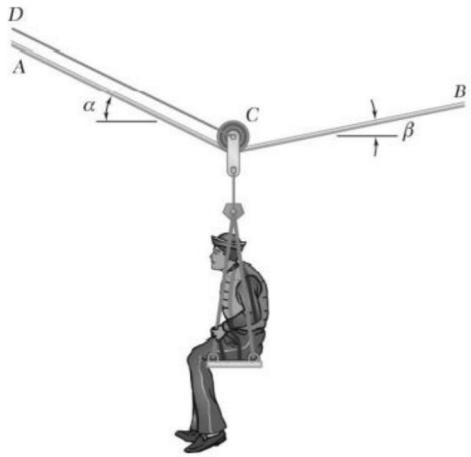
Module 3 part 1 Equilibrium

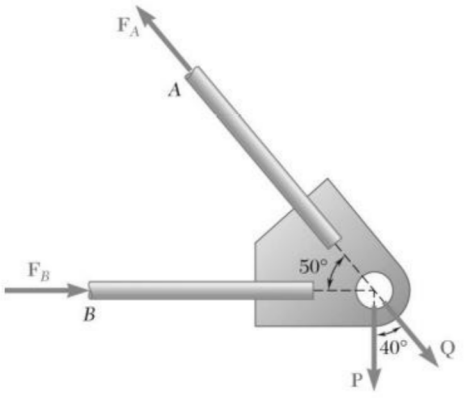
1. A sailor is being rescued using a boatswain's chair that is suspended from a pulley that can roll freely on the support cable ACB and is pulled at a constant speed by cable CD. Knowing that α = 30° and β = 10° and that the combined weight of the boatswain's chair and the sailor is 900 N, determine the tension (a) in the support cable ACB, (b) in the traction cable CD.

1.a. A sailor is being rescued using a boatswain's chair that is suspended from a pulley that can roll freely on the support cable ACB and is pulled at a constant speed by cable CD. Knowing that α = 25° and β = 15° and that the tension in cable CD is 80 N, determine (a) the combined weight of the boatswain's chair and the sailor, (b) in tension in the support cable ACB.

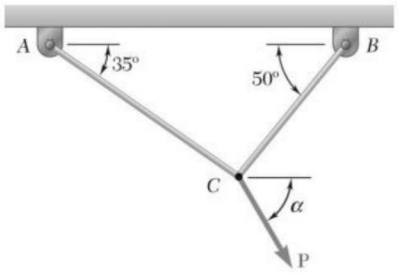


2. Two forces P and Q are applied as shown to an aircraft connection. Knowing that the connection is in equilibrium and that P = 500 N and Q = 650 N, determine the magnitudes of the forces exerted on the rods A and B.

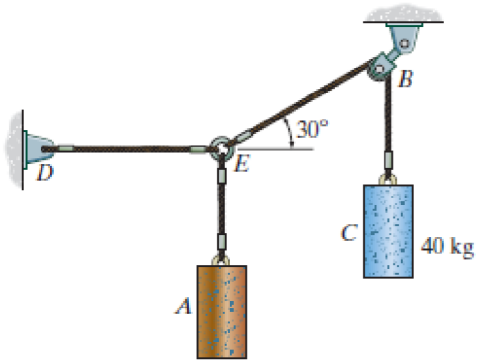
2.a. Two forces P and Q are applied as shown to an aircraft connection. Knowing that the connection is in equilibrium and that the magnitudes of the forces exerted on rods A and B are F_A = 750N and F_B = 400N, determine the magnitudes of P and Q.



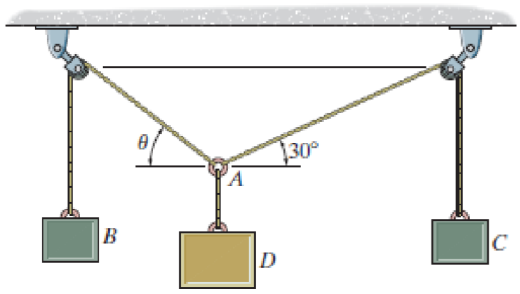
3. Two cables tied together at C are loaded as shown. Knowing that the maximum allowable tension in each cable is 800 N, determine (a) the magnitude of the largest force P that can be applied at C, (b) the corresponding value of α



