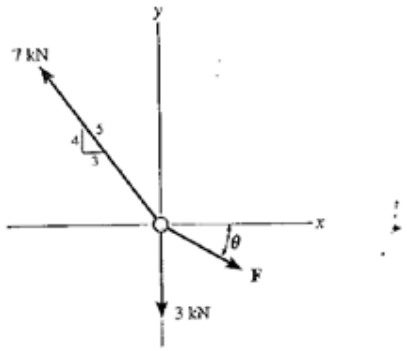
CE 221 ENGINEERING MECHANICS I (FALL 2014 – 2015)
Home Exercise III –Equilibrium
(http://www2.ce.metu.edu.tr/~ce221)

Q1.

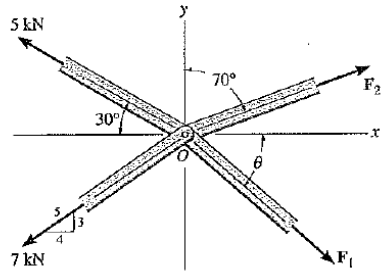
Determine the magnitude and direction θ of F so that the particle is in equilibrium.



Ans: θ=31.8 ° , F=4.94 kN

Q2.

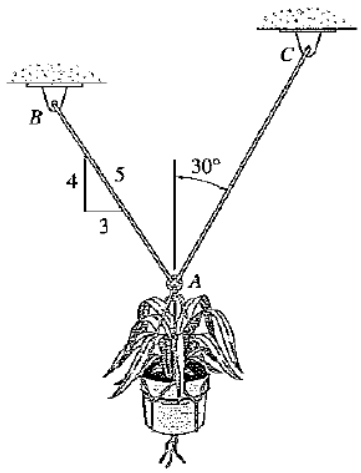
The members of a truss are pin-connected at joint O. Determine the magnitude of $\mathbf{F}_1$ and its angle θ for equilibrium. Set $F_2 = 6$ kN.



Ans: θ=4.69 ° , F_1=4.31 kN

Q3.

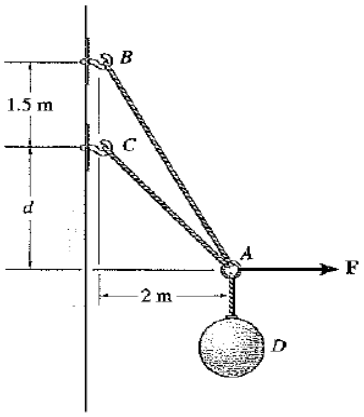
Determine the maximum weight of the flowerpot that can be supported without exceeding a cable tension of 250 N in either cable AB or AC.



Ans: W=383.2 N

Q4.

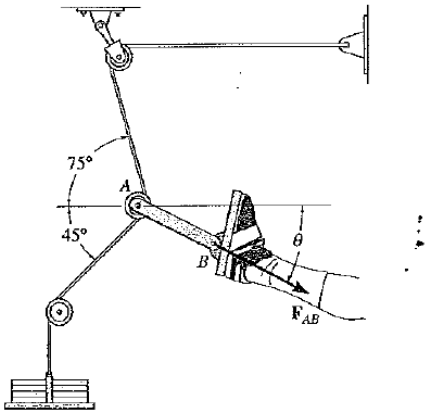
Determine the forces in cables AC and AB needed to hold the 20-kg ball D in equilibrium. Take $F = 300$ N and $d = 1$ m.



Ans: F_{AB} =98.6 N , F_{AC} =267 N

Q5.

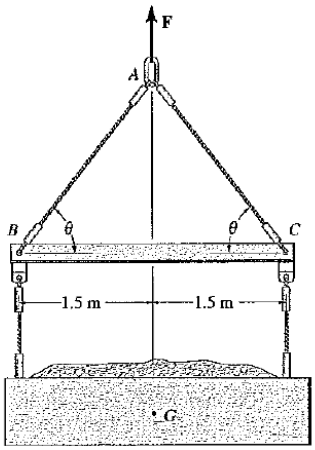
Determine the magnitude and direction θ of the equilibrium force F_{AB} exerted along link AB by the tractive apparatus shown. The suspended mass is 10 kg. Neglect the size of the pulley at A.



