Appendix 2 Homework Problems

Problem A2.1

A shape is bounded on the left by the y axis, on the bottom by the x axis, and along its remaining side by the function y = -1/2 x2 + 8. Determine the x and y coordinates of the centroid of this shape via integration. (Hint: for y bar, work from the top down to make the math easier)

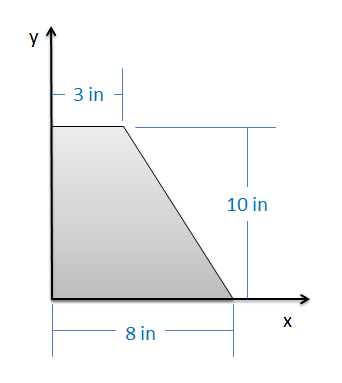
A close up of a logo

Description automatically generated

Solution: = 1.5 cm, = 3.2 cm

Problem A2.2

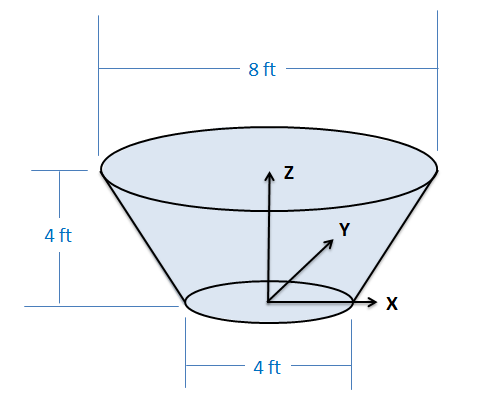
Determine the x and y coordinates of the centroid of the shape shown below via integration.



Solution: XC = 2.94 in, YC = 4.24 in

Problem A2.3

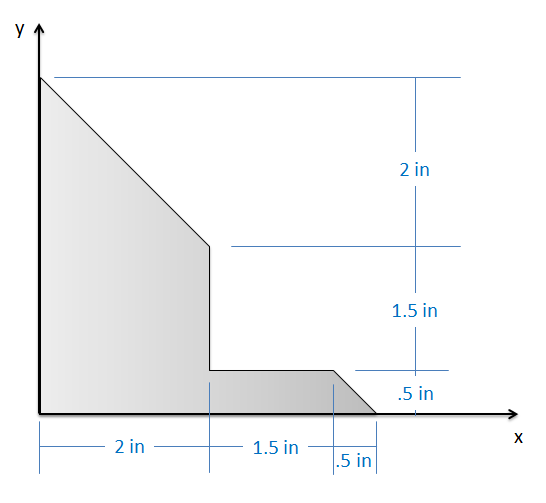
A water tank as shown below takes the form of an inverted, truncated cone. The diameter of the base is 4 ft, the diameter of the top is 8 ft, and the height of the tank is 4 ft. Using integration, determine the height of the center of mass of the filled tank. (Assume the tank is filled with water and the walls have negligible mass)



Solution: ZC = 2.43 ft

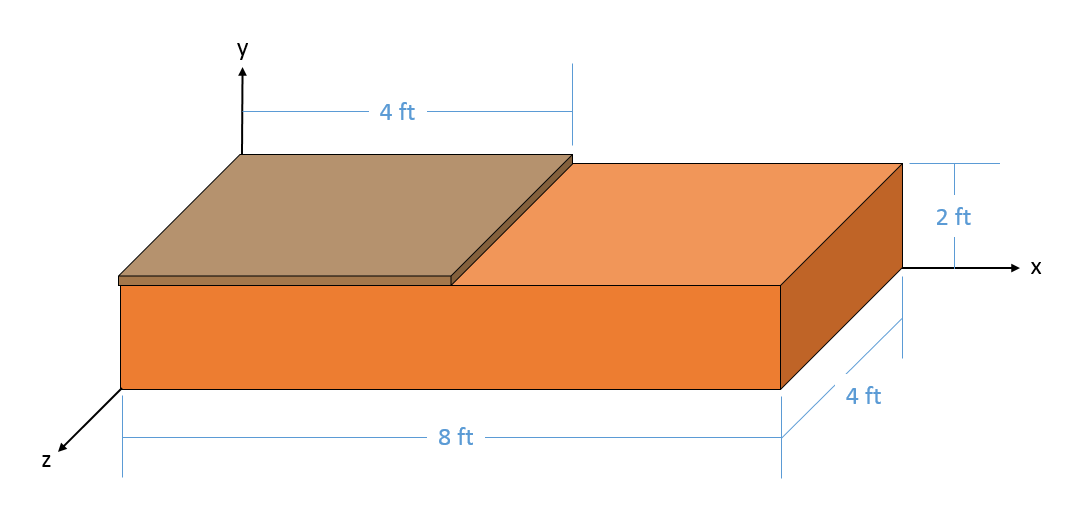
Problem A2.4

Use the method of composite parts to determine the centroid of the shape shown below.



