Equilibruim

1- For Coplanar forces system :

a- concurrent coplanar forces system

Rx = 0 , R y = 0 , R = 0

b - non-concurrent coplanar forces system

Rx = 0 , R y = 0 , R = 0 , Σ M = 0

2 - Non coplanar forces system :

a. concurrent non-coplanar forces system

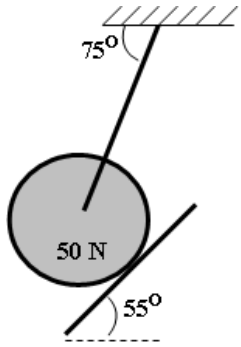
Rx = 0 , R y = 0 , R = 0 , Σ M = 0

b. non-concurrent non-coplanar forces system

Rx = 0 , R y = 0 , R = 0 , Σ M = 0

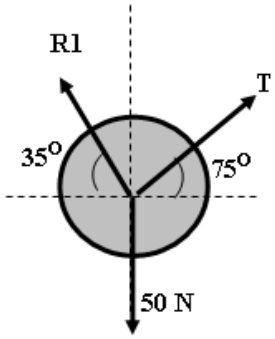
Ex (1) :

Determine the tension in the cord and the reaction of inclined plane acting on the sphere of (**50 N**) weight shown in fig.



Solution

we draw **F.B.D** for the sphere , then :



Σ Fx = 0

T cos 75 – R1 cos 35 = 0 …….. (1)

Σ Fy = 0

T sin 75 + R1 sin 35 – 50 = 0 ……...(2)

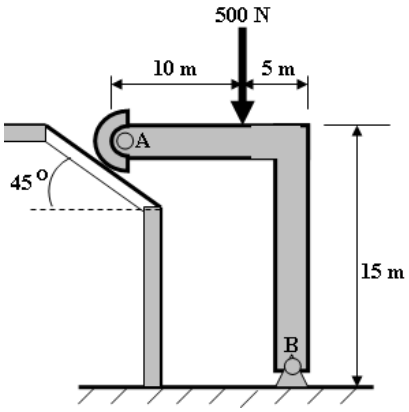
Subst. (2) in (1) we get :

T = 4361 N

R1 = 137.7 N

Ex (2) :

Determine the reactions at the points (**A**) and (**B**) , the angle beam was in equilibrium state as shown in fig .



Solution

Σ M (A) = 0

500* 10 – N * 15 = 0

N = 5000 / 15 = 333.34 N

Σ Fy = 0

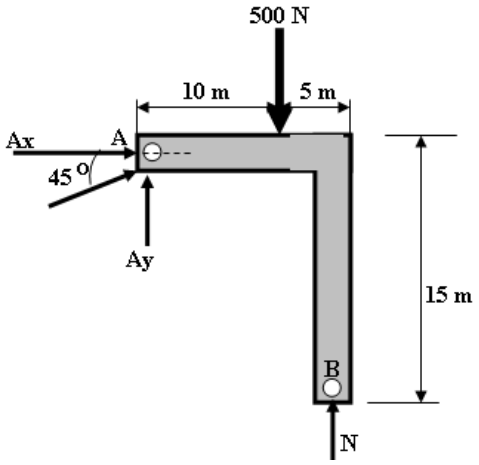
Ay + N – 500 = 0

Ay + 333.34 – 500 = 0

Ay = 166.67 N

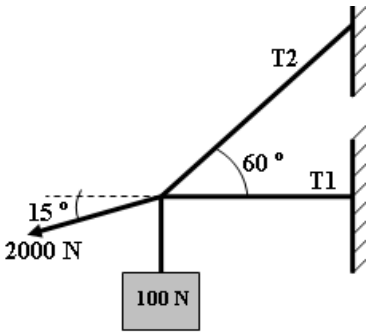
Σ Fx = 0 , Ax = 0

RA = Ay = 166.67 N



Ex (3) :

Determine the tension forces (**T1**) and (**T2**) in the equilibrium system shown in fig. .

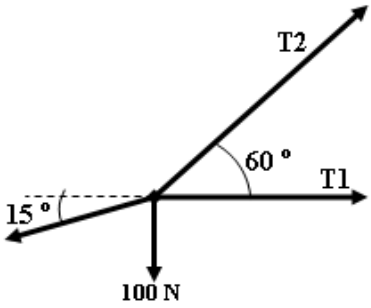


Solution

Σ Fx = 0

T1 . cos (0) + T2 .cos (60) – 2000 cos (15) = 0

T1 + 0.5 T2 – 1931.85 = 0 …….. (1)



Σ Fy = 0

T1 . sin (0) + T2 . sin (60) – 2000 . sin (15) – 100 = 0

0.866 T2 – 617.63 = 0

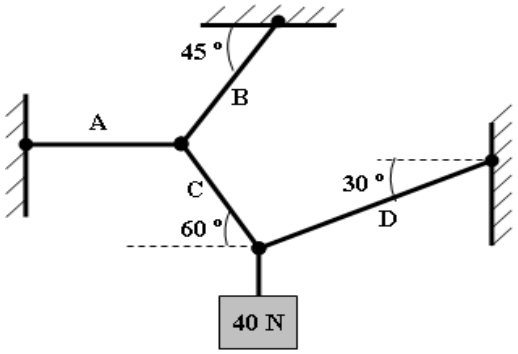
T2 = 713.2 N

Subs. in (1)

