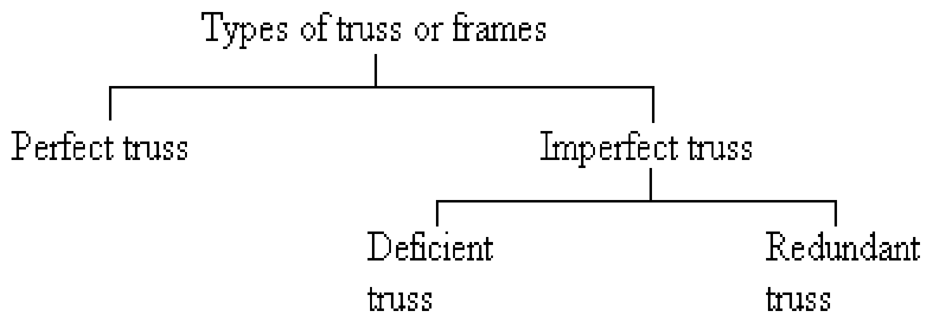
Unit No.2

Part 1

Trusses or frames

Q1. Define truss. State and explain different types of trusses.

Ans: A frame or truss is defined as a structure made up of several members welded or bolted together.



a) Perfect truss- A truss in which numbers of members are just sufficient to keep it in equilibrium is called as perfect truss. OR

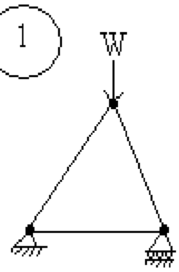
A truss which satisfies the equation m= 2j-3 is called as perfect truss.

Where

m = number of members

j = number of joints

e.g. 1



$m = 3$

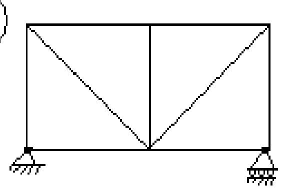
$j = 3$

$2j-3 = 2x3-3$

$= 3$

$= m$

2



$m = 9$

$j = 6$

$2j-3 = 2x6-3$

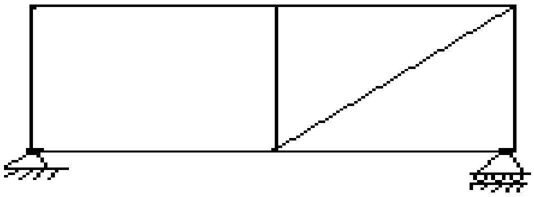
$= 9$

$= m$

b) Imperfect truss- A truss which does not satisfies the equation m= 2j-3 is known as imperfect truss.

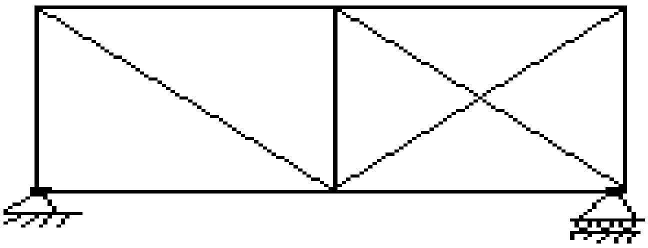
It is further divided in to two types.

1. **Deficient truss –** A truss in which numbers of members are less than 2j-3 is called as deficient truss. (m< 2j-3)



$m = 8$
$j = 6$
$2j-3 = 2x6-3$
$= 9$

2. Redundant truss - A truss in which numbers of members are greater than 2j-3 is called as redundant truss. (m> 2j-3)

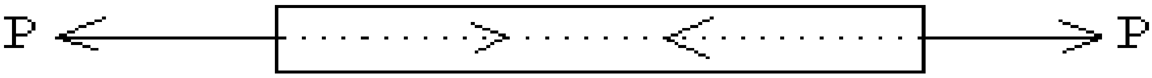


$m = 10$
$j = 6$
$2j-3 = 2x6-3$
$= 9$

Q2. Explain different stresses / forces / members in a truss.

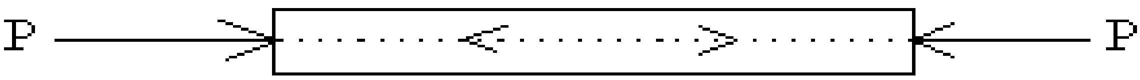
Ans: There are two different types of stresses / forces / members in a truss.

1. Tensile stress/Tensile force/ tension member



Sometimes a member is pulled outward by two equal and opposite forces, the member tends to extend as shown. The stresses induced in a member are called as tensile stresses. The corresponding force is called as tensile force and corresponding member is called as tension member.

2. Compressive stress/Compressive force/ Compression member -



Sometimes a member is pushed inward by two equal and opposite forces, the member tends to shortened in its length as shown. The stresses induced in a member are called as Compressive stresses. The corresponding force is called as Compressive force and corresponding member is called as Compression member.

Q3. State the assumptions made in the analysis of truss.

Ans: Following are the assumptions made in the analysis of truss.

1. All the members are pin jointed.
2. The truss is loaded only at the joints.
3. The self weight of members is negligible and hence neglected.
4. The truss is a perfect truss.
5. All members have uniform cross sectional area

Q4.State the difference between Method of joints and Method of section.

Method of joints

i) This method is used when forces in all members of the truss are required to find out.

ii) The unknown forces are found out by using following condition of equilibrium

$\Sigma Fx = 0, \Sigma Fy = 0$

Method of section

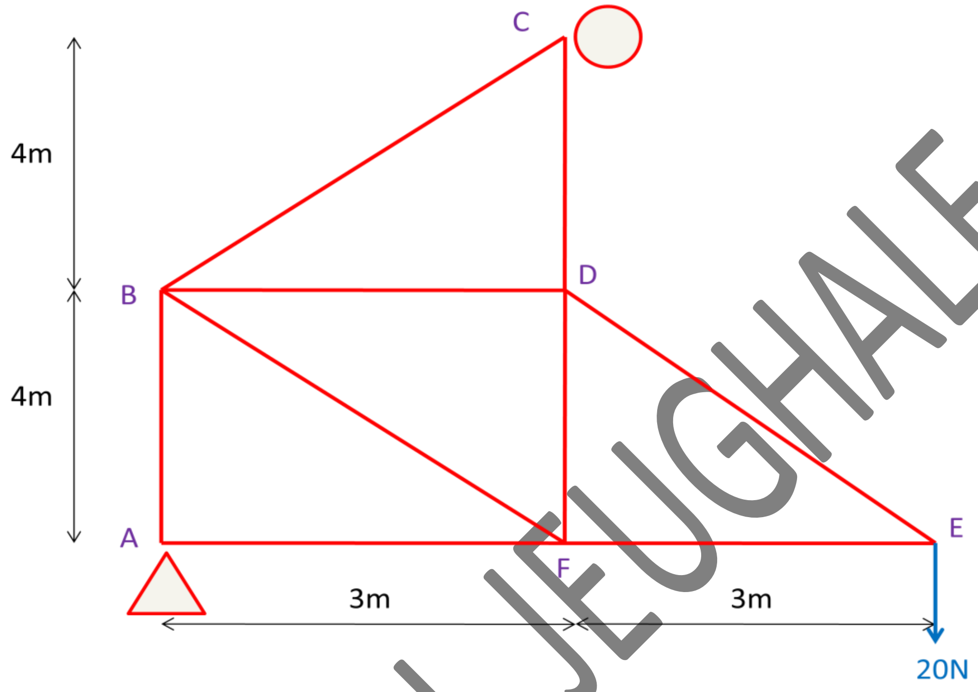
i) This method is used when forces in few members are required to find out.

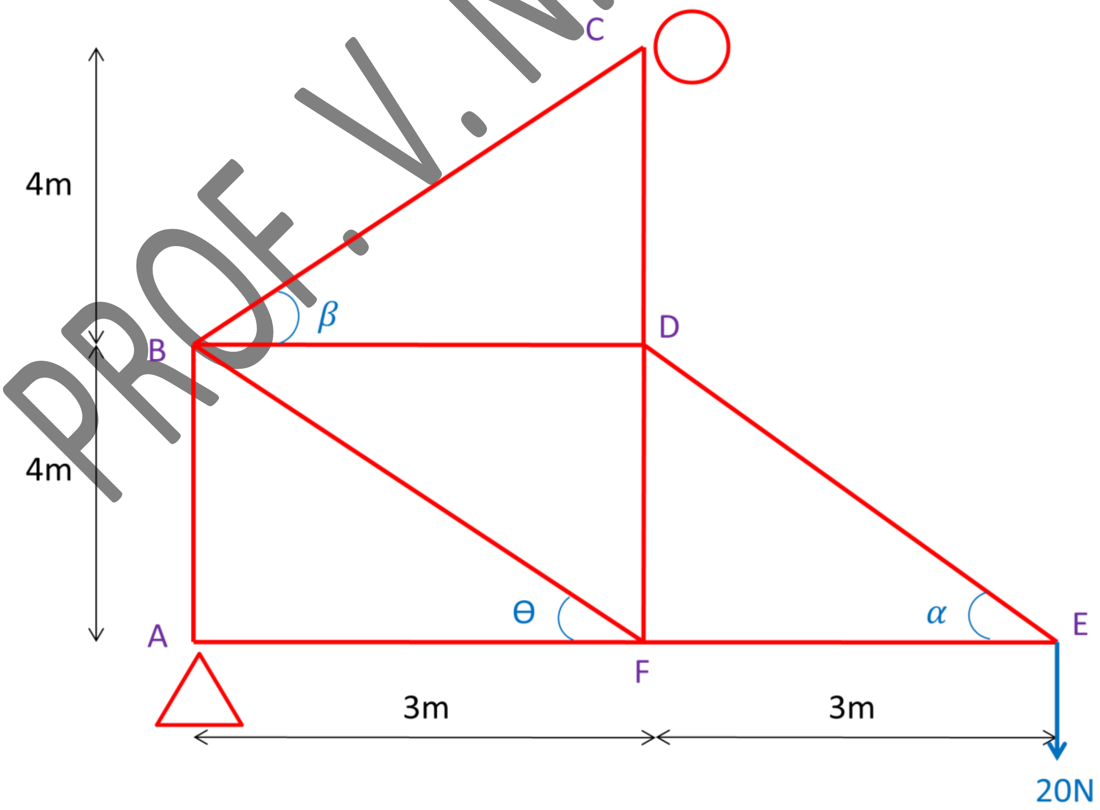
ii) The unknown forces are found out by using following condition of equilibrium

$\Sigma M = 0$

Numerical:-

Analyze the truss given below.