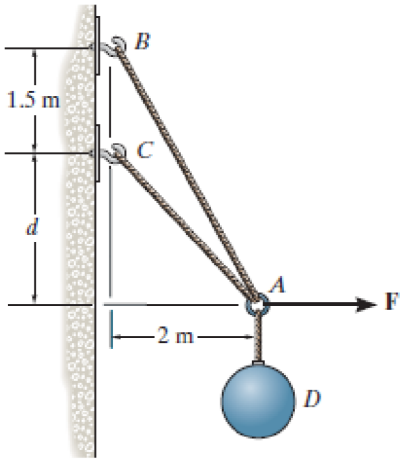
4. If the mass of cylinder *C* is 40 kg, determine the mass of cylinder *A* in order to hold the assembly in the position shown.



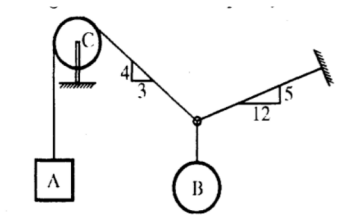
5. If block D weighs 300N & Block B weighs 275 N, find the required weight of block C and the angle θ for equilibrium.



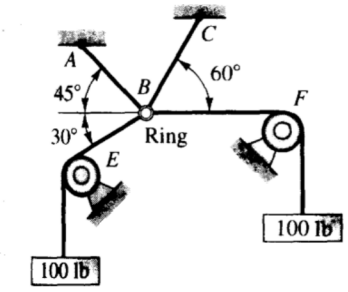
6. If d=1.2 m,W=200N and F=100 N find tension in the wires.



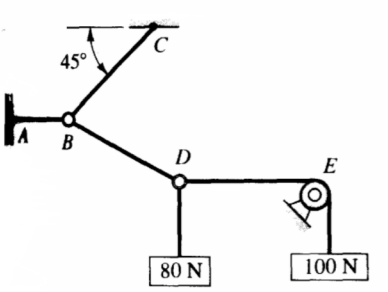
7. Determine the weight of sphere B required to keep the system as shown in Fig. in equilibrium, if body A weighs 200 N. Consider pulley C as smooth.(Ans : W_B = 210 N)



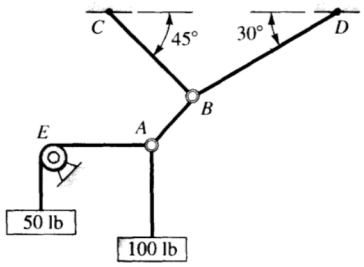
8. Find the tensile force in cables AB and CB. The remaining cable ride over frictionless pulleys E and F.(Ans : BC = 26.79 , AB = 37.9)



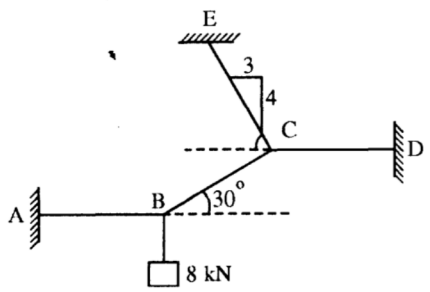
9. Find the force transmitted by wire BC. The pulley E can be assumed to be frictionless in this problem. (Ans : BC = 113.14, AB = 180, BD = 128.13)



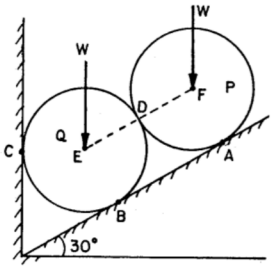
10. Find the tensions in the three cables connected to B. The entire system of cables is coplanar. The roller at F is free to turn without resistance.(Ans : BD = 109.81, BC = 63.8 , AB = 111.8)



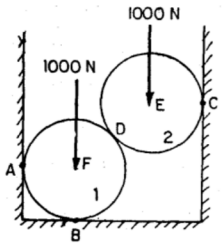
11. Find the tensions in the cables AB, BC, CD and CE, when a load of 8 KN is attached at B as shown in Fig. (Ans : T_{BA} = 13.856, T_{CE} = 10, T_{CD} = 19.856)



12.Two identical rollers P and Q, each of weight W, are supported by an inclined plane and a vertical wall as shown in Fig. Assume all the surfaces to be smooth. Draw the free body diagrams of: (i) roller Q, (ii) roller P and (iii) rollers P and Q taken together. (iv) If W = 1000 N find reactions at all contact surfaces. (Ans : R_A = 866 , R_C = 1154.7, R_D = 500 , R_B = 1443.3)

