight 50 N, are supported by an inclined plane and a vertical wall as shown in fig. Find the reactions at the points of supports A,B and C. assume all the surface to be smooth.



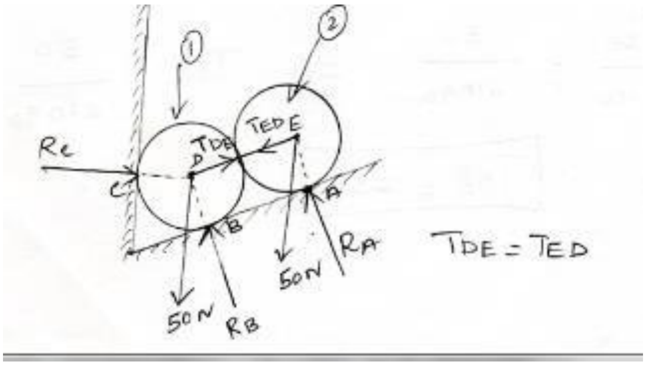
Given:

Weight of roller A & B = 50 N

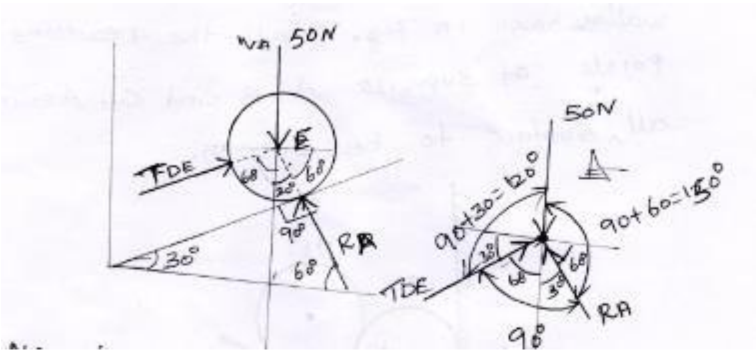
To find:

Reaction at the support A,B and C

Soln:



Free body diagram of roller 2



No of forces is three, apply Lami's Theorem

$$\frac{R_A}{sin120} = \frac{T_{DE}}{sin150} = \frac{50}{sin90}$$

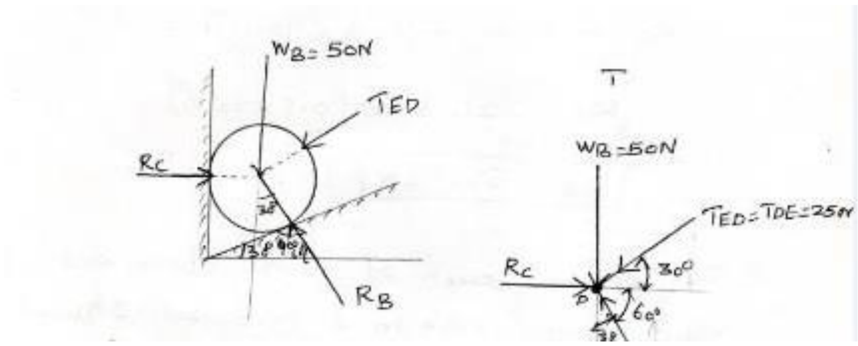
$$\frac{R_A}{sin120} = \frac{50}{sin90} \Rightarrow R_A = \frac{50}{sin90} \times sin120$$

$R_A = 43.3\ N$

$$\frac{}{sin150} = \frac{50}{sin90} \Rightarrow T_{DE} = \frac{50}{sin90} \times sin150$$

$T_{DE} = 25N$

<u>Free body diagram of roller 1</u>



All forces acting at point D.

In equilibrium condition

∑FH=0 &∑FH=0

∑FH=0 →+ - ←

R_C-TED cos 30-R_B cos 60 =0

R_C-25 cos 30-R_B cos 60 =0

R_C-21.65-0.5R_B =0 --------(1)

∑FH=0 ↓- ↑+

$R_B$sin60- TED sin 30-50 =0

R_B-sin60-25 sin30-50=0

R_B-sin 60 =25 sin 30+ 50=62.5

$$R_B = \frac{62.5}{sin60}$$

$$R_B = 72.17 \text{ N}$$

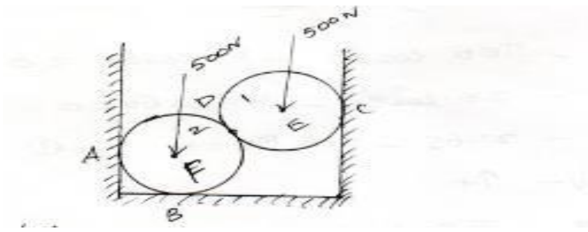
R_B value substitute Eqn(1)

$$R_C - 21.65 - (0.5 \times 72.17) = 0$$

$$R_c = 21.65 + (0.5 \times 72.17)$$

$$R_C = 57.73\ N$$

7. Two spheres each of weight 500 N and of radius 100mm rest in a horizontal channel of width of 360mm as shown in fig. find the reactions on the points of contact A ,B and C. Assume all the surface of contact are smooth.