Ans: θ=15.0 ° , F_{AB}=98.1 kN

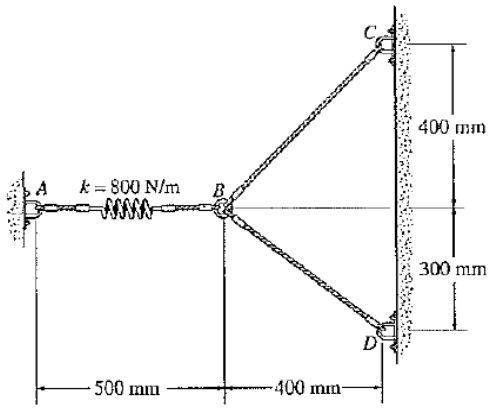
Q6.

The lift sling is used to hoist a container having a mass of 500 kg. Determine the force in each of the cables AB and AC as a function of θ. If the maximum tension allowed in each cable is 5 kN, determine the shortest lengths of cables AB and AC that can be used for the lift. The center of gravity of the container is located at G.



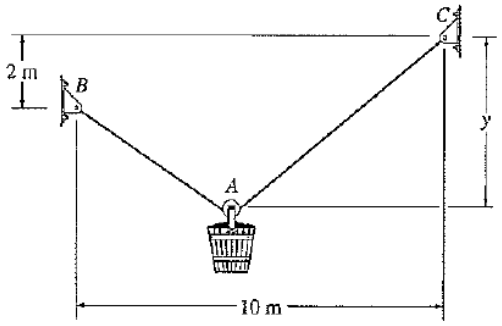
Ans: $F_{AC} = F_{AB} = F = \{2.45 \csc\theta\}$ kN, l=1.72 m

Q7. The spring has a stiffness of $k = 800$ N/m and an unstretched length of 200 mm. Determine the force in cables BC and BD when the spring is held in the position shown.



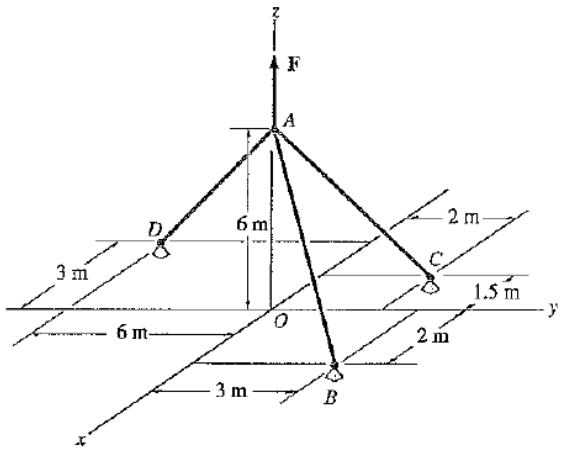
Ans: $F_{BD} = 171$ N , $F_{BC} = 145$ N

Q8. The pail and its contents have a mass of 60 kg. If the cable is 15 m long, determine the distance y of the pulley for equilibrium. Neglect the size of the pulley at A.



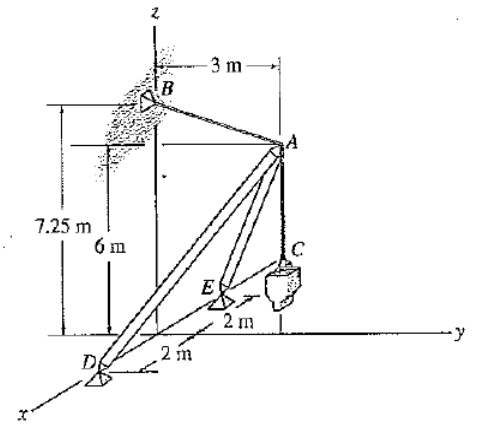
Ans: y =6.59 m

Q9. If cable AB is subjected to a tension of 700 N, determine the tension in cables AC and AD and the magnitude of the vertical force **F**.