Solution: XC = 1.14 in, YC = 1.39 in

Problem A2.5

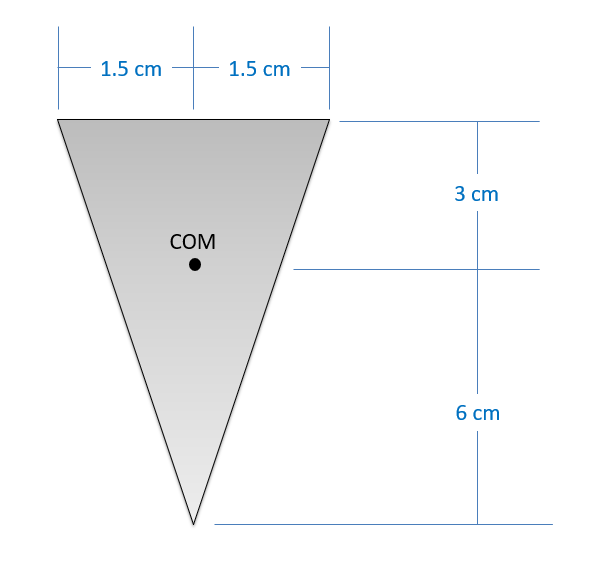
A floating platform consists of a square piece of plywood weighing 50 lbs with a negligible thickness on top of a rectangular prism of a foam material weighing 100 lbs as shown below. Based on this information, what is the location of the center of mass for the floating platform?

Solution: XC = 3.33 ft, YC = 1.33 ft, ZC = 2 ft

Problem A2.6

Use the integration method to find the moments of inertia for the shape shown below…

1. About the x axis through the centroid.
2. About the y axis through the centroid.



Solution: Ixx = 6.075\*10-7 m4, Iyy = 5.0625\*10-8 m4

A2.7

Use the integration method to find the polar moment of inertia for the semicircle shown below about point O.

Chart

Description automatically generated

Solution: Jzz = 1017.9 in4

Problem A2.8

A plastic beam has of a four-inch square cross section with semi-circular cutouts on the top and bottom as shown below. What is the area moment of inertia of the beam’s cross section about x and y axes through the center point?

Diagram

Description automatically generated

Solution: Ixx = 7.08 in4, Iyy = 17.36 in4

Problem A2.9

A piece of angled steel has a cross section that is 1 cm thick and has a length of 6 cm on each side as shown below. What are the x and y area moments of inertia through the centroid of the cross section?

A picture containing graphical user interface

Description automatically generated

Solution: Ixx = Iyy = 35.462 cm4 = 3.546 \* 10-7 m4

Problem A2.10

The pendulum in an antique clock consists of a 6 cm brass disc with a mass of .25 kg at the end of a slender wooden rod with a mass of .1 kg. Determine the mass moment of inertia of the pendulum about the top of the rod.

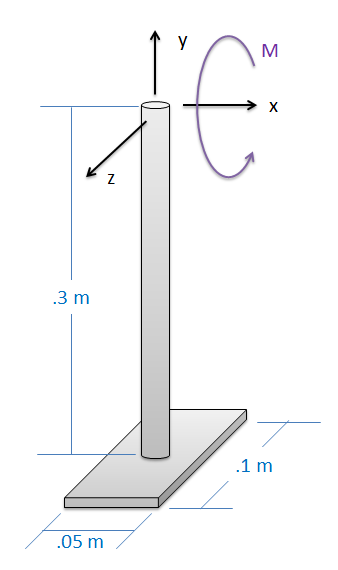


(Solution: )

Problem A2.11

A robotic leg (from the knee down) can be approximated as a slender rod with a mass of 1kg and a length of .3 meters attached to the center of a flat plate with a mass of .75 kg measuring .1 x .05 m.