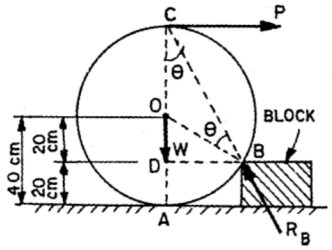


13. Two spheres, each of weight 1000 N and of radius 25 cm rest in a horizontal channel of width 90cm as shown in Fig. Find the reactions on the points of contact A, B and C. (Ans : R_A = R_C = 1333.33, R_B = 2000 , R_D = 1666.67)



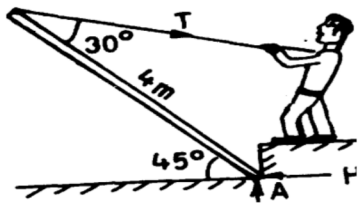
14. A roller of radius 40cm, weighing 3000 N is to be pulled over a rectangular block of height 20 cm as shown in Fig, by a horizontal force applied at the end of a string wound round the circumference of the roller. Find the magnitude of the horizontal force which will just turn the roller over the corner of the rectangular block. Also determine the magnitude and direction of reactions at A and B. All surfaces may be taken as smooth.

If the force P is applied horizontally at the centre of the roller, what would be the magnitude of this force? Also determine the least force and its line of action at the roller centre, for turning the roller over the rectangular block. (Ans : P = 1732.1, P = 5196)



15. A 4 m long joist weighing 100 N is raised by a man, by pulling the rope connected to it as shown a Fig. Find the tension T in he rope and the reaction at A.

(Ans ; T = 70.71, H_A = 68.3 , V_A = 118.3)



16. A small boat is fastened by means of three ropes tied to posts on the banks of a stream as shown in fig. The stream flow exerts a force on the boat which acts directly downstream. The tensions in the ropes A and B are measured and found to he T_A=120 N and T_B = 80N. Determine the magnitude of the force exerted by the flow and the tension in the rope C.(Ans : T_C = 85.13 , F = 40.16)

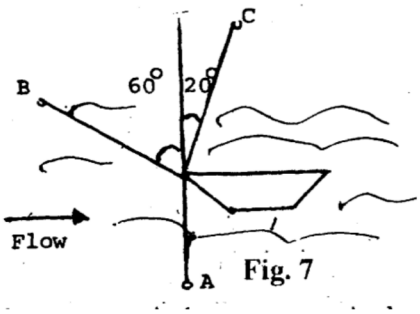
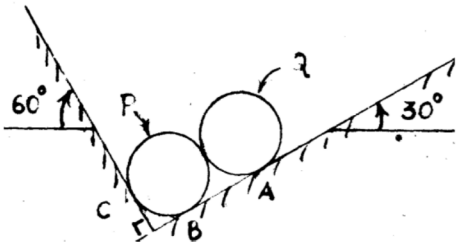


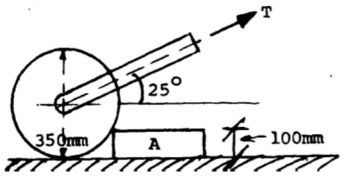
Fig. 7

17. Two homogeneous solid cylinders of identical weight of 5000 N and radius of 0.4 m are resting against inclined wall and sloping ground as shown in the figure. Assuming all smooth surfaces find the reactions at A, B and C of the contact points on ground and wall.

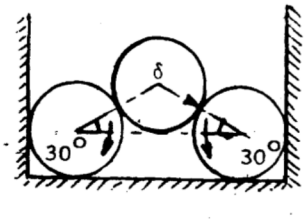
(Ans : $R_A = 4330.13$, $R_B = 4330.13$, $R_C = 5000$)



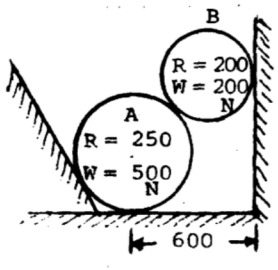
18. The roller shown in fig is of weight 1500 N . What force T is necessary to start the roller over the block A?(Ans : 1759.34)