T1 = 1575 N

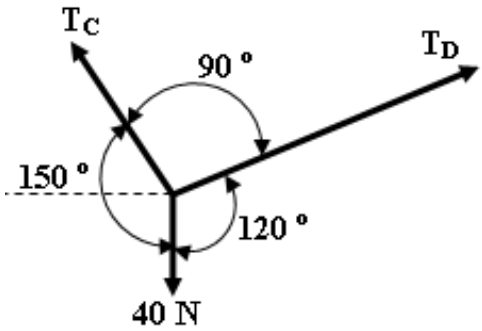
Ex (4) :

Determine the tension in each cord shown in fig. (T_A , T_B , T_C , T_D) .



Solution

By using Lami' s rule :



$$\frac{T_D}{\sin 150} = \frac{40}{\sin 90}$$

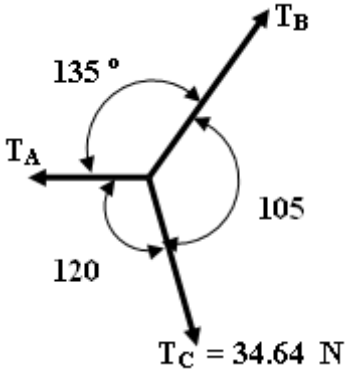
$$\frac{T_D}{0.5} = \frac{40}{1}$$

$$T_D = 20\ N$$

$$\frac{T_C}{\sin 120} = \frac{40}{\sin 90}$$

$$\frac{T_C}{0.866} = \frac{40}{1}$$

$$T_C = 34.64\ N$$



$$\frac{T_B}{\sin 90} = \frac{T_C}{\sin 135}$$

$$\frac{T_B}{0.5} = \frac{34.64}{0.707}$$

$$T_B = 48.98\ N$$

$$\frac{T_A}{\sin 135} = \frac{T_C}{\sin 135}$$

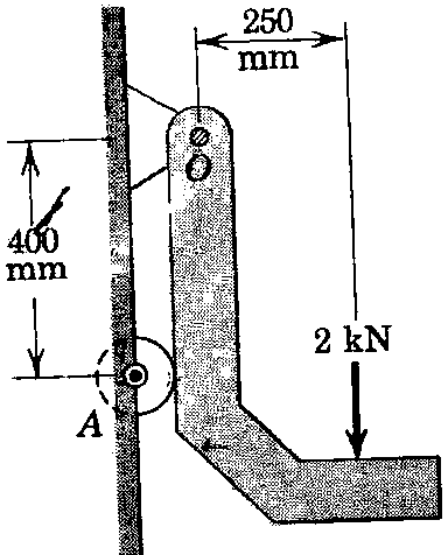
$$\frac{T_A}{0.707} = \frac{34.64}{0.707}$$

$$T_A = 34.64\ N$$

Ex (5) :

Find out the reaction on the cylinder (**A**)

and the total force acting on the pin (**O**)



Solution

Σ M (O) = 0

$2 * 250 - R_A * 400 = 0$

$400\ R_A = 500$

$R_A = 1.25$ KN

Σ Fy = 0

$Oy - 2 = 0$

$Oy = 2$ KN

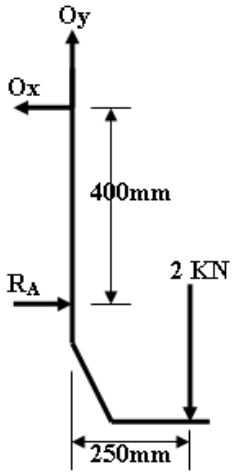
Σ Fx = 0

$R_A - Ox = 0$

$Ox = R_A = 1.25$ KN

$$F = \sqrt{(Ox)^2 + (Oy)^2}$$

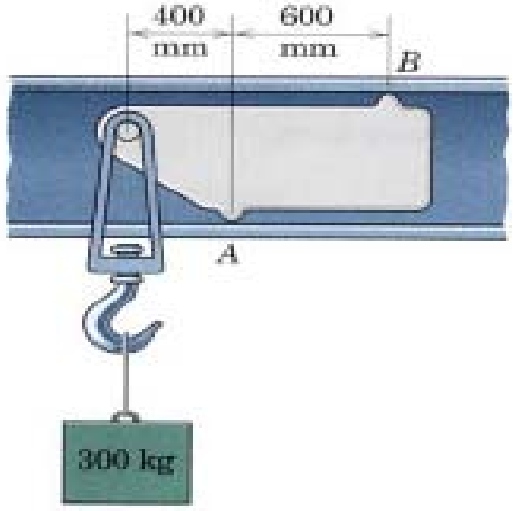
$$F = \sqrt{(1.25)^2 + (2)^2} = 2.35N$$



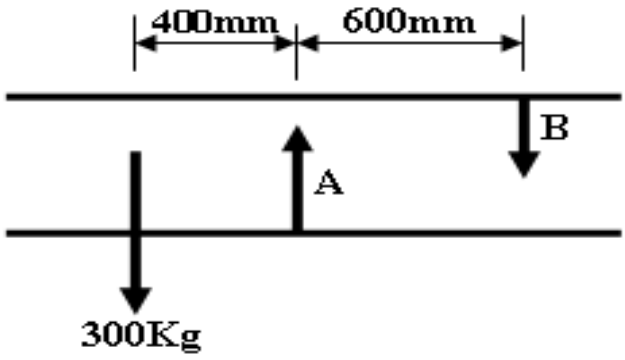
F.B.D

Ex (6) :

Find out the reactions at the points (A) & (B) .