Let,

Θ be the inclination of member BF,

β be the inclination of member BC,

α be the inclination of member DE.

Inclination of BF i.e. Θ

$$\tan\Theta = \frac{4}{3}$$

$$\Theta = \tan^{-1}\frac{4}{3}$$

$$\Theta = 53.13°$$

As the length of horizontal & vertical member is same,

$$\therefore\ \Theta = \beta = \alpha = 53.13°$$

To determine the reaction VA,

Making algebraic sum of all the forces which are acting in Vertical direction i.e.

$$\Sigma_V^{\uparrow+} = 0$$

$$VA - 20 = 0$$

$$VA = 20N$$

To determine the reaction RC,

Taking moment @ joint A,

$$M_{@A} = 0$$

$$-RCx8 + 20x6 = 0$$

$$RC = \frac{20x6}{8}$$

$$RC = \frac{120}{8}$$

$$RC = 15N$$

Now to determine reaction HA,

Making algebraic sum of all the forces which are acting in horizontal direction i.e.

$$\Sigma_{H}^{\rightarrow +} = 0$$

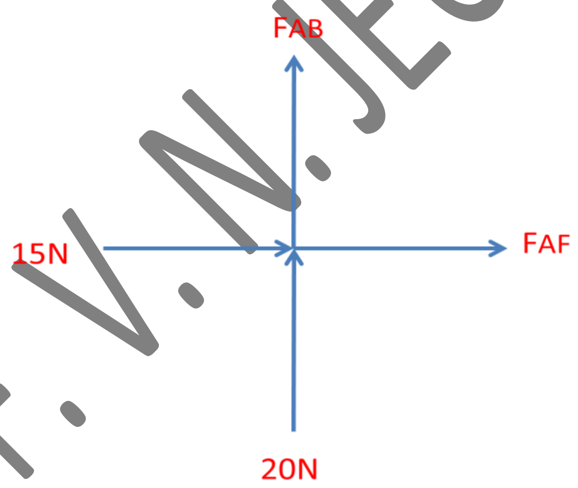
$$HA - 15 = 0$$

$$HA = 15N$$

Now, chose such a joint in the truss where there are only two unknown after drawing FBD of that joint.

So in this truss joint A & E are such a joint where there are only two unknown after drawing FBD of these joint.

Initially Consider FBD of joint A.



$$\Sigma_{V}^{\uparrow +} = 0$$

$$20 + FAB = 0$$

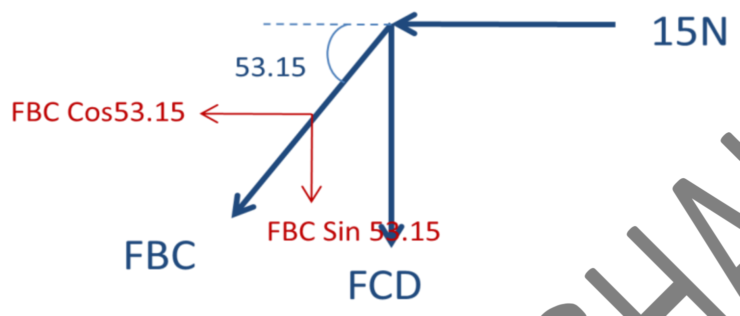
$$FAB = -20N$$

$$\Sigma_{H}^{\rightarrow +} = 0$$

$$FAF + 15 = 0$$

$$FAF = -15N$$

Consider FBD of joint C



$$\Sigma_{\mathrm{H}}^{\rightarrow +} = 0$$

$$-15 - FBC\ Cos53.13 = 0$$

$$FBC = \frac{-15}{Cos53.13}$$

$$FBC = -25N$$

$$\Sigma_{V}^{\uparrow +} = 0$$

$$-FCD - FBC\ Sin53.13 = 0$$

$$-FCD - (-25)\ Sin53.13 = 0$$

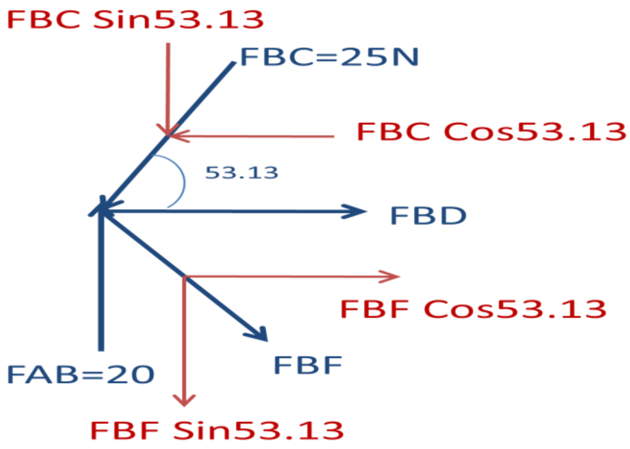
$$-FCD + 25\ Sin53.13 = 0$$

$$-FCD = -25\ Sin53.13$$

$$FCD = 25\ Sin53.13$$

$$FCD = 20N$$

Considering FBD of joint B



$$\Sigma_V^{\uparrow+} = 0$$

$$20 - FBFSin53.13 - FBCsin53.13 = 0$$

$$20 - FBFSin53.13 - 25sin53.13 = 0$$

$$-FBFSin53.13 = 25sin53.13 - 20$$

$$FBFSin53.13 = -25sin53.13 + 20$$

$$FBF = \frac{-25sin53.13 + 20}{Sin53.13}$$

$$FBF = 3.34x10^{-5}$$

$$FBF = 0$$

$$\Sigma_H^{\rightarrow+} = 0$$

$$FBD + FBFCos53.13 - FBC\ Cos53.13 = 0$$

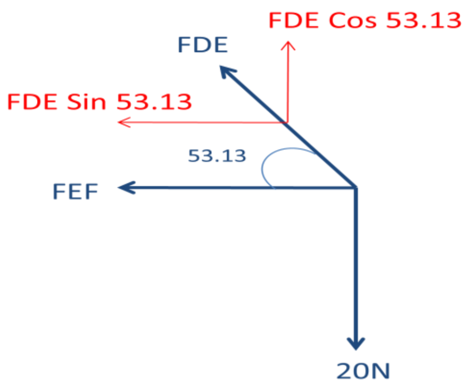
$$FBD + (0)Cos53.13 - FBC\ Cos53.13 = 0$$

$$FBD - 25\ Cos53.13 = 0$$

$$FBD = 25\ Cos53.13$$

$$FBD = 15N$$

Consider FBD joint E



$$\Sigma_V^{\uparrow +} = 0$$

$$-20 + FDE\ Sin\ 53.13 = 0$$

$$FDE = \frac{20}{Sin\ 53.13}$$

$$FDE = 25N$$

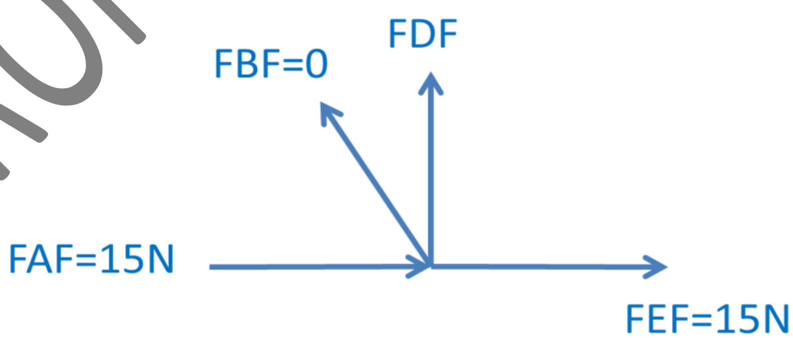
$$\Sigma_{\mathrm{H}}^{\rightarrow +} = 0$$