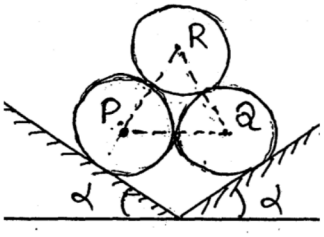
19. Three similar tubes of weight 8 KN each are placed as shown in the fig. Determine the forces exerted by the tubes on the smooth walls and floor.(Ans : $R_A = R_B = 6.928$, $R_C = R_D = 12$)



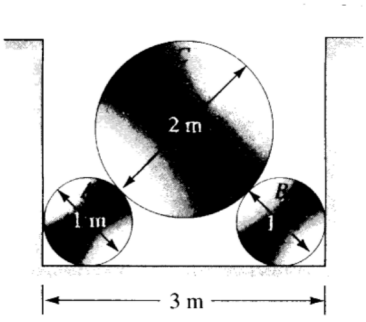
20. Two spheres A and B are resting in a smooth trough as shown in fig. Draw the free body diagrams of A and B showing all the forces, both, in magnitude and direction acting on them. (Ans : $R_1 = 388$, $R_2 = 448$, $R_3 = 476$, $R_{AB} = 436.5$)



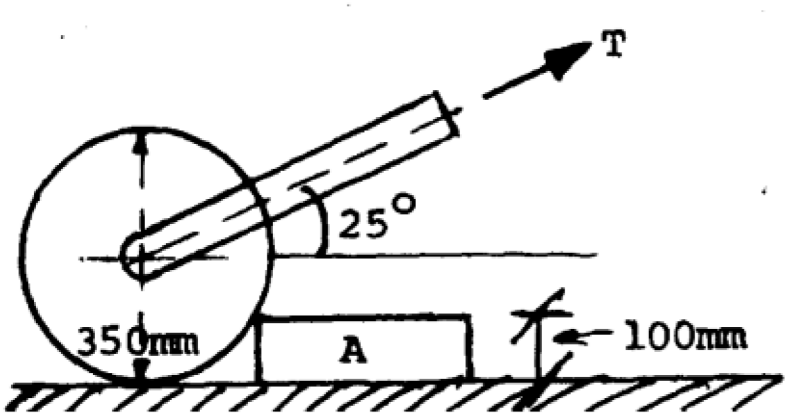
21. Three identical spheres P,Q & R of weight 'W' are arranged on smooth inclined surface as shown in the Figure. Determine the angle 'α' which will prevent the arrangement from collapsing. (Ans : α = 10.88 °)



22. Cylinders A and B weigh 500 N each and cylinder C weighs 1000 N. Compute all contact forces.(Ans : 671, 447, 1000)

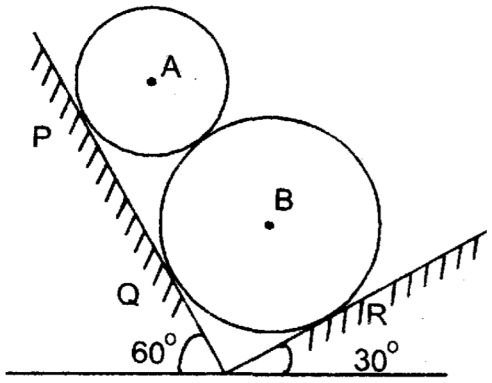


23. The roller shown in fig is of weight 1500N. What force T is necessary to start the roller over the block A?

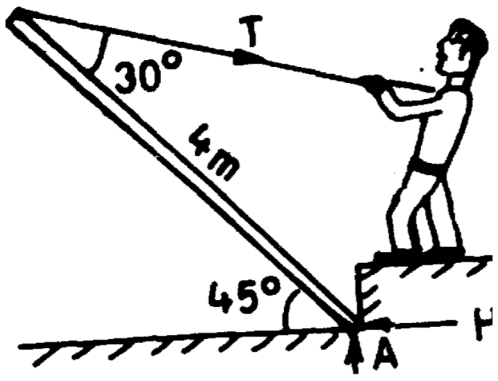


24. Spheres A and B rest against inclined planes as shown. Knowing weight of sphere A = 1500 N and radius = 300 mm, while weight of sphere B = 2500 N and radius = 500 mm, determine reactions at contact points P, Q and R. Assume all smooth surfaces.