Given data:

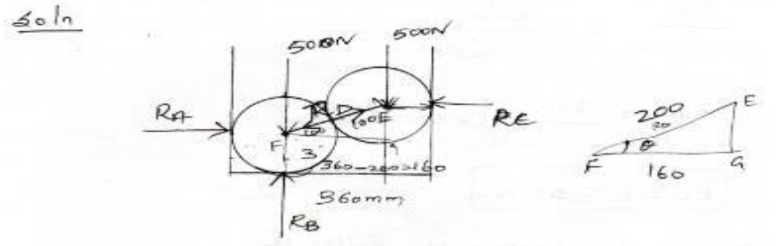
Weight of each Roller w = 500 N

Width of channel = 360 mm

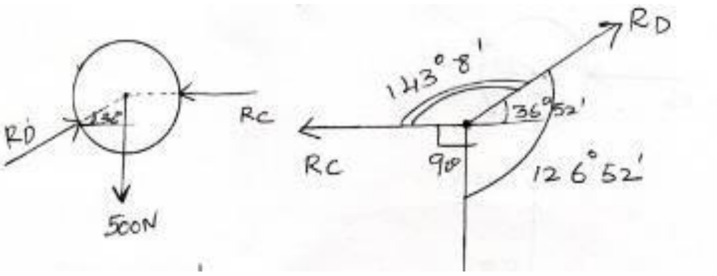
Radius of rollers r = 100mm

To find:

Reaction on the points of A,B & C.



Free body diagram of roller (1)



$\cos\theta = \frac{FG}{EF}$

$$\theta = cos^{-1}\left(\frac{FG}{EF}\right)$$

$$\theta = cos^{-1}\left(\frac{160}{200}\right)$$

$$\theta = 36°52'$$

By Lami's Theorem

$$\frac{R_D}{sin90} = \frac{R_C}{sin126°52} = \frac{500}{sin143°8}$$

$$\frac{R_D}{sin90} = \frac{500}{sin143°8}$$

$$R_D = \frac{500}{sin143°8} \times sin90$$

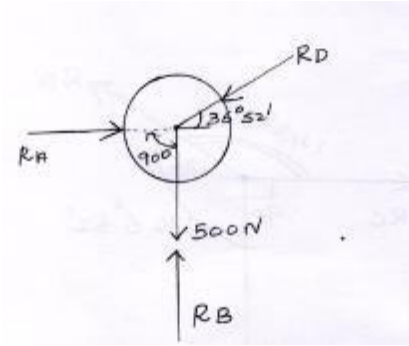
$$R_D = 833.39\ N$$

$$\frac{R_C}{sin126°52} = \frac{500}{sin143°8}$$

$$R_C = \frac{500}{sin143°8} \times sin126°52'$$

$$R_C = 673.08N$$

Free body diagram of roller(2)



$\sum$FH = $R_A - R_D \cos 36°52'$=0

→+ - ← $R_A = R_D \cos 36°52'$

$R_A - 833.39 \times \cos 36°52'$

$R_A = 666.74\ N$

$\sum$FV =0 ↓- ↑+

$R_B - R_D \sin 36°52' - 500$=0

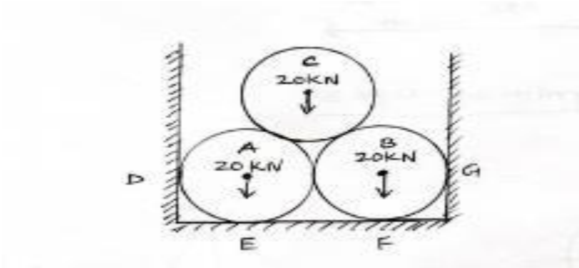
$R_B - 833.39 \sin 36°52'$-500=0

$R_B - 499.99 - 500$=0

$R_B = 999.99N$

8. Three smooth pipes each weighting 20 KN and of diameter 60 cm are to be placed in a rectangular channel with horizontal base as shown in fig.

Calculate the reactions at the points of contact b/w the pipes and b/w the channel and the pipes. Take width of the channel as 160 cm.