$$-FEF - 25Cos\ 53.13 = 0$$

$$-FEF = 25Cos\ 53.13$$

$$FEF = -15N$$

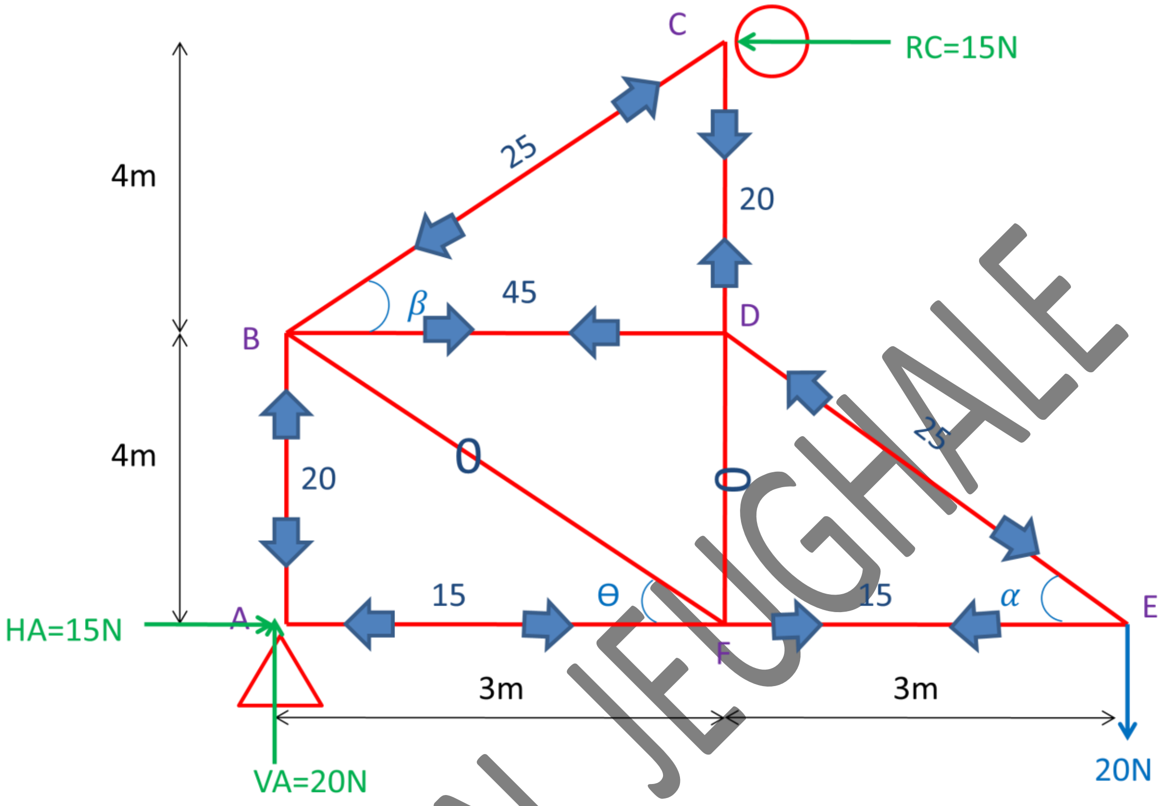
Consider FBD of joint F



$$\Sigma_V^{\uparrow +} = 0$$

$$FDF = 0$$

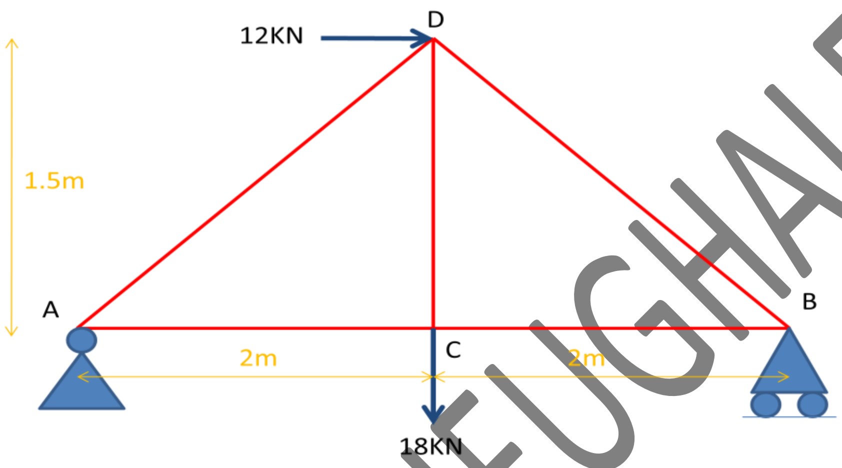
$$FDF = 0$$

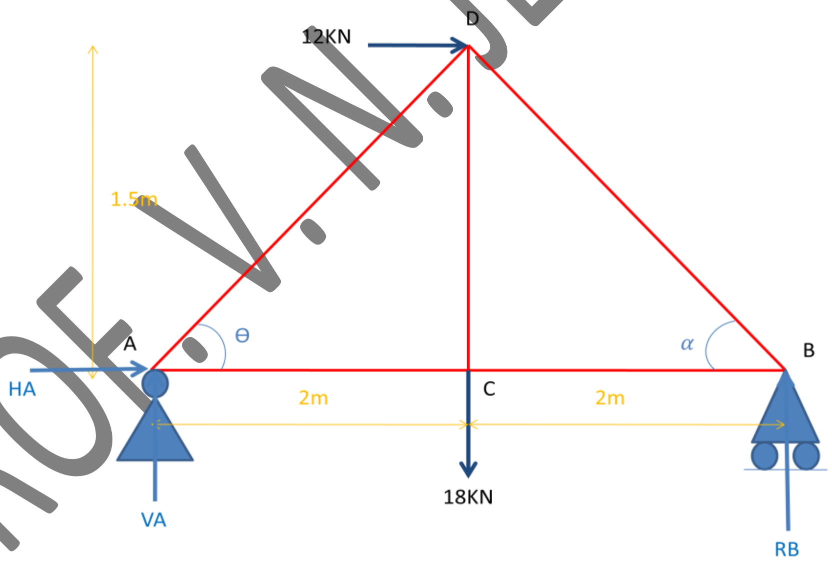


Joint	Member	Magnitude	Nature
A	AB AF	20N 15N	Compressive Compressive
B	BC BD BF	25N 45N 0	Compressive Tensile Null
D	CD DE DF	20N 25N 0	Tensile Compressive Null

F	EF	15N	Tensile

2) Determine the forces in all the member of truss.





Let,

Ɵ be the angle between AD with Horizontal

α be the angle between BD with horizontal

$$tan\theta = \frac{1.5}{2}$$

$$\theta = 36.86°$$

$$tan\alpha = \frac{1.5}{2}$$

$$\alpha = 36.86°$$

To determine the reaction RB,

Taking moment @ joint A,

$$M_{@A} = 0$$

$$18x2 - RBx4 + 12x1.5 = 0$$

$$RB = 13.5KN$$

Making algebraic sum of all the forces which are acting in Vertical direction i.e.

$$\Sigma_V^{\uparrow +} = 0$$

$$RB + VA - 18 = 0$$

$$13.5 + VA - 18 = 0$$

$$VA = 4.5KN$$

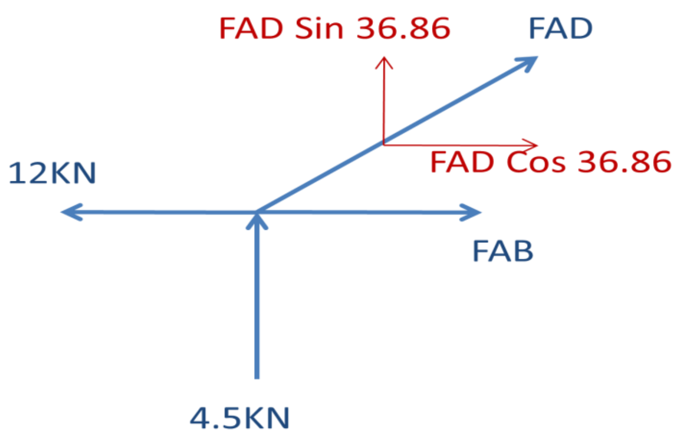
Making algebraic sum of all the forces which are acting in horizontal direction i.e.