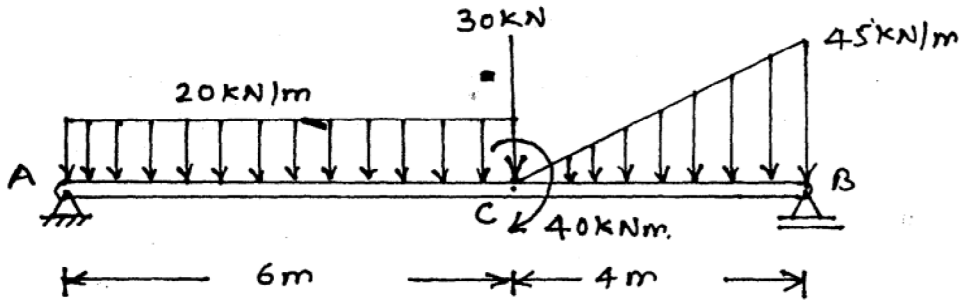
(Ans : R_P = 1085.4, R_Q = 914.6 , R_R = 3464.1)



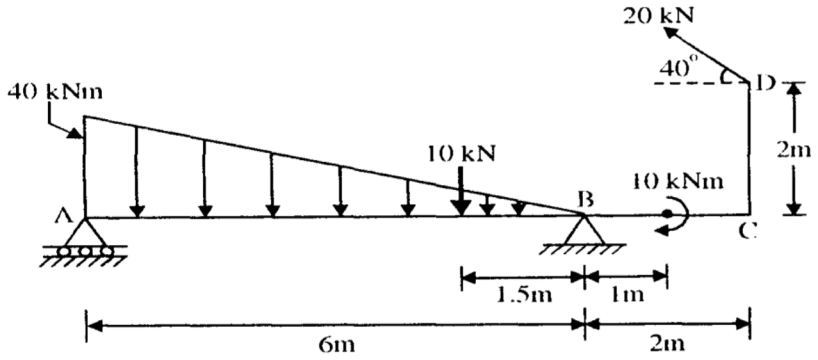
25. A 4 m long joist weighing 100 N is raised by a man, by pulling the rope connected to it as shown a Fig. Find the tension T in the rope and the reaction at A.



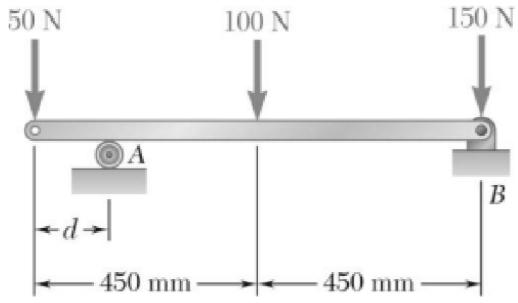
26. Calculate support reactions for the following beam.



27. Determine the reactions of supports for the beam as shown in Fig.

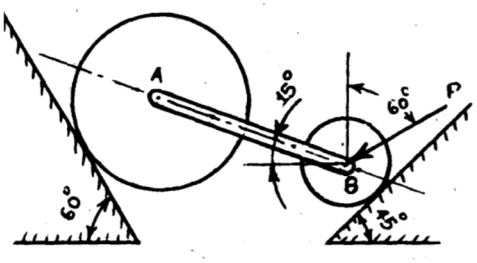


28. The maximum allowable value of each of the reactions is 180 N. Neglecting the weight of the beam, determine the range of the distance d for which the beam is safe.

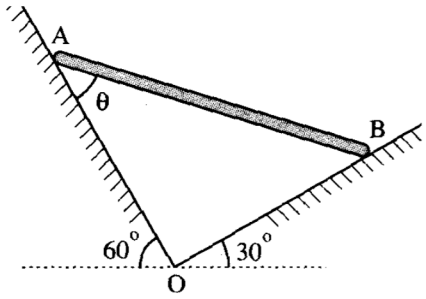


29. Two cylinders, having weights WA = 2000 N and WB = 1000 N, are resting on smooth inclined planes having inclinations 60° and 45º with the horizontal respectively as shown in figure. They are connected by a weightless bar AB with hinge connections. The bar AB makes 15° angle with the horizontal. Find the

magnitude of the force P required to hold the system in equilibrium.(Ans : P = 537.22, C = 2449.5)