Solution



Σ M (A) = 0

$- R_A * 600 + 300 * 9.8 * 1000 = 0$

$- 600\ R_A + 2940\ 000 = 0$

$R_A = 4900\ N = 4.9\ KN$

Σ Fy = 0

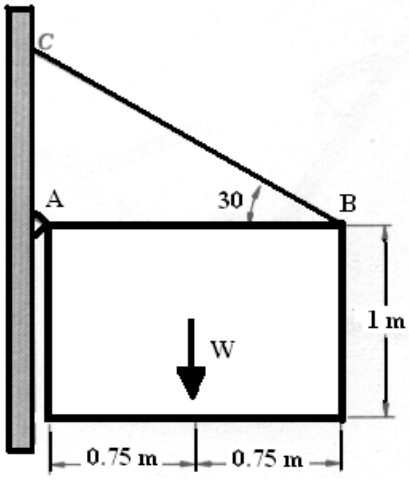
$R_A - R_B - 300 * 9.8 = 0$

$4900 - R_B - 2943 = 0$

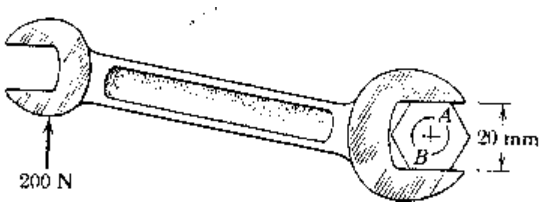
$R_B = 1950\ N = 1.95\ KN$

PROBLEMS

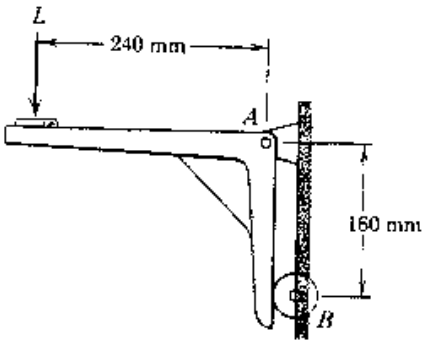
1 - A (200 N) weight of the block shown in fig. is supported by a pin and bracket at (A) and by a cable (BC) , Determine the reaction at (A) and the tension in the cable .



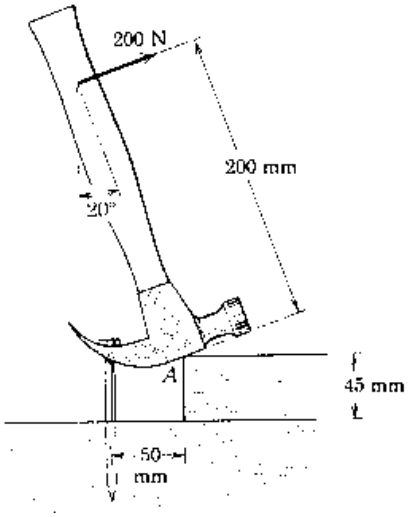
2 - The 200-N force produces a torque (moment) of 40 N.m about the axis of the bolt in order to tighten the hexagonal nut . Find the forces between the smooth jaws of the wrench and the nut if contact occurs at the corners A and B of the hexagon .



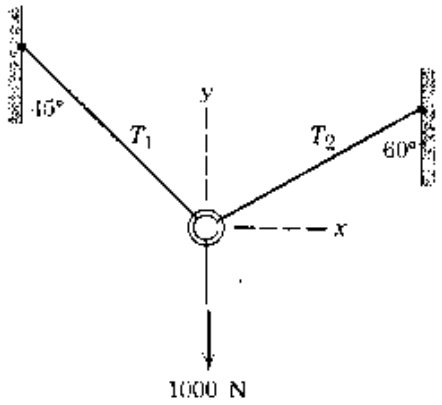
3 - The pin at A can support a maximum force of 3.2 KN . What is the corresponding maximum load L which can be supported by the bracket ?



4 - A block placed under the head , of the claw hammer as shown greatly facilitates the extraction of the nail . If the 200-N pull on the handle is required to pull the nail calculate the tension T in the nail and the magnitude A of the force exerted by the hammer head on the block . The contacting surfaces at A are sufficiently rough to prevent slipping



5 - The ring supports the 1000-N load and is held in position by the two cables attached to vertical walls . Find the tensions T_1 and T_2 by at least two different ways .



6 - The cable from A to B is 6 m long and supports the 100-kg crate from the small pulley . Calculate the tension T in the cable .