$$\Sigma_{\mathrm{H}}^{\rightarrow +} = 0$$

$$HA + 12 = 0$$

$$HA = -12KN$$

Considering FBD of joint A



$$\Sigma_V^{\uparrow +} = 0$$

$$4.5 + FAD\ Sin\ 36.86 = 0$$

$$FAD\ Sin\ 36.86 = -4.5$$

$$FAD = \frac{-4.5}{Sin\ 36.86}$$

$$FAD = -7.50KN$$

$$\Sigma_H^{\rightarrow +} = 0$$

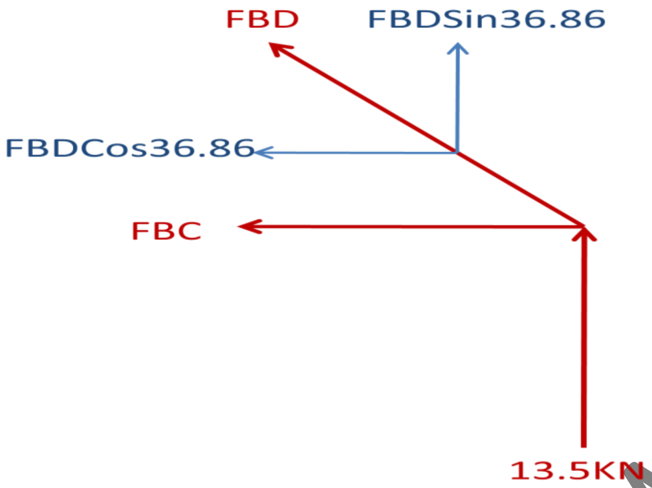
$$FAC + FADCos\ 36.86 - 12 = 0$$

$$FAC + (-7.50)Cos\ 36.86 - 12 = 0$$

$$FAC = 12 + 7.50Cos36.86$$

$$FAC = 18KN$$

Considering FBD of joint B



$$\Sigma_V^{\uparrow +} = 0$$

$$13.5 + FBD\ Sin\ 36.86 = 0$$

$$FBD\ = \frac{-13.5}{Sin\ 36.86}$$

$$FBD\ = -22.50KN$$

$$\Sigma_{\mathrm{H}}^{\rightarrow +} = 0$$

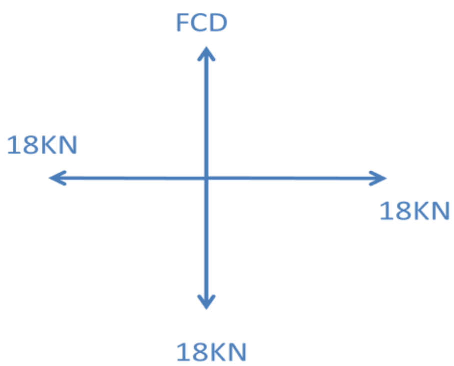
$$-FBC - FBDCos\ 36.86 = 0$$

$$-FBC - (-22.50)Cos\ 36.86 = 0$$

$$FBC = 22.50Cos\ 36.86$$

$$FBC\ = 18KN$$

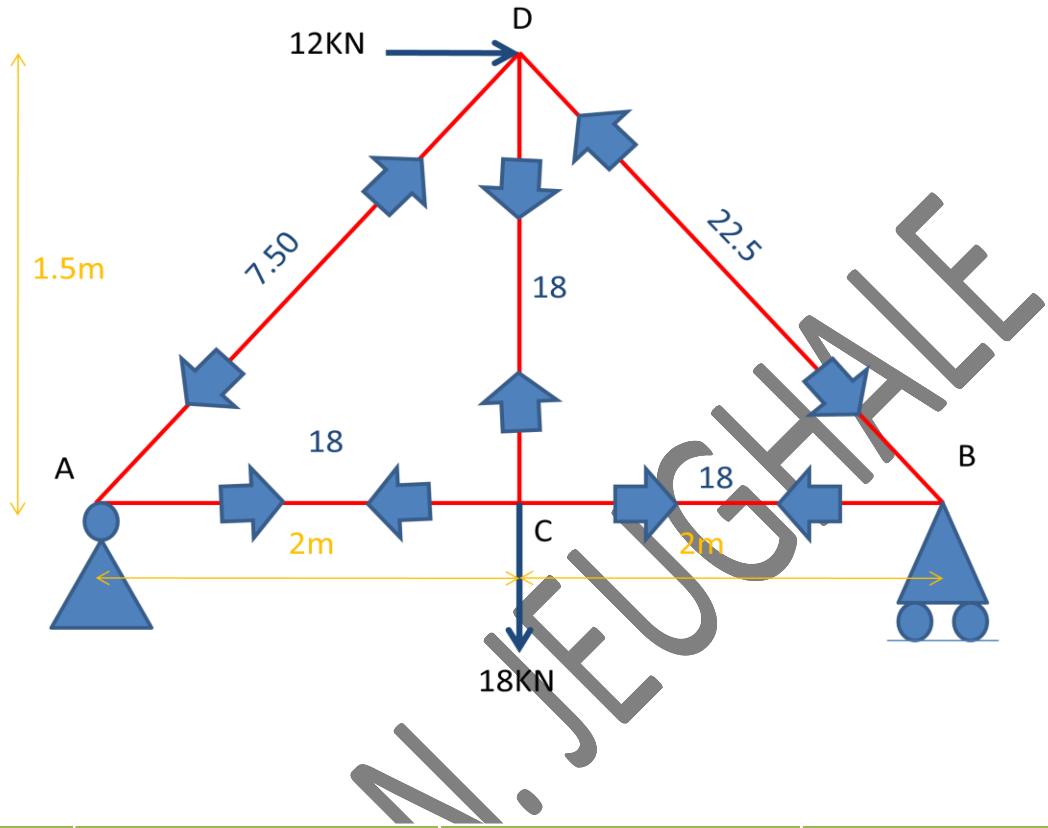
Considering FBD of joint C



$$\Sigma_V^{\uparrow +} = 0$$

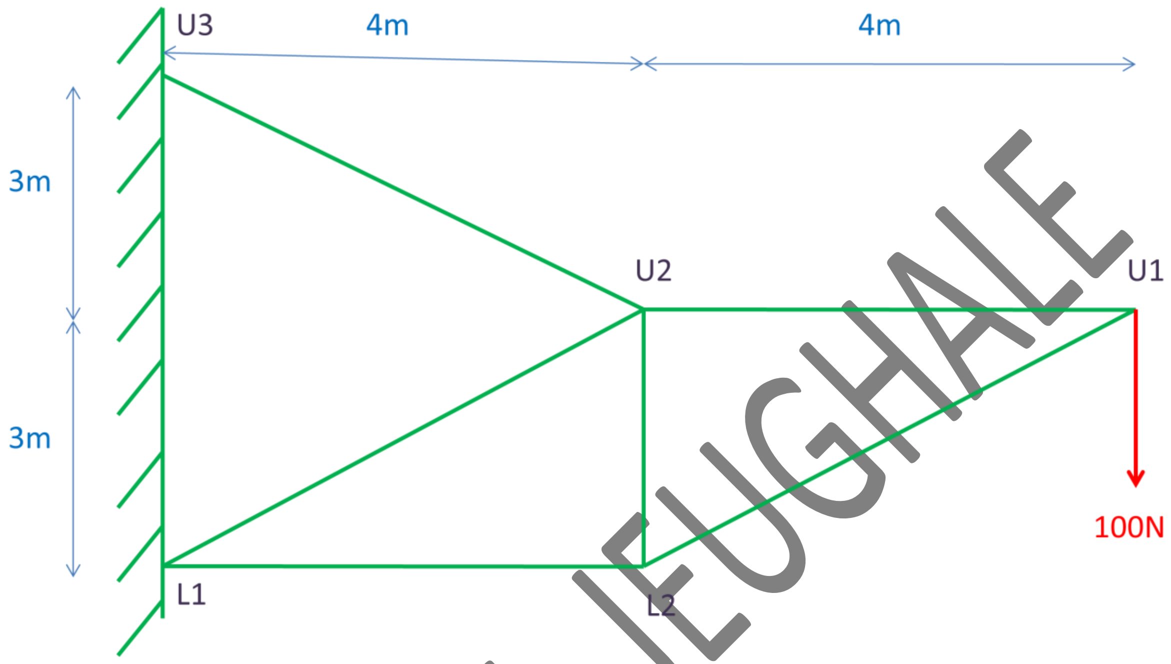
$$FCD - 18 = 0$$

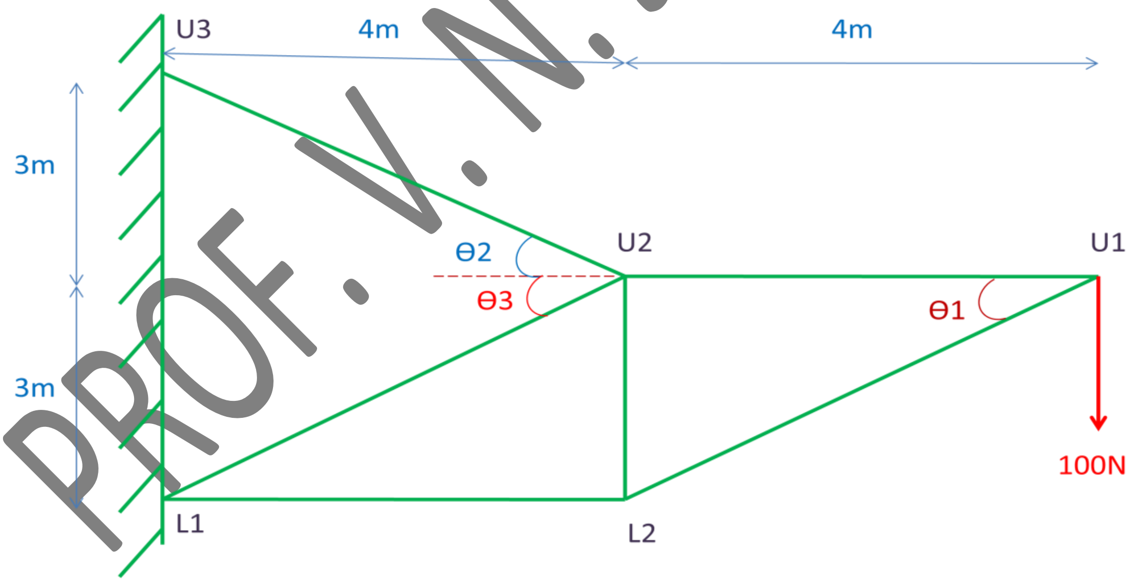
$$FCD = 18KN$$



Joint	Member	Magnitude	Nature
A	AD AC	7.50 18	Compressive Tensile
D	CD BD	18 22.50	Tensile Compressive
B	BC	18	Tensile

3) Find the forces in all the member of the truss & indicate the result in tabular form