Given:

Weight of each pipe = $w_A = w_B = w_C = 20\ KN$

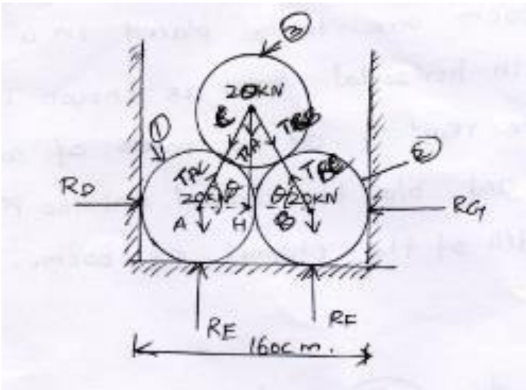
Diameter of each pipe = $D_A = D_B = D_C = 60cm$

Width of channel = 160 cm

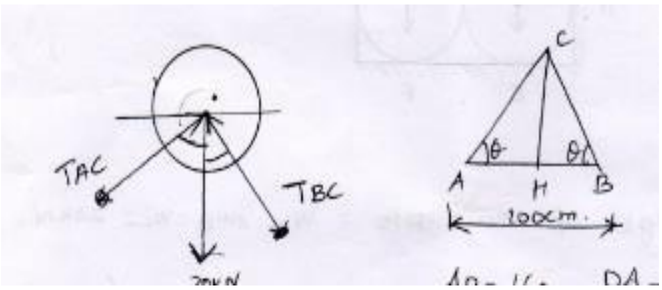
To find:

Reaction at the points : D,E,f,G

Soln:



Free body diagram of pipe 3



AB=160-DA-BG diameter

From triangle HAC AB=160-30-30 DA=Db=60cm

$\cos\theta = \frac{AH}{AC}$

AB=100cm

$\theta = cos^{-1}\left[\frac{AH}{AC}\right]$

AC=BC

BG=DB/2

AC=BC=2×radius

DA=BG=radius

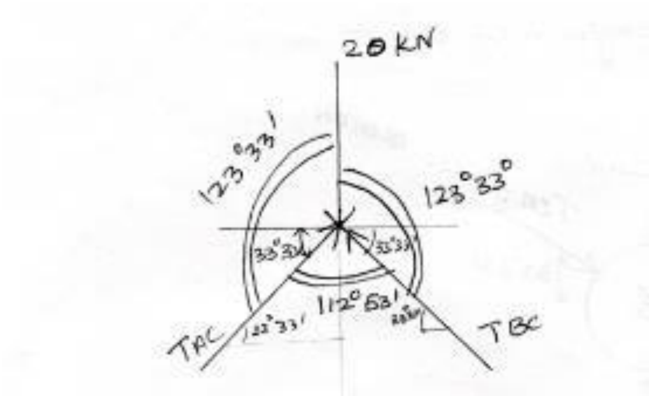
$= cos^{-1}\left[\frac{50}{60}\right]$

AC=BC=2× 30

$\theta = 33°33'$

AC=BC=60 cm

AH=$\frac{AB}{2} = \frac{100}{2} = 50cm$



By Lami's theorem

$$\frac{T_{AC}}{sin123°33'} = \frac{T_{BC}}{sin123°33'} = \frac{20}{sin112°53'}$$

$$\frac{T_{AC}}{sin123°33'} = \frac{20}{sin112°53'}$$

$$T_{AC} = \frac{20}{sin112°53'} \times sin123°33'$$

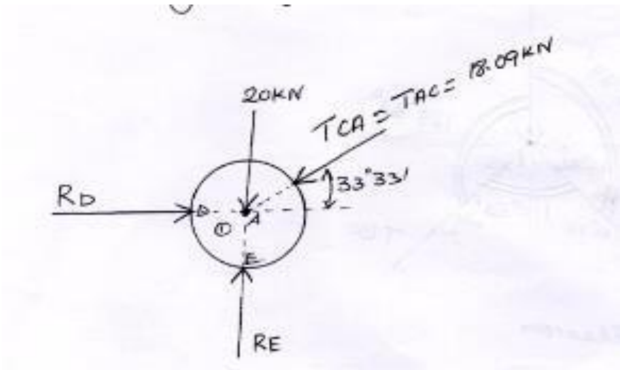
T_{AC} =18.09 KN

$$\frac{T_{BC}}{sin123°33'} = \frac{20}{sin112°53'}$$

$$T_{BC} = \frac{20}{sin112°53'} \times sin123°33'$$

$$T_{BC} = 18.09KN$$

Free body diagram of pipe(1)