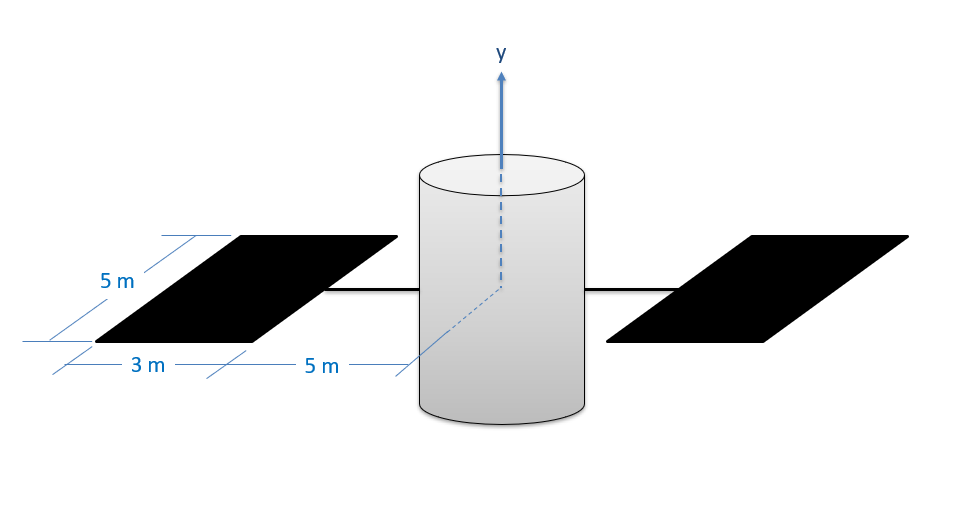
* 1. What is the moment of inertia of the leg about the x axis at the knee joint at the top?
  2. What is the moment at the knee joint required to achieve an angular acceleration of 3 rad/s2 for this leg about the x axis?



(Solution: Ixx = .098125 kg m2, M = .2944 Nm)

Problem A2.12

A space telescope can be approximated as a 600 kg cylinder with a 4-meter diameter and 4-meter height attached to two 100 kg solar panels as shown below. What is the approximate mass moment of inertia for the space telescope about the y axis shown?

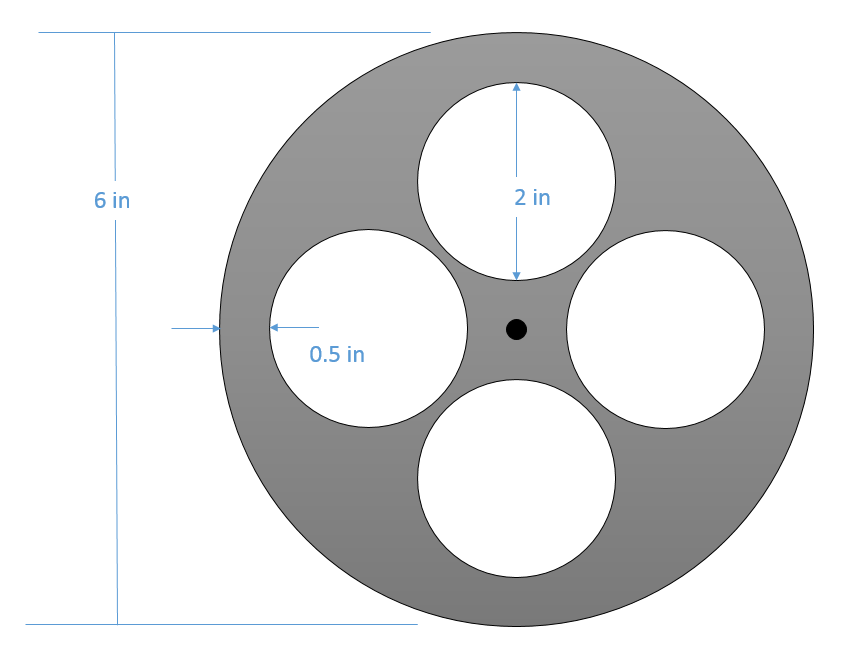


(Solution: )

Problem A2.13

A flywheel has an original weight of 15 pounds and a diameter of 6 inches. To reduce the weight, four two-inch diameter holes are drilled into the flywheel, each leaving half an inch to the outside edge as shown below.

* What was the original mass moment of inertia about the center point (without holes)?
* Assuming a uniform thickness, what is the new mass moment of inertia after drilling in the holes? (Hint: holes count as negative mass in the mass moment calculations)



(Solution: Jwithout holes = .01456 slug ft2, Jwith holes = .01060 slug ft2)