$$tan\theta 1 = \frac{3}{4}$$

$$\theta 1 = 36.86°$$

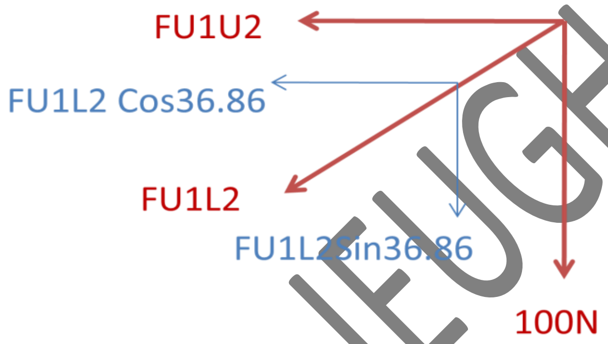
$$tan\theta 2 = \frac{3}{4}$$

$$\theta 2 = 36.86°$$

$$tan\theta 3 = \frac{3}{4}$$

$$\theta 3 = 36.86°$$

Considering FBD joint U1



$$\Sigma_V^{\uparrow +} = 0$$

$$-100 - FU1L2\ Sin\ 36.86 = 0$$

$$FU1L2 \ = \frac{-100}{Sin\ 36.86}$$

$$FU1L2 \ = -166.70N$$

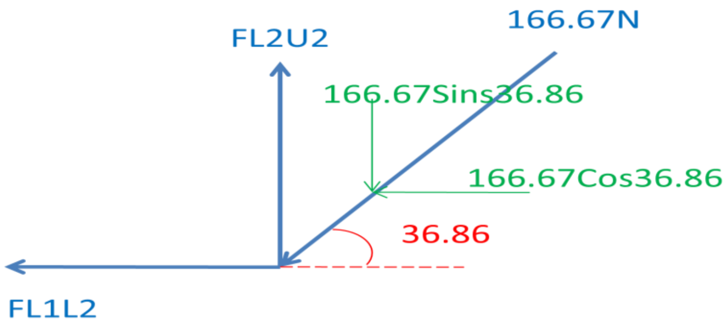
$$\Sigma_H^{\rightarrow +} = 0$$

$$-FU1U2 - FU3L2Cos\ 36.86 = 0$$

$$-FU1U2 - (-166.70)Cos\ 36.86 = 0$$

$$FU1U2 = 133.37N$$

Considering FBD joint L2



$$\Sigma_V^{\uparrow +} = 0$$

$$FL2U2 - 166.70\,Sin\,36.86 = 0$$

$$FL2U2 \ = 166.70\,Sin\,36.86$$

$$FL2U2 \ = 100N$$

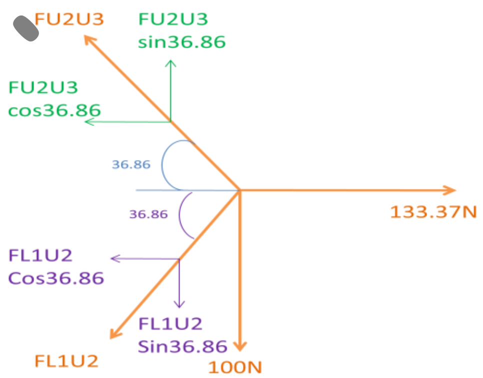
$$\Sigma_H^{\rightarrow +} = 0$$

$$-166.70Cos\,36.86 - FL1L2 = 0$$

$$FL1L2 = -166.70Cos\,36.86$$

$$FL1L2 = -133.37N$$

Considering FBD joint U2



$$\Sigma_V^{\uparrow +} = 0$$

$$FU2U3\,Sin\,36.86 - FL1U2\,Sin\,36.86 - 100 -= 0$$

$$0.5998FU2U3 \ - 0.5998FL1U2 \ = 100 - - - -1)$$

$$\Sigma_{H}^{\rightarrow +} = 0$$

$$-FU2U3Cos\ 36.86 - FL1U2Cos\ 36.86 + 133.37 = 0$$

$$-FU2U3Cos\ 36.86 - FL1U2Cos\ 36.86 = -133.37$$

$$-0.8FU2U3 - 0.8FL1U2 = -133.37$$

$$0.8FU2U3 + 0.8FL1U2 = 133.37 - - - - 2)$$

To solve this equation, multiplying eq.1 by 0.8 & eq. 2 by 0.5998 we get,

$$0.4798FU2U3 - 0.4798FL1U2 = 80$$

$$\underline{0.4798FU2U3 + 0.4798FL1U2 = 79.99}$$

$$0.9596FU2U3 = 159.99$$

$$FU2U3 = 166.72N$$

Put this value in eq. 1

$$0.5998FU2U3 - 0.5998FL1U2 = 100 - - - - 1)$$

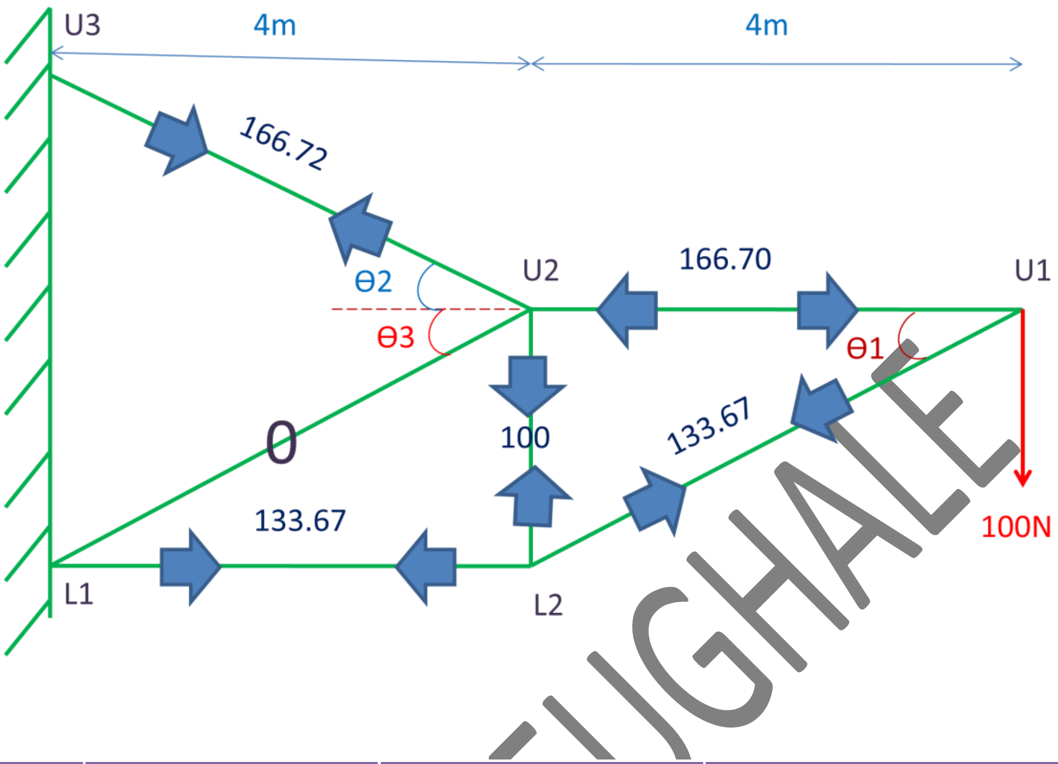
$$0.5998x166.72 - 0.5998FL1U2 = 100$$

$$100 - 0.5998FL1U2 = 100$$

$$-0.5998FL1U2 = 100 - 100$$

$$-0.5998FL1U2 = 0$$

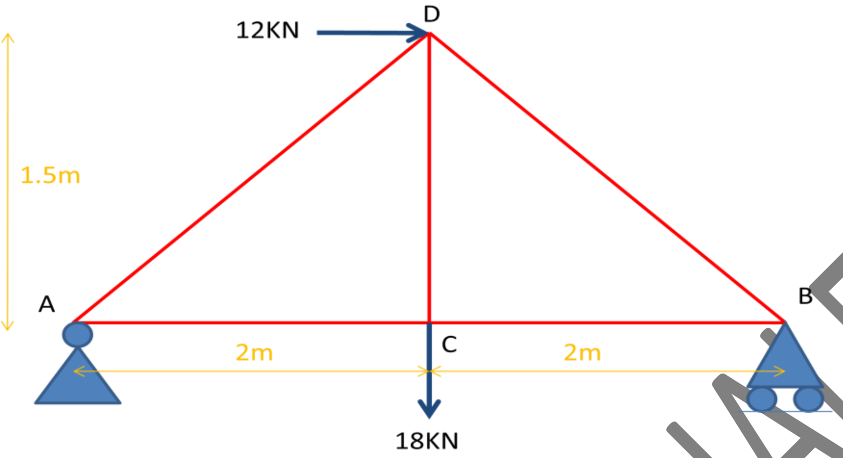
$$FL1U2 = 0$$

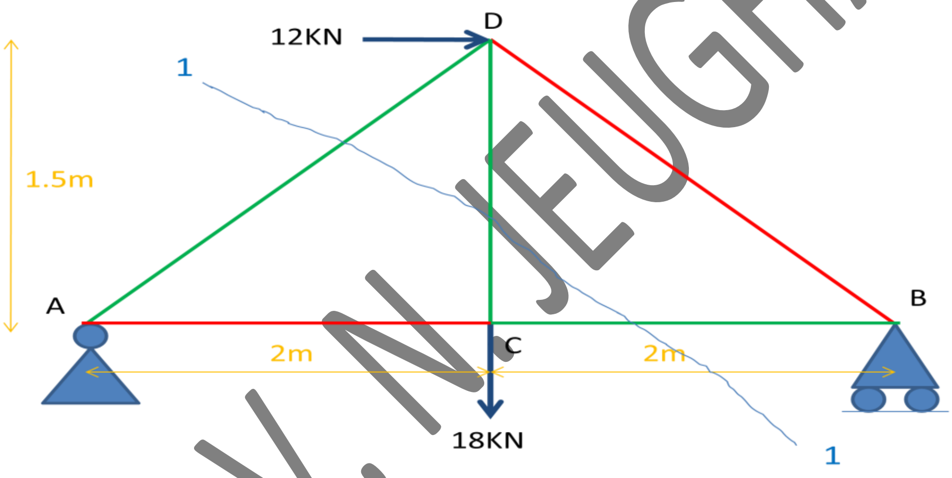


Joint	Member	Magnitude	Nature
U1	U1U2	166.70N	Compressive
	U1L2	133.67N	Tensile
U2	U2U3	166.72N	Tensile
	U2L2	100N	Tensile
	U2L1	0	Null
L1	L1L2	133.37N	Tensile

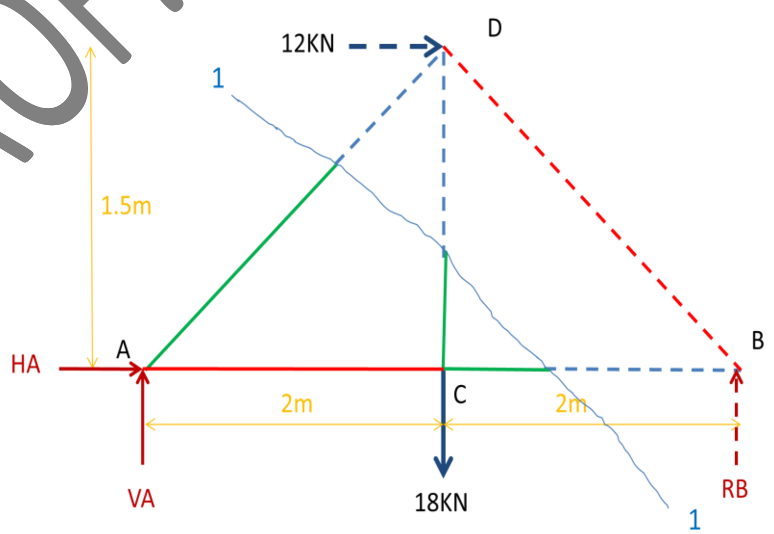
Numericals on method of section

Determine the forces in member AD, CD&BC.





Considering left hand side part from section1-1



To determine the reaction RB,

Taking moment @ joint A,

$$M_{@A} = 0$$

$$18x2 - RBx4 + 12x1.5 = 0$$

$$RB = 13.5KN$$

Making algebraic sum of all the forces which are acting in Vertical direction i.e.

$$\Sigma_V^{\uparrow +} = 0$$

$$RB + VA - 18 = 0$$

$$13.5 + VA - 18 = 0$$

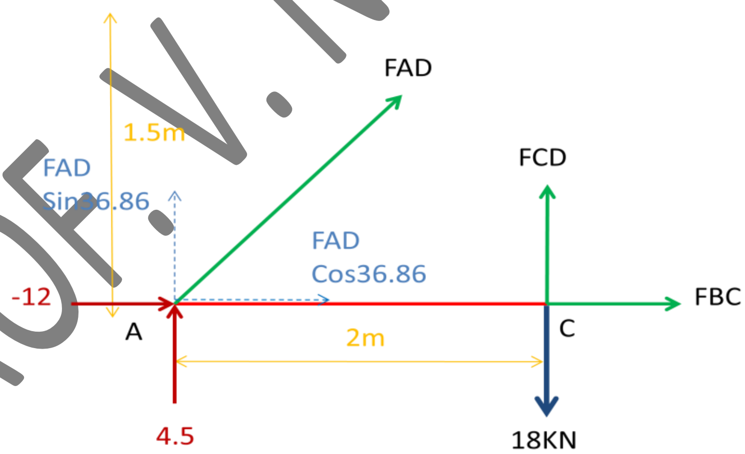
$$VA = 4.5KN$$

Making algebraic sum of all the forces which are acting in horizontal direction i.e.