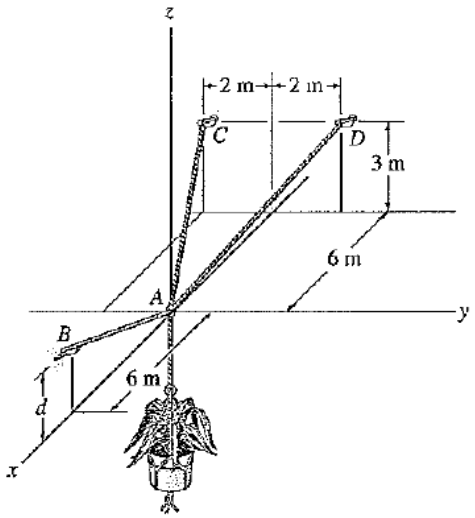
Ans: $F_{AC} = 130$ N , $F_{AD} = 510$ N , F=1.06 kN

Q10. The boom supports a bucket and contents, which have a total mass of 300 kg. Determine the forces developed in struts AD and AE and the tension in cable AB for equilibrium. The force in each strut acts along its axis.



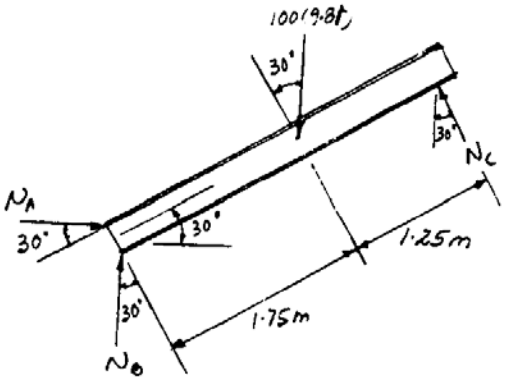
Ans: $F_{AE} = F_{AD} = 1.42$ kN , F_{AB}=1.32 kN

Q11. Determine the height d of cable AB so that the force in cables AD and AC is one-half as great as the force in cable AB. What is the force in each cable for this case? The flowerpot has a mass of 50 kg.



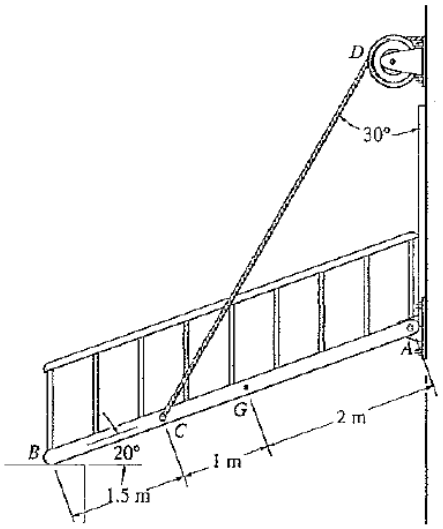
Ans: $F_{AC} = F_{AD} = 260$ N , F_{AB}=520 N , d=3.61 m

Q12.



Q13.

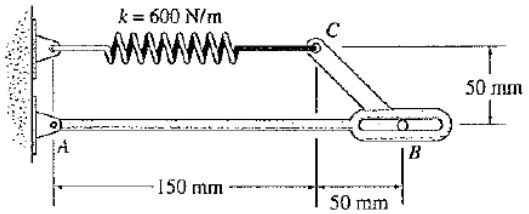
The ramp of a ship has a weight of 1000 N (≈ 100 kg) and a center of gravity at G. Determine the cable force in CD needed to just start lifting the ramp, (i.e., so the reaction at B becomes zero). Also, determine the horizontal and vertical components of force at the hinge (pin) at A.



Ans: F_{CD} = 975 N , A_x = 487.4 N , A_y =155.8 N

Q14.

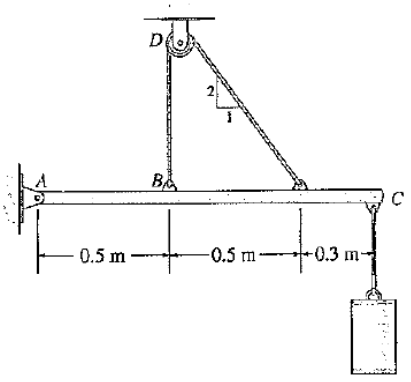
Determine the reactions at the pins A and B. The spring has an unstretched length of 80 mm.



Ans: N_B = 10.5 N , A_x = 42 N , A_y =10.5 N

Q15.