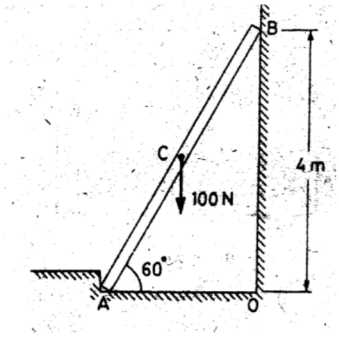


30. nA uniform bar AB of length L and weight W lies in a vertical plane with its ends resting on two smooth surfaces on OA and OB. Find angle θ for equilibrium of bar.(Ans : θ= 30°)

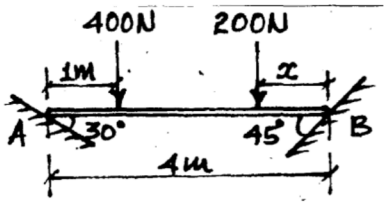


31. If the end B of the ladder of the rest against a wall find the reactions-at A and B

(Ans : $H_A = R_B = 28.85$, $V_A = 100$)

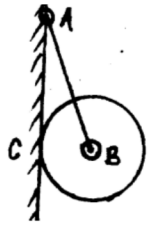


32. A weightless bar is placed in a horizontal position on the smooth inclines as shown in figure. Find ‘x’ at which the 200 N force should he placed from point B to keep the bar horizontal. (Ans : x = 1.61)

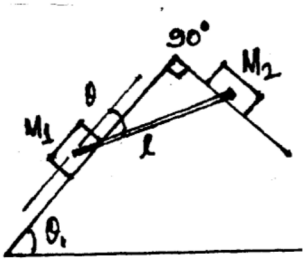


33. A circular roller of weight 1000 N and radius 20cm hangs by a tie rod AB= 40cm and rests against a smooth vertical wall at C as shown in the figure. Determine the tension in the tie rod at reaction R_C at point C.

(Ans : T = 1154.7 , R_C = 577.35)

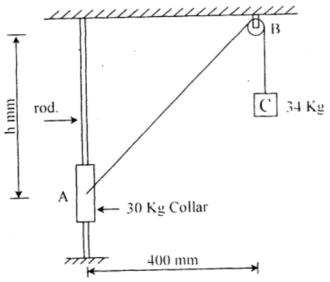


34. Masses M_1 and M_2 are held on the frictionless planes by a rigid inextensible bar of length 'l' as shown in figure. Find the equilibrium angle θ. (Ans : $\tan\theta = M_2\cot\theta_1/M_1$)



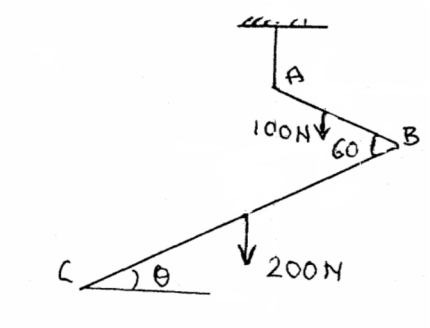
35. The 30 kg collar may slide on a frictionless vertical rod and is connected to a 34 kg counter weight. Find the value of h for which the system is in equilibrium.

(Ans : 750)



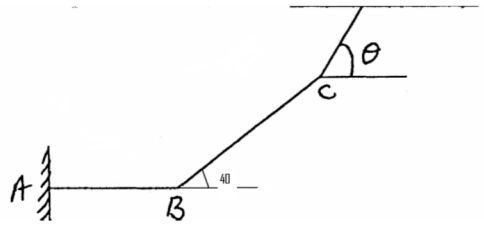
36. Two bars AB and CD of length 1 meter and 2 meter and weights 100 N & 200 N respectively are rigidly joined at B and suspended by string AO as shown in fig. Find the inclination θ of bar BC to the horizontal when the system is in equilibrium.

(Ans: θ = 19.1°)



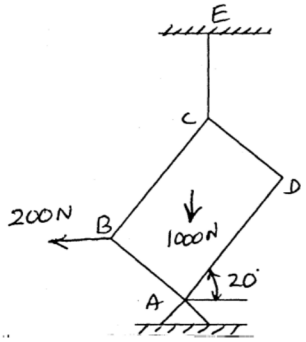
37. Determine the angle θ & tensions in the cables AB & CD. (AB is horizontal) Wt of BC is w N.