$$\Sigma_{\mathrm{H}}^{\rightarrow +} = 0$$

$$HA + 12 = 0$$

$$HA = -12KN$$



To determine FAD,

Taking moment @ joint C,

$$M_{@C} = 0$$

$$4.5x2 + FADSin36.86x2 = 0$$

$$FAD = -\frac{9}{Sin36.86x2}$$

$$FAD = -7.50KN$$

To determine FCD,

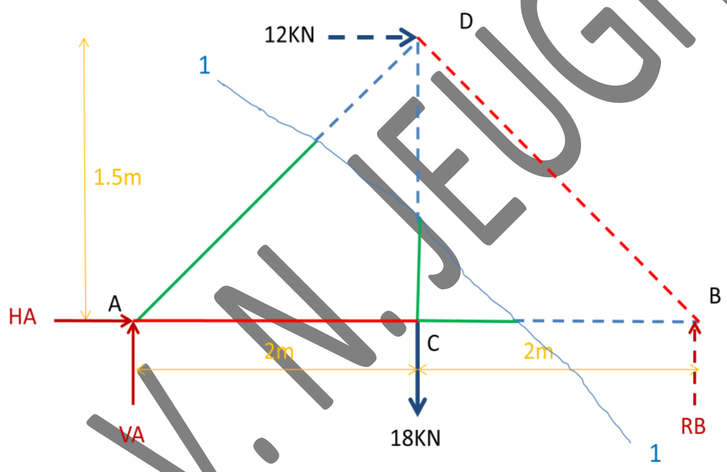
Taking moment @ joint A,

$$M_{@A} = 0$$

$$18x2 - FCDx2 = 0$$

$$FCD = \frac{36}{2}$$

$$FCD = 18KN$$



To determine FBC,

Taking moment @ joint D,

$$M_{@D} = 0$$

$$4.5x2 - (-12x1.5) - FBCx1.5 = 0$$

$$9 + 18 - FBCx1.5 = 0$$

$$FBC = \frac{27}{1.5}$$

$$FBC = 18KN$$

Joint	Member	Magnitude	Nature
A	AD	7.50	Compressive
D	CD	18	Tensile
B	BC	18	Tensile

Part 2

FRICTION

INTRODUCTION:-

It has been observed since long period that all surfaces of the bodies are never perfectly smooth, it is having minutely projecting particle which are not seen by necked eyes, but whenever surface is viewed under the microscope, it is found to have some roughness and irregularities, which may not be detected by an ordinary touch.

When ever one block move or tends to move over another block on which it rests, the interlocking property of the projecting particles opposes the motion. This opposing force, which acts in the opposite direction of the movement of the block, is called *force of friction* or *simply friction*.

TYPES OF FRICTION:-

1} Static friction:- It is the friction experienced by a body when it is at rest. Or in other words it is the friction when the body tends to move.

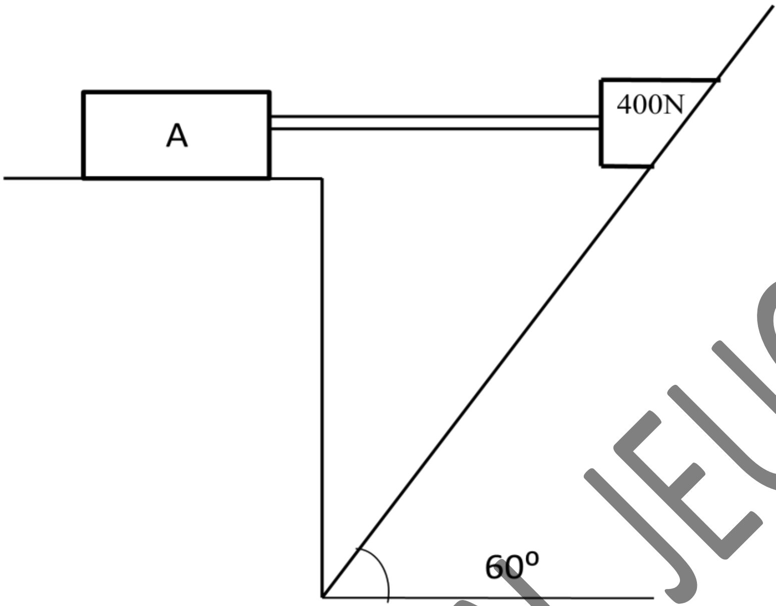
2} Rolling friction:- It is the friction experienced by the body when one body roll over another body.

LIMITING FRICTION:-

ANGLE OF FRICTION (ϴ):-

The angle between

Prob 1. Two blocks connected with a tie rod as shown. If angle of limiting friction for block B is 15^0 and coefficient of friction for block A is 0.40, find the smallest value of weight of block A required to keep the system in equilibrium.

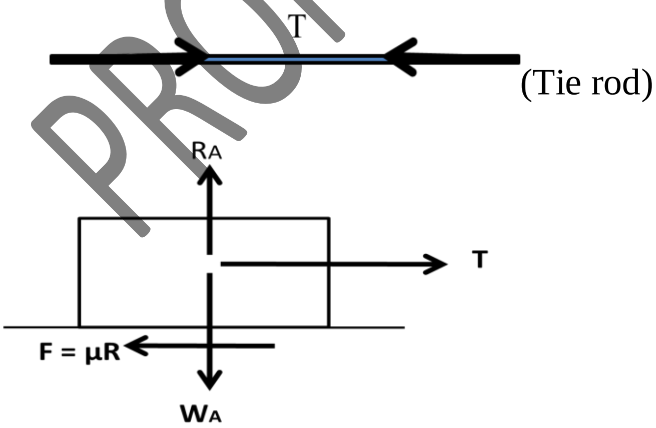


Given: - $W_B = 400$ N, W_A =? $\mu_A = \tan 15 = 0.26$, $\mu_B = 0.40$

Sol:-Considering each block separately

Consider block A

Assume the force in tie rod is T. (Tensile)



$\Sigma Fx = 0 \Longrightarrow \quad T - F = 0$

$+ \quad\quad T - \mu\, RA = 0$

$T - 0.26\,RA = 0$ ……………………….1.

$+\uparrow\ \Sigma Fy = 0 \Longrightarrow \quad R_A - W_A = 0$

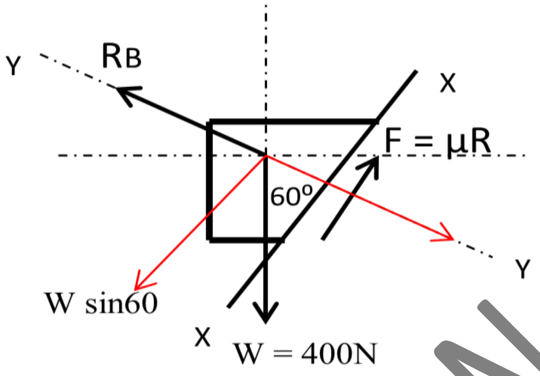
$R_A = W_A$

Putting in equation 1;

$T - 0.26W_A = 0$

$T = 0.26\,W_A$ …………………..2.

Consider block B



$\Sigma Fx = 0 \Longrightarrow \quad F - 400 \sin 60 = 0$

$\xrightarrow{+}$

$\mu\, RB = 0.86W$

$0.4RB = 346.4$

$RB = 866.02$ …………………..1.

$+\uparrow\ \Sigma Fy = 0 \Longrightarrow \quad R_B - W_B \cos 60 = 0$

$866.02 - W_B \cos 60 = 0$

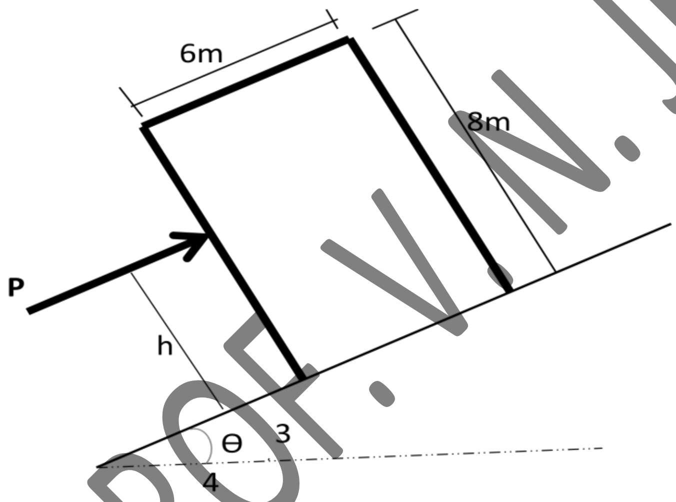
$W_B = 1732.05$ N

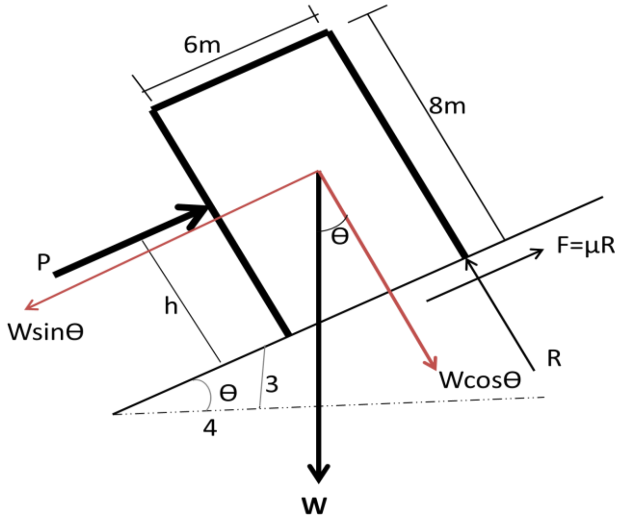
Putting in equation 1;

$T - 0.26W_A = 0$

$T = 0.26\,W_A$ …………………..2.

Prob 2. A block of weight W N rests on an inclined plane as shown. Determine the greatest height h at which the force P may be applied so that the block will slide up the inclined plane without tipping over(Tilting over).Take μ= 0.3. (8-9 marks.)





Sol:-

$\Theta = \tan^{-1}(4/3) = 36.86^o$

$\Sigma Fx = 0 \Longrightarrow$ P- F- W sin36.86 = 0

$\xrightarrow{+}$ P-0.3R-0.59W=0-----------------1.

