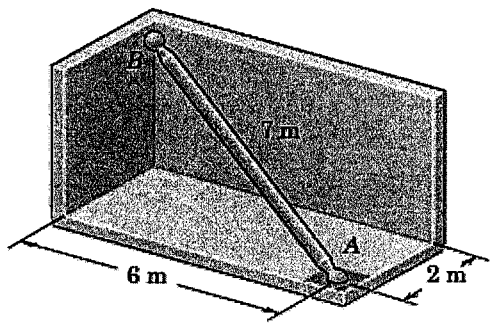
Problem 1 (30%)

The uniform 7-m steel shaft has a mass of 200 kg and is supported by a ball-and-socket joint at A in the horizontal floor. The ball end B rests against the smooth vertical walls as shown.



(a) Draw the free-body diagram of the steel shaft, where ball B contacts two walls.

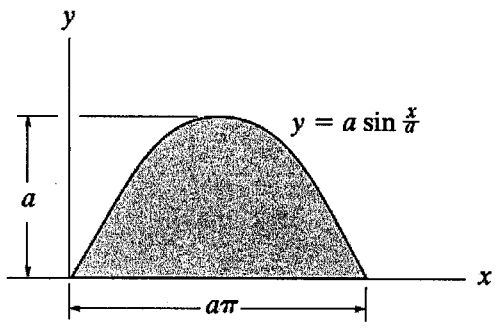
(b) Determine the height of the ball end B measured from the horizontal floor.

(c) Determine the reaction force **vector** at B by $\sum \mathbf{M}_A = 0$.

(d) Determine the reaction force **vector** at A and its magnitude.

Problem 2 (20%)

Consider the shaded area shown in the figure.

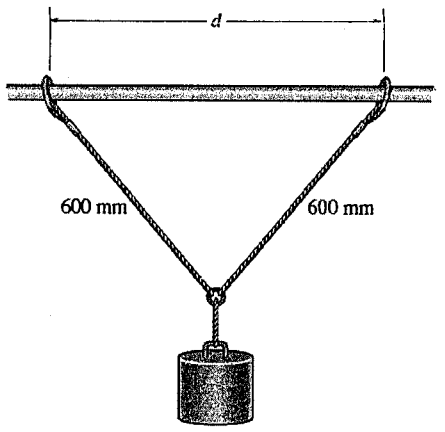


(a) Locate the centroid $\bar{x}$.

(b) Locate the centroid $\bar{y}$.

Problem 3 (25%)

The 5-kg cylinder is suspended from two equal-length cords. The end of each cord is attached to a ring of negligible mass that passes along a horizontal shaft.

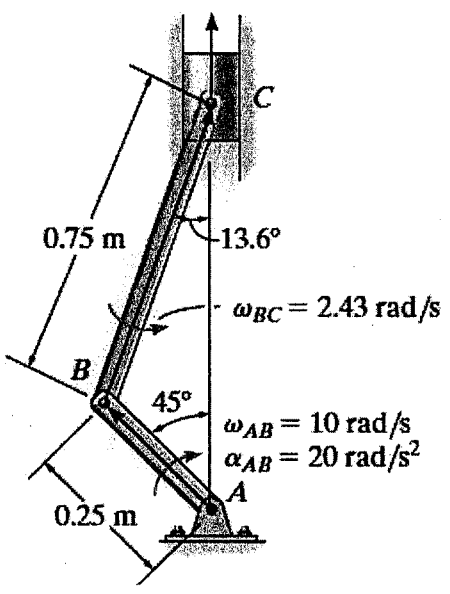


(a) If the rings can be separated by the greatest distance $d = 400$ mm and still support the cylinder, determine the coefficient of static friction between each ring and the shaft.

(b) If the coefficient of static friction between each ring and the shaft is $\mu_s = 0.5$, determine the greatest distance by which the rings can be separated and still support the cylinder.

Problem 4 (25%)

The crankshaft AB of an engine turns with a clockwise angular acceleration of 20 rad/s^2, where $\omega_{AB} = 10$ rad/s and $\omega_{BC} = 2.43$ rad/s.



(a) Determine the acceleration of the piston at this instant.

(b) Determine the acceleration of point B.

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