$\sum$FH = 0 $\rightarrow$+ - $\leftarrow$

$$R_D - T_{CA}\cos 33°33'=0$$

$$R_D = 18.09\cos 33°33' = 0$$

$$R_D - 15.07 = 0 \qquad T_{CA} = T_{Ac}$$

$$R_D = 15.07\ KN$$

$\sum$FV =0 $\downarrow$- $\uparrow$+

$$R_E - 20 - T_{CA}\sin 33°33'=0$$

$$R_E - 20 - 18.09\sin 33°33'=0$$

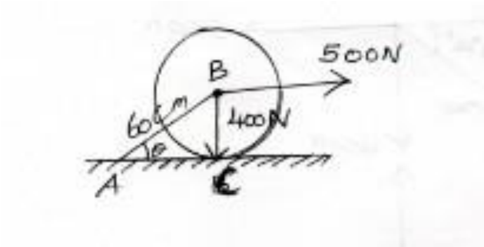
$$R_E - 29.99 =0$$

$$R_E = 29.99KN$$

Similarly the free body diagram of pipe (2) is analyzed for pipe (1)

$$\therefore R_E = 29.99KN \ \ \&R_D = 15.07\ KN$$

9. A circular roller of radius 20 cm and of weight 400 N resets on a smooth horizontal surface and is held in position by an inclined bar AB of length 60 cm as shown in fig. a horizontal force of 500 n is acting at b. Find the Tension in bar AB and the reaction at C.



Given:

Radius of circular roller r=20 cm

Weight of roller w = 400 N

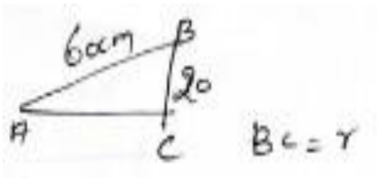
Horizontal force =500 N

To find:

1) Tension in AB
2) Reaction at C.

Soln:

From triangle ABC

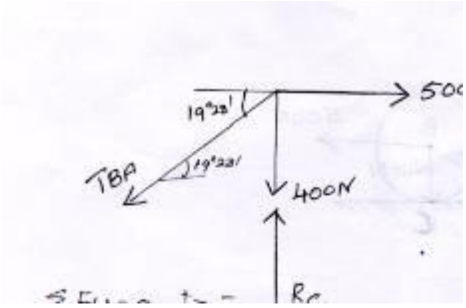


$\sin\theta = \frac{BC}{AB} \Rightarrow \theta = sin^{-1} (\frac{BC}{AB})$

$\theta = sin^{-1} (\frac{20}{60})$

$\theta = 19°28'$

Free body diagram



$\sum$FH = 0 →+ - ←

$\sum$FH $= -T_{BA}cos19°28' + 500$=0

$-T_{BA} = cos19°28' = -500$

$-T_{BA} = \frac{-500}{cos19°28}$

$-T_{BA} = 530.31N$

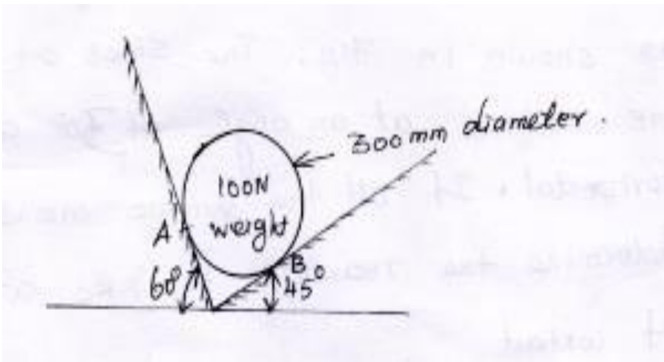
$\sum$FV =0 ↓- ↑+

-400+$R_c - T_{BA}$ sin $19°28'$=0

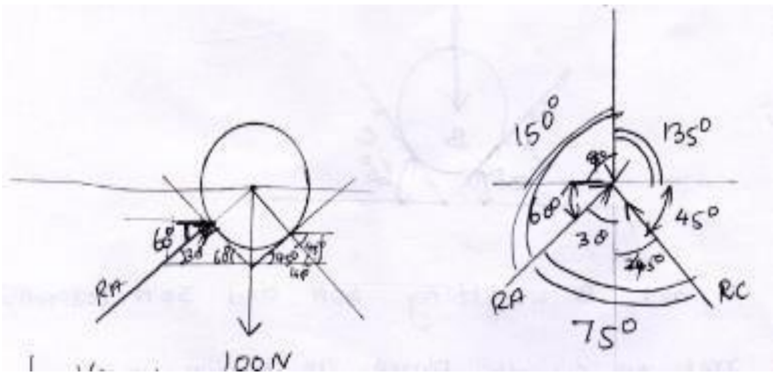
$R_c = T_{BA}sin19°28' + 400 = 530.31 \times sin19°28' + 400$

$R_C - 576.62N$

10. Determine the reaction at a and B



Soln:



By Lami’s theorem

$$\frac{R_A}{sin135} = \frac{R_C}{sin150} = \frac{100}{sin75}$$

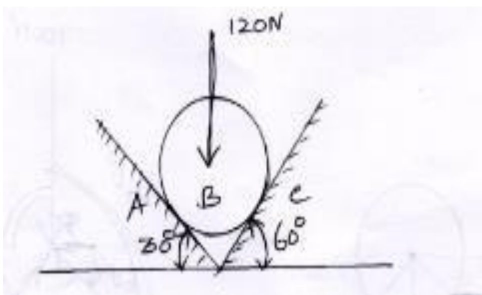
$$\frac{R_A}{sin135} = \frac{100}{sin75} \Rightarrow R_A = \frac{100}{sin75} \times sin135$$

$$R_A = 73.2N$$

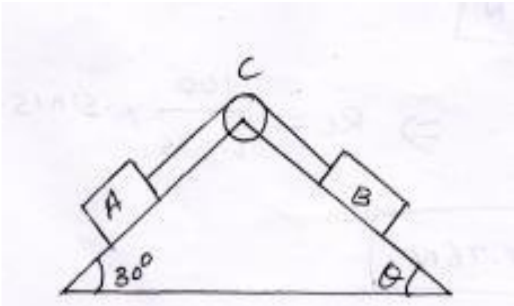
$$\frac{R_C}{sin135} = \frac{100}{sin75} \Rightarrow R_C \frac{100}{sin75} \times sin150$$

$$R_C = 51.76N$$

11. A Ball weighht120N in a right angle groove as shown in fig. The sides of the groove are inclined at an angle of $30° and\ 60°$ to the horizontal. If all the surface are smooth,then determine the reaction RA&RC at the point of contact



12. A and B weighting 40 N and 30 N respectively rest on smooth planes as shown in fig. They are connected by a weight less chord passing over a friction less pulley. Determine the angleθ &the tension in the chord for equilibrium. Also find the reaction of Block A&B



Given:

WA=40N

WB=30N

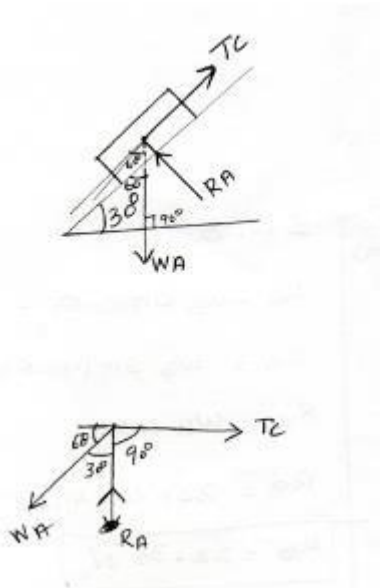
To find

1.θ

2. Reaction of Block A&B

Soln

F B D of Block A



$\sum FH = 0$

TC-WA cos 60=0

TC = WA cos 60

TC = 40 cos 60

TC = 20N

$\sum FV = 0$

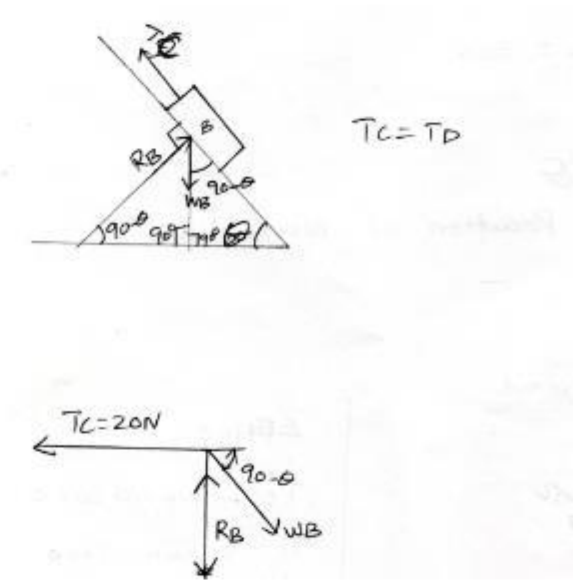
+RA - WA sin 60=0

+ RA = WA sin 60

RA = 40 sin 60

RA = 34.64N

FBD of Block B



$\sum FH = 0$

$-T_C + W_B \times \cos(90-\theta) = 0$

$-T_C = -W_B \cos(90-\theta)$

$\sum FV = 0$

$R_B - W_B \sin(90-\theta) = 0$

$R_B = W_B \sin(90-\theta)$

T_C=$W_B$sinθ

20=30sinθ

sinθ $= \frac{20}{30}$

$\theta = sin^{-1} (\frac{20}{30})$

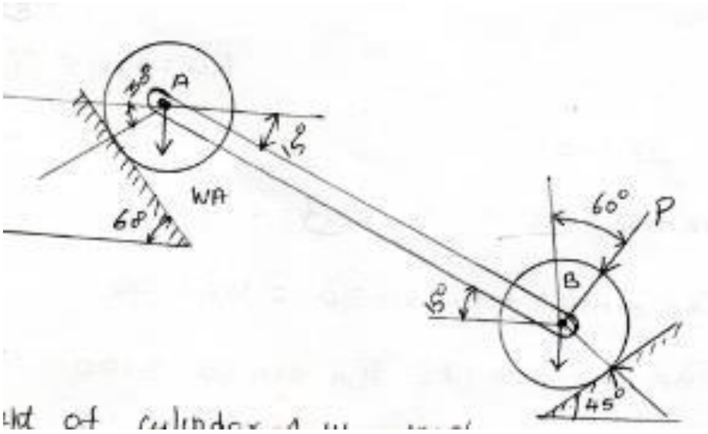
$\theta = 41°48'$

R_B= $W_B$cosθ

R_B=30× $cos 41°48'$

$R_B = 22.36N$

13. The following fig shows cylinders, A of weight 100 N and B weight 50 N resting on smooth inclined planes. They are connected by a bar of negligible weight hinged to each cylinder at their geometric centers by smooth pins. Find the force P, that can hold the system in the given position.



Given:

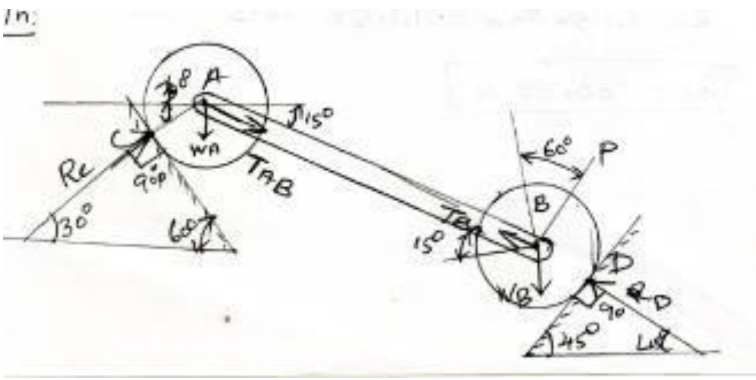
Weight of cylinder A $W_A = 100\ N$

Weight of cylinder B $W_B = 50\ N$

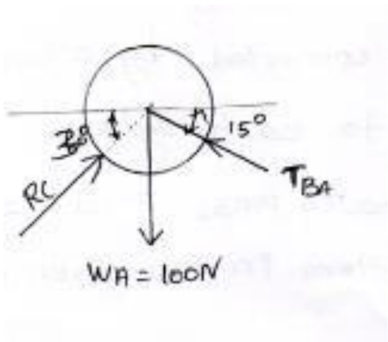
To find:

Force ‘P’

Soln:



<u>**Free body diagram for cylinder A**</u>



$\sum$FH = 0

$\sum$FH $= R_C cos30 - -T_{BA} cos15$=0

$R_C cos3 = T_{BA} cos15$

$R_C = \frac{T_{BA} cos15}{cos30}$

$R_C = 1.115 T_{BA}$---------------- (1)

$\sum$FV = 0

$\sum$FV - $W_A + T_{BA} sin15 + R_C sin30 = 0$

$T_{BA}sin15 + R_C sin30 = W_A = 0$

$T_{BA}sin15 + 1.115\, T_{BA}sin30 = 0$

$[sin15 + 1.115sin30] = 100$

$T_{BA} = \frac{100}{sin15+1.115sin30}$

$T_{BA} = 122.5\ N$

$R_C = 1.115 \times T_{BA} = 1.115 \times 122.5 R_C = 136.58N$

Free body diagram of cylinder B

∑FH = 0 →+ - ←

$T_{AB}cos15 - Pcos30 - R_D 45 = 0$

$122.5\ cos15° - Pcos30 - R_D cos45 = 0$

$118.32 - 0.866P - 0.707R_D$=0

$-0.866P - 0.707R_D = -118.32$-------- (1)

∑FV =0 ↓- ↑+

-$W_{B\_}Psin30 - T_{AB}sin15 + R_D sin45 = 0$

$-50 - P \times sin30 - 122.5sin15 + R_D sin45 = 0$

-50 $- 0.5P - 31.7 + 0.707\ R_D = 0$

$-81.7 - 0.5P + 0.707\ R_D = 0$

$0.707\ R_D - 0.5P = 81.7$

$-0.5P + 0.707R_D = 81.7$----------------- (2)

(1)$\Rightarrow -0.866P - 0.707R_D = -118.32$

(2)$\Rightarrow \quad -0.5P + 0.707R_D \quad = 81.7$

-0.366P = -36.62

P=$\frac{36.62}{0.366}$

P=100 N

Substitute in (1)