$+\uparrow \Sigma Fy = 0$ R – W cos 36.86 = 0

R=0.8W Put in eqn 1.

P-0.3R-0.59W=0

P-0.3x 0.8W-0.59W=0

P = 0.83W ----------------2.

$\Sigma M_{@O} = 0$ Pxh –Wsin 36.86x 4 – Wcos36.86x 3 = 0

0.83Wxh - 2.39 W-2.40W = 0

h = 4.79/0.83

h = 5.77 m.

Prob: 3 Determine the value of force P that will just start the system of blocks as shown, moving in right ward direction. Take μ = 0.3 for all contact surfaces.

Sol: here $\Theta = \tan^{-1}(3/4) = 36.86^o$

Consider block 1

$\Sigma Fx = 0 \Longrightarrow$ T- F_1- 200 sin36.86 = 0

$T - 0.3R_1 - 119.97 = 0$

$T - 0.3R_1 = 119.97$ -------- (1)

$+\uparrow \Sigma F_y = 0$ $\quad R_1 - 200\cos 36.86 = 0$

$R_1 = 160.02$ N

Put in equation 1

$T = 0.3 \times 160.02 + 119.97$

$T = 167.97$ N

Consider block 2

$\Sigma F_x = 0 \Longrightarrow$ $\quad P\cos\alpha - T - F_2 = 0$

$P\cos\alpha - 167.97 - 0.3R_2 = 0$ ………………… (2)

$+\uparrow \Sigma F_y = 0$ $\quad P\sin\alpha - R_2 - 300 = 0$

$R_2 = 300 - P\sin\alpha$

Putting this value in eqn 2

$P\cos\alpha - 167.97 - 0.3 \times (300 - P\sin\alpha) = 0$

$P(\cos\alpha + 0.3\sin\alpha) = 257.97$

$P = 257.97/(\cos\alpha + 0.3\sin\alpha)$ ------------ (3)

To get minimum value of P, the denominator must be maximum. To get the maximum value of any term, its derivative should be equated to zero.

$\frac{d}{d\alpha}((\cos\alpha + 0.3\sin\alpha) = 0$

$-\sin\alpha + 0.3\cos\alpha = 0$

$\tan\alpha = 0.3$

$\boldsymbol{\alpha = 16.69^o}$

$P = 257.97/(\cos 16.69 + 0.3\sin 16.69)$

P = 247.09 N.

Prob 4. A 100N cylinder as shown is held at rest by a cord suspending weight P.If slipping impends between the cylinder and the inclined plane determine value of force P and coefficient of friction.

Sol:-

$\Sigma Fx = 0 \Longrightarrow$ F- 100sin30-Psin30 = 0

F – 0.5P= 50 ---------------(1)

$+\uparrow \Sigma Fy = 0$ R -100cos30-Pcos30 =0

R = 0.86P +86.6 ------------------ (2)

$\Sigma M_{@O} = 0$ Fx1 –Px1 = 0

F=P

Put in eqn.1

P-0.5P=50

P = 100N

F = μ (0.86 x100+86.6)-0.5x100 =50

μ = 0.57

Prob 5: Determine the angle ϴ and force T in the cord, if the coefficient of friction for the system of blocks as shown is 0.33

Sol: Consider block 1

$\Sigma Fx = 0 \Longrightarrow$ F_1- 90sinϴ-F_2 = 0

$0.33R_1$ -90sinϴ-$0.33R_2$=0 --------------- (1)

$+\uparrow \Sigma Fy = 0$ R_1 -90cosϴ –R_2 =0

R_1 =90cosϴ+R_2

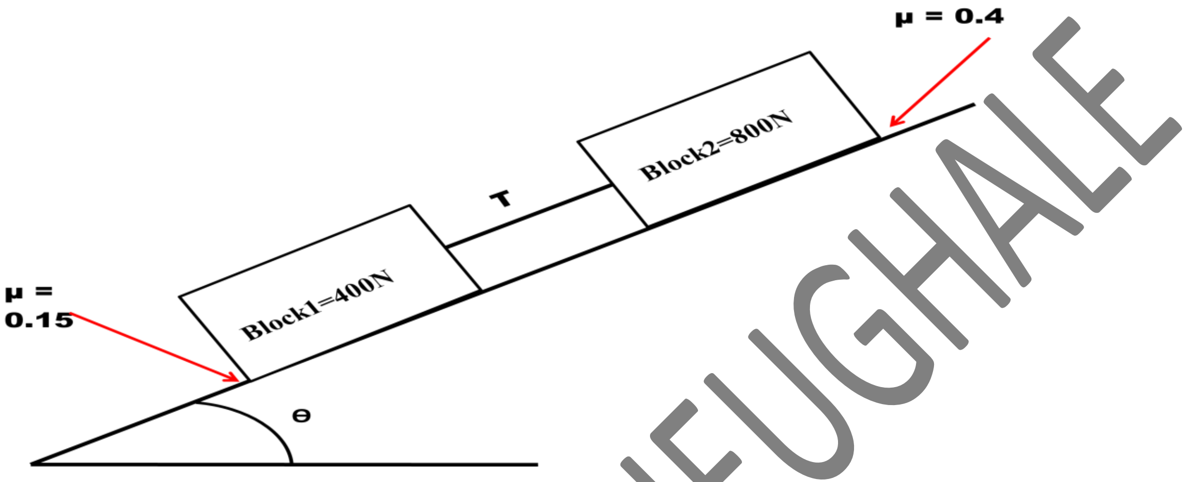
Put in eqn1

0.33(90cosϴ+R_2)-90sinϴ-$0.33R_2$=0

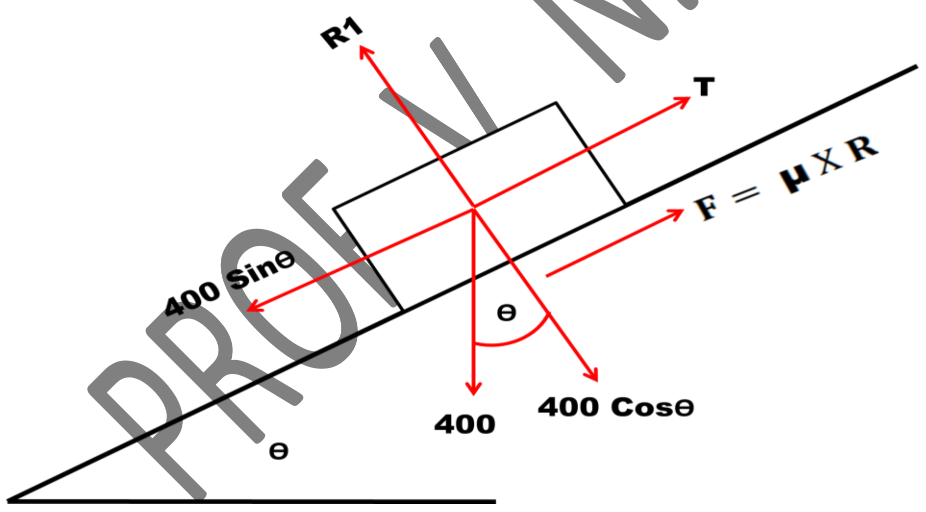
0.66 R_2=90sinϴ-29.7cosϴ ---------------- (2)

Prob.5 A cord connects two blocks as shown resting an inclined plane. If the coeff. Of friction for block of weight 400 N is .15 & for block of wt. 800 is 0.4 determine force in the cord & inclination of the inclined plane when the block are tends to move.

Ans.:-



Consider block 1



$\Sigma Fx = 0 \Longrightarrow$ $\qquad$ **T+ F_1- 400 sinΘ = 0**

T+ 0.15R_1- 400 sinΘ = 0 $\qquad$ **…………..1**

+ $\Sigma Fy = 0$ $\qquad$ **R_1– 400 cos Θ = 0**

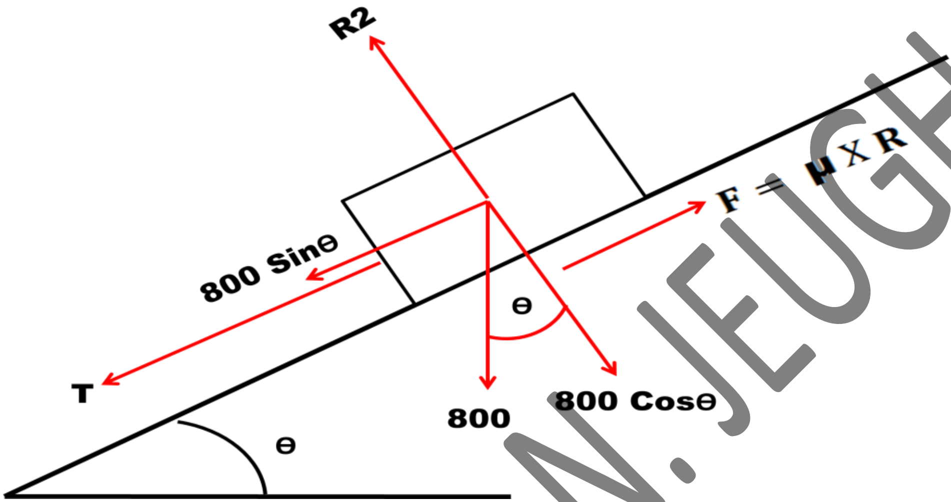
$R_1 = 400 \cos \Theta$ ………….2

Put equ. 2 in equ.1

$T + 0.15 \times (400\cos \Theta) - 400 \sin\Theta = 0$

$T = 400\sin\Theta - 60 \cos \Theta$ ……………. 3

Consider block 2



$\Sigma Fx = 0 \Longrightarrow$ $-T + F_2 - 800 \sin\Theta = 0$

$-T + 0.4R_2 - 800 \sin\Theta = 0$ ………….4

$+ \quad \Sigma Fy = 0$ $R_2 - 800 \cos \Theta = 0$

$R_2 = 800 \cos \Theta$ …………5

Put equ. 5 in equ.4

$-T + 0.4 (800 \cos \Theta) - 800 \sin\Theta = 0$

$T = 320 \cos \Theta - 800 \sin \Theta$

……………6

Equating equation 3 & 6

$400\sin\theta - 60\cos\theta = 320\cos\theta - 800\sin\theta$

$1200\sin\theta = 380\cos\theta$

$\tan\theta = (380/1200)$

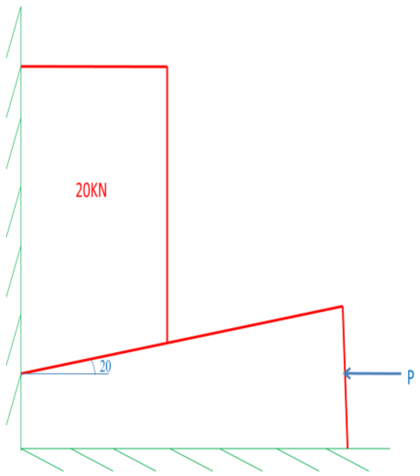
$\theta = 17.37°$

$T = 320\cos(17.37) - 800\sin(17.37)$

$T = 63.37$ N.