(Ans : : θ = 59.22°, T_{CD} = 1.164W)



38. Determine reaction at A and tension in string CE. (Wt of rectangular plate ABCD is 1KN) AB = 1.5m, CD=lm.

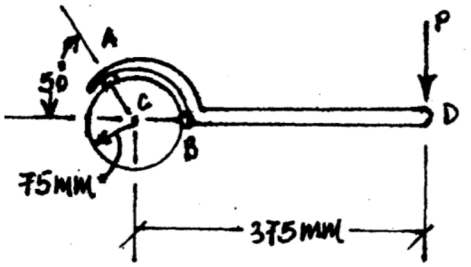
(Ans : T = 323.6 , H_A = 200 , V_A = 676.4)



39. The spanner shown in figure is used to rotate a shaft. A pin fits in a hole at A, while a flat, frictionless surface rests against the shaft at B. If a 250 N force P is

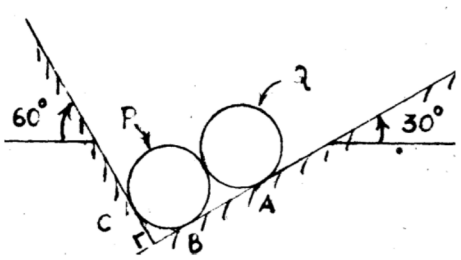
exerted on the spanner at D, find (a) the reaction at B, (b) the component of the reaction at A in a direction perpendicular to AC.

(Ans : R_A =1250, R_B = 1841.53)



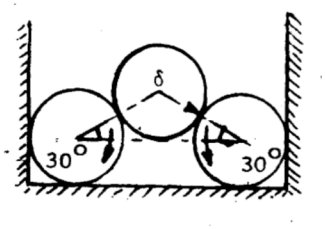
40. Two homogeneous solid cylinders of identical weight of 5000 N and radius of 0.4 m are resting against inclined wall and sloping ground as shown in the figure. Assuming all smooth surfaces find the reactions at A, B and C of the contact points on ground and wall.

(Ans : R_A = 4330.13, R_B = 4330.13, R_C = 5000)



41. Three similar tubes of weight 8 KN each are placed as shown in the fig. Determine the forces exerted by the tubes on the smooth walls and floor.

(Ans : R_A = R_B = 6.928, R_C = R_D = 12)

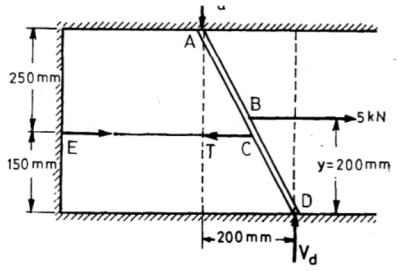


42. A light bar AD is in contact with smooth horizontal surfaces at A and D. A horizontal force of 5 kN is applied at D as shown in Fig. If y = 200 mm.

(i) Determine the tension in the horizontal cable CE and the reactions at A and D.

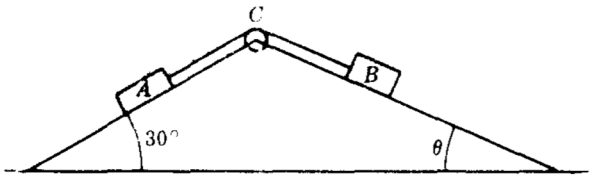
(ii) If the allowable reaction at D is 1.5 kN find the maximum distance y.

(Ans : (i) V_A = V_D = 1.25 . (ii) y = 210)



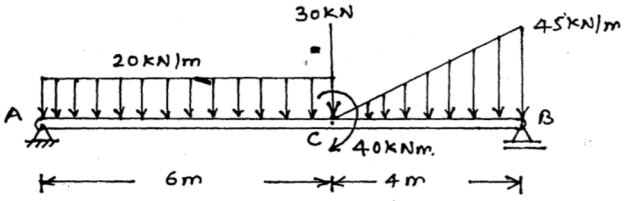
43. A and B, weighing 40 N and 30 N, respectively, rest on smooth planes as shown in Fig. They are connected by a weightless cord passing over a frictionless pulley. Determine the angle θ and the tension in the cord for equilibrium.

(Ans; T = 196.2 N , θ = 41.8 °)



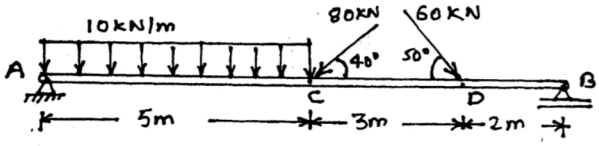
44.. Calculate support reactions for the following beam.