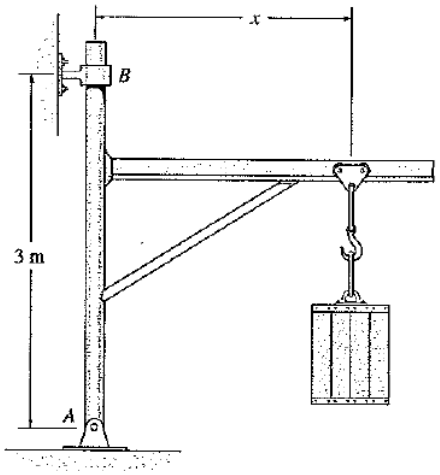
Determine the tension in the cable and the horizontal and vertical components of reaction of the pin A. The pulley at D is frictionless and the cylinder weighs 80 N (≈ 8 kg).



Ans: T = 74.6 N , A_x = 33.4 N , A_y =61.3 N

Q16.

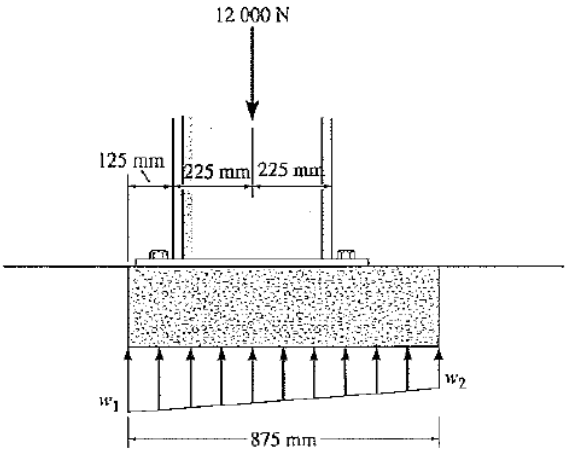
The jib crane is pin-connected at A and supported by a smooth collar at B. Determine the roller placement x of the 5000-N load so that it gives the maximum and minimum reactions at the supports. Calculate these reactions in each case. Neglect the weight of the crane. Require 1 m ≤ x ≤ 2.5 m.



Ans: x = 2.5 m , A_x =N_B= 4.17 kN , A_y =5.0 kN
x = 1 m , A_x =N_B= 1.67 kN , A_y =5.0 kN

Q17.

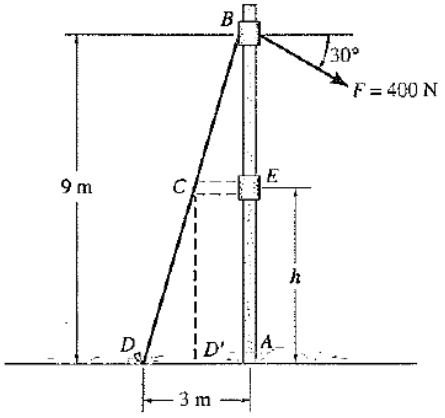
The pad footing is used to support the load of 12 000 N. Determine the intensities w_1 and w_2 of the distributed loading acting on the base of the footing for the equilibrium.



Ans: w_1 = 21.5 N/mm , w_1 = 5.5 N/mm

Q18.

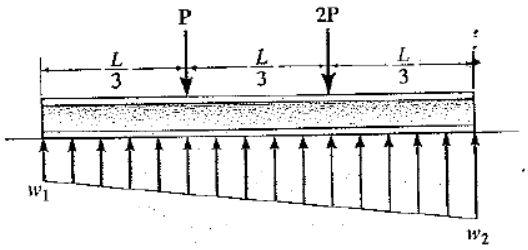
The telephone pole of negligible thickness is subjected to the force of 400 N directed as shown. It is supported by the cable BCD and can be assumed pinned at its base A. In order to provide clearance for a sidewalk right of way, where D is located, the strut CE is attached at C, as shown by the dashed lines (cable segment CD is removed). If the tension in CD' is to be twice the tension in BCD, determine the height h for placement of the strut CE.



Ans: h=4.731 m

Q19.

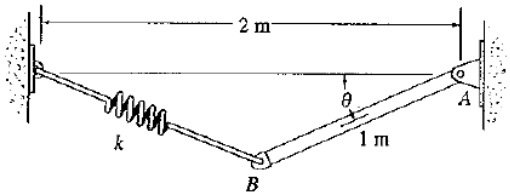
The beam is subjected to the two concentrated loads as shown. Assuming that the foundation exerts a linearly varying load distribution on its bottom, determine the load intensities w_1 and w_2 for equilibrium (a) in terms of the parameters shown; (b) set $P = 500$ N, $L = 12$ m.