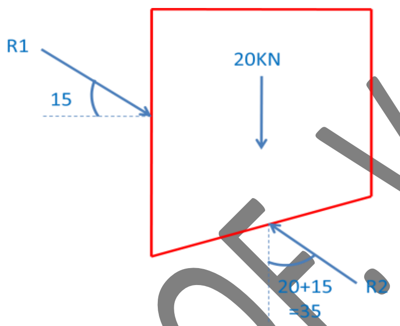
Wedge Friction

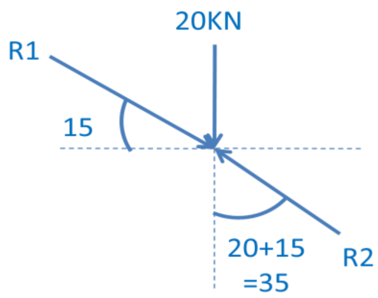
1) Determine the force P required to start the movement of the wedge as shown. The angle of limiting friction for all contact surfaces is 15^0

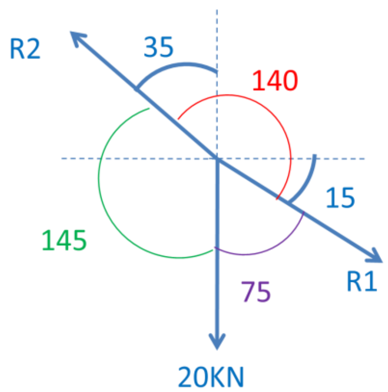


Solution:-

Considering FBD of 20KN block







Applying Lami's theorem

$$\frac{20}{Sin140} = \frac{R1}{Sin145} = \frac{R2}{Sin75}$$

Equating

$$\frac{20}{Sin140} = \frac{R1}{Sin145}$$

$$\text{R1} = \frac{20Sin145}{Sin140}$$

$$\text{R1} = 17.84KN$$

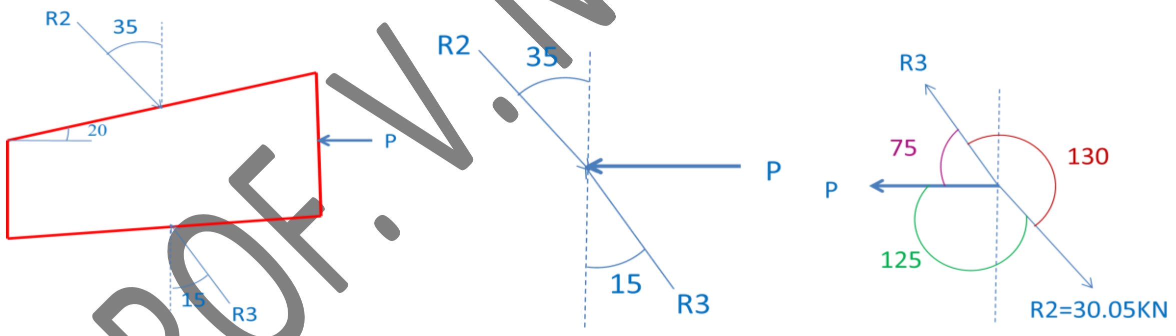
Equating

$$\frac{20}{Sin140} = \frac{R2}{Sin75}$$

$$\text{R2} = \frac{20Sin75}{Sin140}$$

$$\text{R1} = 30.05KN$$

To determine P, considering FBD of bottom wedge



Applying Lami's theorem

$$\frac{30.05}{Sin75} = \frac{R3}{Sin125} = \frac{P}{Sin130}$$

Equating

$$\frac{30.05}{Sin75} = \frac{R3}{Sin125}$$

$$R3 = \frac{30.05Sin125}{Sin75}$$

$$R3 = 25.48KN$$

Equating

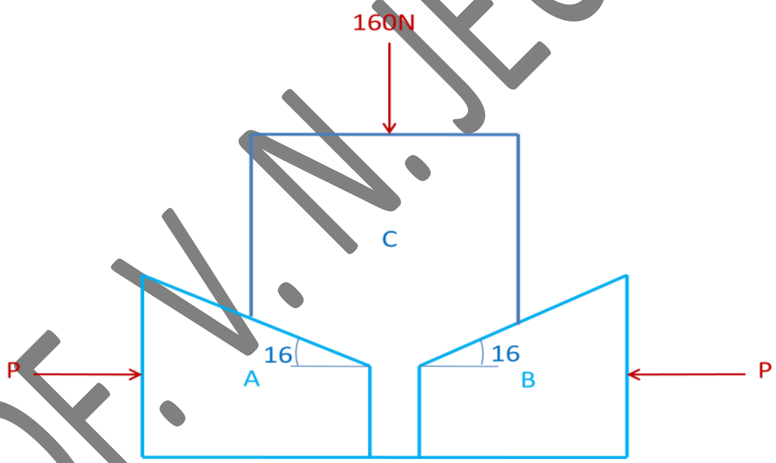
$$\frac{30.05}{Sin75} = \frac{P}{Sin130}$$

$$P = \frac{30.05Sin130}{Sin75}$$

$$P = 23.83KN$$

Force P required to start the movement of the wedge is 23.83KN

2} A weight of 160N is to be retained by means of wedges as shown. Determine the value of force P, if μ= 0.25. The blocks have negligible weights.



Solution:-

We know

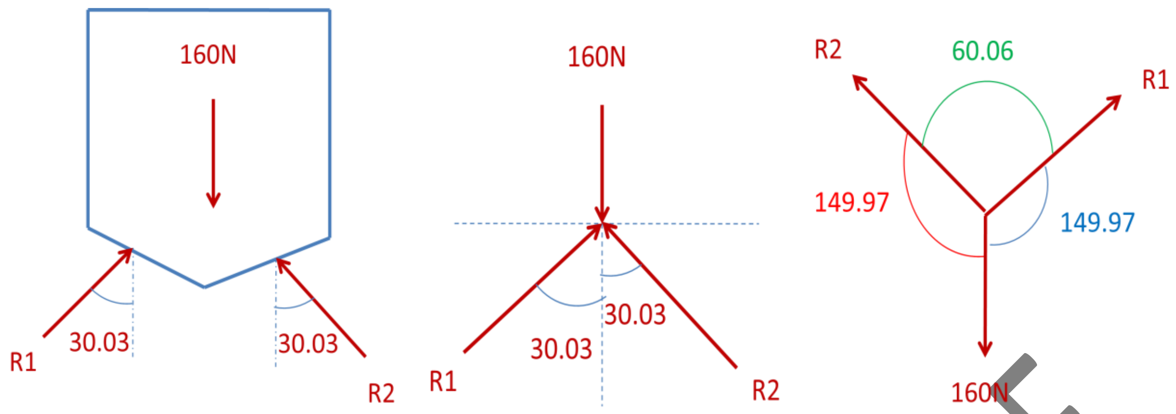
$\mu = \tan \Theta$

$0.25 = \tan \Theta$

$\Theta = \tan^{-1} 0.25$

$\Theta = 14.03^0$

Considering FBD of block C



Applying Lami's theorem

$$\frac{160}{Sin60.06} = \frac{R1}{Sin149.97} = \frac{R2}{Sin149.97}$$

Equating

$$\frac{160}{Sin60.06} = \frac{R1}{Sin149.97}$$

$$R1 = \frac{160Sin149.97}{Sin60.06}$$

$$R1 = 92.40N$$

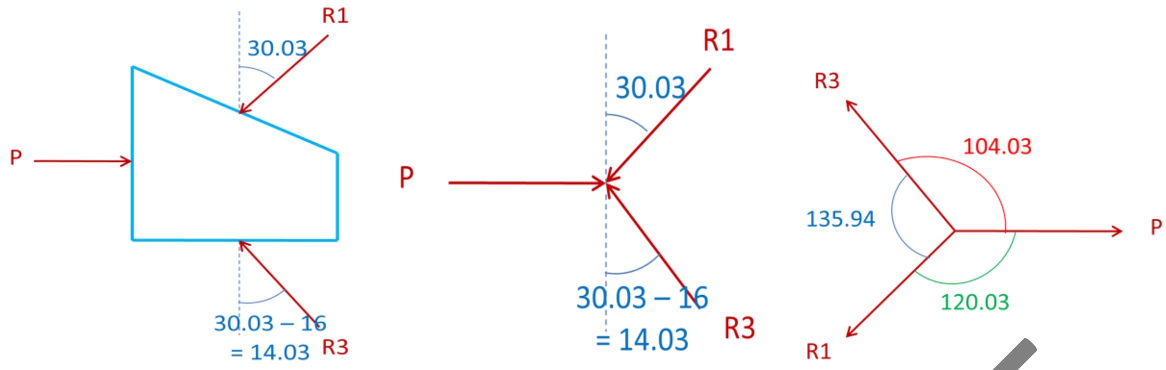
Equating

$$\frac{160}{Sin60.06} = \frac{R2}{Sin149.97}$$

$$R2 = \frac{160Sin149.97}{Sin60.06}$$

$$R2 = 92.40N$$

Considering FBD of block A



Applying Lami's theorem

$$\frac{92.40}{Sin104.03} = \frac{R3}{Sin120.03} = \frac{P}{Sin135.94}$$

Equating

$$\frac{92.40}{Sin104.03} = \frac{R3}{Sin120.03}$$

R3 = 84.46N

Equating

$$\frac{92.40}{Sin104.03} = \frac{P}{Sin135.94}$$

P = 66.23N