$-0.866P - 0.707R_D = -118.32$

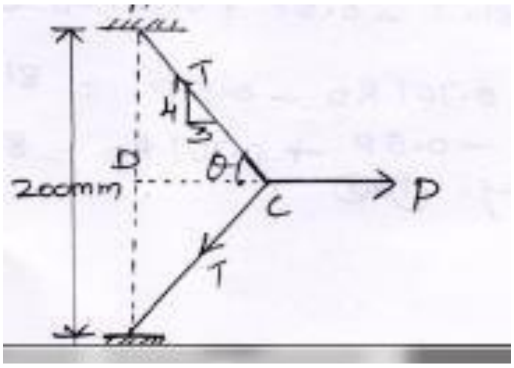
$-86.6 - 0.707 \times R_D = -118.32$

$-0.707R_D = -118.32 + 86.6 = -32$

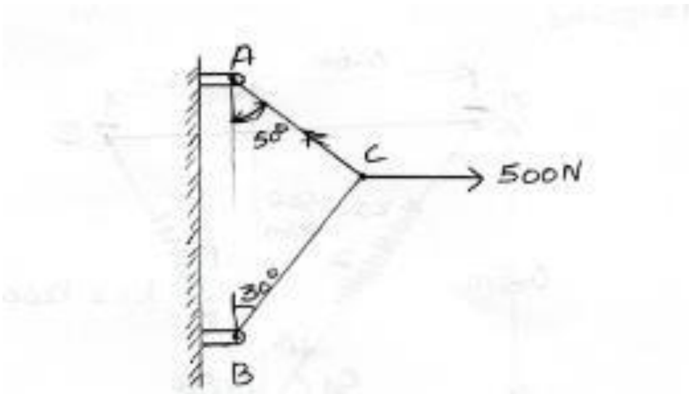
$R_D = \frac{-32}{-0.707}$

$R_D = 45.26N$

14. A rubber band has an unstretuched length of 200mm.It is pulled until its length is 250mm. as shown in fig. the horizontal force P is 1.75 n. what is the tension in the band (HW)



15. Two cables are tied together at c and are loaded as shown in fig below. Determine the tension in the cable AC and BC



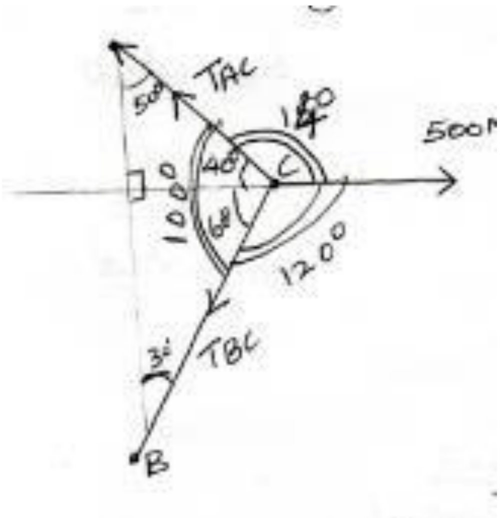
Given:

Force on C=500 N

To find: Tension of cable AC & Bc

Soln:

Free body Diagram



By using Lami's Theorem

$$\frac{T_{AC}}{sin120} = \frac{T_{BC}}{sin140} = \frac{500}{sin100}$$

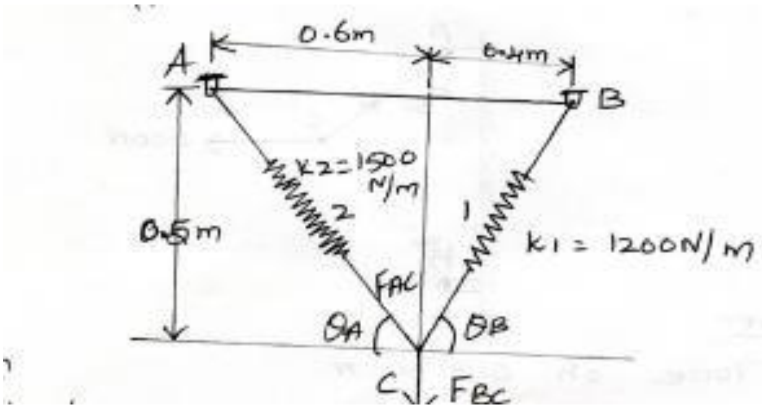
$$\frac{T_{AC}}{sin120} = \frac{500}{sin100} \Rightarrow T_{AC} = \frac{500}{sin100} \times sin120$$

$$T_{AC} = 439.69N$$

$$\frac{T_{BC}}{sin140} = \frac{500}{sin100} \Rightarrow T_{BC} \frac{500}{sin100} \times sin140$$

$$T_{BC} = 326.35N$$

16. A 30kg block is suspended by two spring having stiffness as shown. Determine the instructed length of each spring after the block is removed.