Ans: w_1 =83.3 N/m , w_2 =167 N/m

Q20.

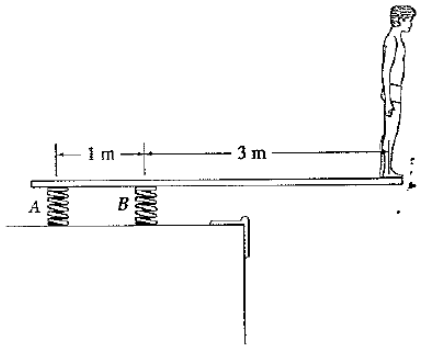
The uniform rod AB has a weight of 150 N (≈ 15 kg) and the spring is unstretched when $\theta = 0°$. If $\theta = 30°$, determine the stiffness k of the spring so that the rod is in equilibrium.



Ans: k=336.8 N/m

Q21.

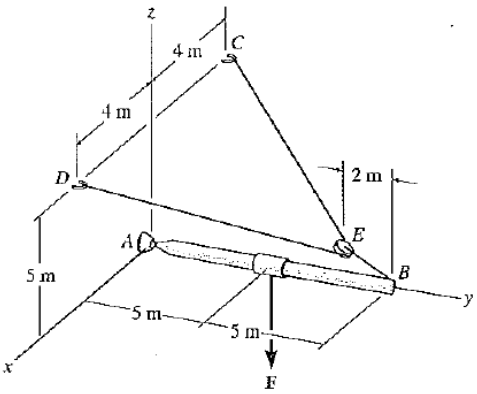
A boy stands out at the end of the diving board, which is supported by two springs A and B, each having a stiffness of $k = 15$ kN/m. In the position shown the board is horizontal. If the man has a mass of 40 kg, determine the angle of tilt which the board makes with the horizontal after he jumps off. Neglect the weight of the board and assume it is rigid.



Ans: θ=10.4 °

Q22.

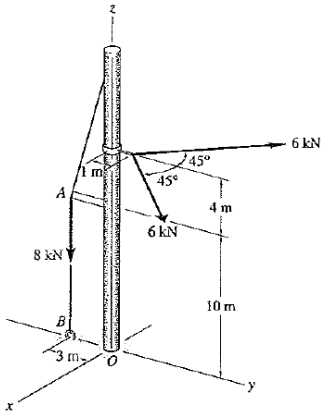
The cable CED can sustain a maximum tension of 800 N before it fails. Determine the greatest vertical force F that can be applied to the boom. Also, what are the x, y, z components of reaction at the ball-and-socket joint A?



Ans: F=1.31 kN , A_x = 0 , A_y=1.31 kN , A_z =653 kN

Q23.

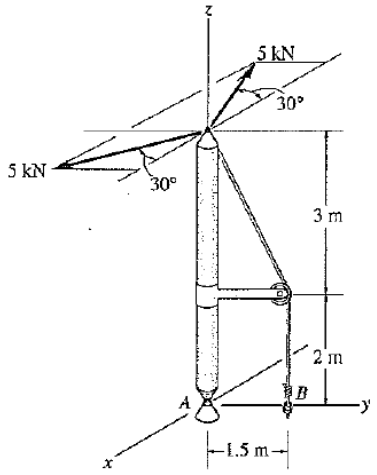
The pole for a power line is subjected to the two cable forces of 6 kN, each force lying in a plane parallel to the x–y plane. If the tension in the guy wire AB is 8 kN, determine the x, y, z components of reaction at the fixed base of the pole, O due to these three forces.



Ans: O_x=0 , O_y =-8.49 kN , O_z =8 kN , $(M_o)_x$=0 , $(M_o)_y$= $M_o)_z$ =0

Q24.

The boom is supported by a ball-and-socket joint at A and a guy wire at B. If the 5-kN loads lie in a plane which is parallel to the x–y plane, determine the x, y, z components of reaction at A and the tension in the cable at B.



Ans: T_B=16.7 kN , A_x =0 , A_y =5 kN , A_z =16.7 kN