(Ans : R_A = 104 ↑ , R_B = 136 ↑)



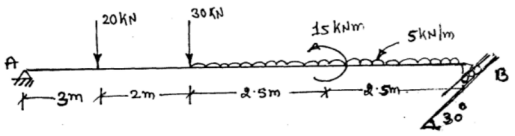
45. Find support reactions of the beam shown below.

(Ans : H_A = 22.72 → , V_A = 72.4 ↑, R_B = 75 ↑)



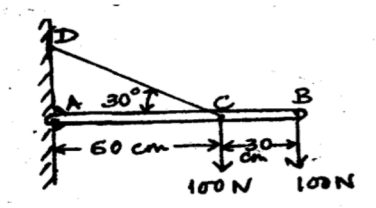
46. Find support reactions of the beam shown below.

(Ans : H_A = 22.08 → , V_A = 36.74 ↑, R_B = 44.167)



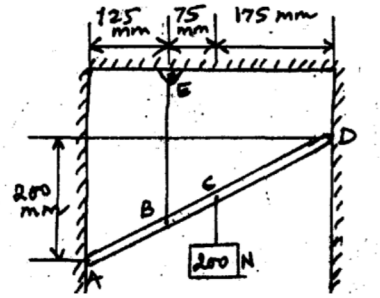
47. A horizontal beam AB hinged to a vertical wall at A and supported by a tie rod CD is subjected to the loading shown in figure. Calculate the horizontal and vertical components of the reaction at A and the tension S in the tie rod.

(Ans : $H_A = 433.3 \rightarrow$, $V_A = 50 \downarrow$, T = 500)



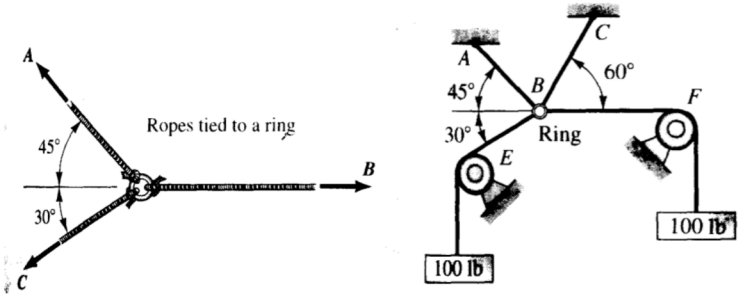
48. A light bar AD is suspended from a cable BE and supports 200N block at C. The extremities A and D of the bar are in contract with frictionless vertical walls. Determine the tension in cable BE and the reactions at A and D.

(Ans : $R_A = 75 \rightarrow$, $R_D = 75 \leftarrow$, T = 200)



49. In a tug of war, when team B pulls with a 400N force, how much force must team C exert for a draw? With what force does team A pull?

(Ans : A = 358.63, C = 292.82)

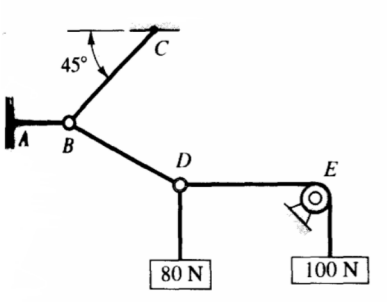


50. Find the tensile force in cables AB and CB. The remaining cable ride over frictionless pulleys E and F.

(Ans : BC = 26.79 , AB = 37.9)

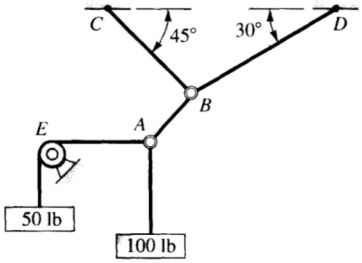
51. Find the force transmitted by wire BC. The pulley E can be assumed to be frictionless in this problem.

(Ans : BC = 113.14, AB = 180, BD = 128.13)



52. Find the tensions in the three cables connected to B. The entire system of cables is coplanar. The roller at F is free to turn without resistance.

(Ans : BD = 109.81, BC = 63.8 , AB = 111.8)



53. Cylinders A and B weigh 500 N each and cylinder C weighs 1000 N. Compute all contact forces.

(Ans : 671, 447, 1000)