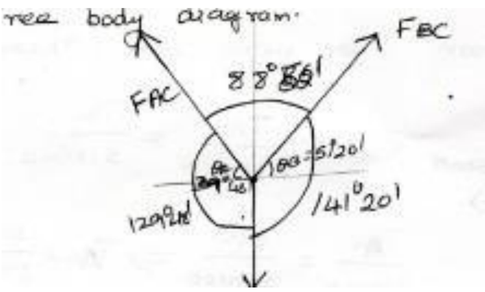


Unknown

Length of each spring L1&L2

Soln:

Free body diagram



$$= tan\theta_B = \frac{0.5}{0.4}$$

$$\theta_B = 51°20'$$

$$= tan\theta_A = \frac{0.5}{0.6}$$

$$\theta_A = 39°48'$$

F=30 kg=30× 9.81

=294.3N

By Lami's theorem $\frac{FAC}{sin141°20'} = \frac{F_{BC}}{sin129°48'} = \frac{294.3}{sin88°52'}$

$$\frac{F_{AC}}{sin141°20'} = \frac{294.3}{sin88°52'} \Rightarrow F_{AC} = \frac{294.3}{sin88°521} \times sin141°20'$$

$F_{AC} = 183.91N$

$\frac{F_{BC}}{sin129°48'} = \frac{294.3}{sin88°52'}$

$F_{BC} = \frac{294.3}{sin88°52'} \times sin129°48'$

$F_{BC} = 226.15N$

Stiffness $= \frac{Force}{Deflection}$

$k_2 = \frac{F_{AC}}{\delta_2}$

$1500 = \frac{183.91}{\delta_2}$

$\delta_2 = 0.122m$

$k_1 = \frac{F_{BC}}{\delta_1}$

$1200 = \frac{226.15}{1}$

$\delta_2 = 0.188m$

$L_1 = \sqrt{(0.4)^2 + (0.5)^2} = 0.6403m$

$L_2 = \sqrt{(0.6)^2 + (0.5)^2} = 0.7810m$

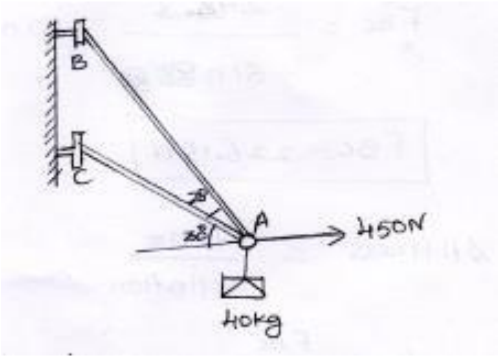
$l_1 = L_1 - \delta_1 = 0.6403 - 0.188$

$l_1 = 0.452m$

$l_2 = L_2 - \delta_2 = 0.7810 - 0.122$

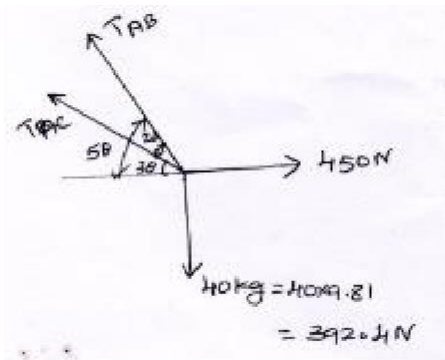
$l_2 = 0.728m$

17.Determine th3e tension in cables AB and AC required to hold the 40 kg crate shown in fig. below.



<u>To find</u>:T_{AB}&T_{AC}

<u>Soln:</u>



$\sum FH = 0 \quad \rightarrow+ \quad -\leftarrow$

$450 - T_{AB}cos50 - T_{AC}cos30 = 0$

$T_{AB}cos50 + T_{AC}cos30 = 450$

$0.64T_{AB} + 0.86T_{AC} = 450$----------(1)

$\sum FV = 0 \downarrow- \ \uparrow+$

$-392.4 + T_{AB} sin50 + T_{AC} sin30 = 0$

$T_{AB} sin50 + T_{AC} sin30 = 392.4$

$0.76T_{AB} + 0.5T_{AC} = 392.4$---------- (2)

Solving Eq(1)&(2)

(1) $\Rightarrow 0.64T_{AB} + 0.86 = 450$

(2)$\times$ 1.72 $\Rightarrow 0.76T_{AB} + 0.85T_{AC} = 392.4$

-0.46T_{AB} = -224.92

$$T_{AB} = \frac{224.92}{0.46}$$

$$T_{AB} = 488.95N$$

T_{AB} *sub in* (1)

$0.64 \times 488.95 + 0.86T_{AC} = 450$

$$T_{AC} = 159.38N$$