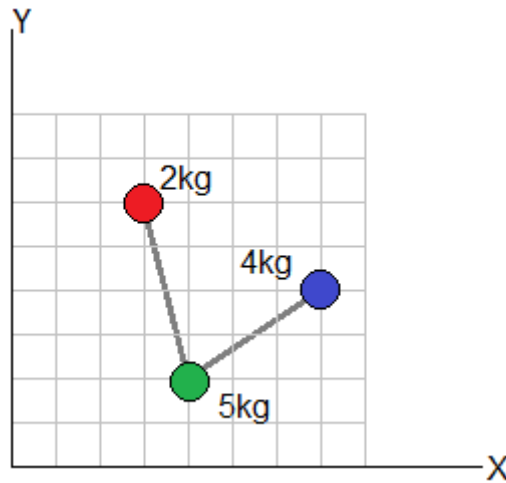# Physics Courseware
Physics I
Center of Mass

Center of mass: $X_{CM} = \dfrac{\sum m_i x_i}{\sum m_i}$ and $Y_{CM} = \dfrac{\sum m_i y_i}{\sum m_i}$

Or $X_{CM} = \dfrac{\int x \, dm}{\int m}$ and $Y_{CM} = \dfrac{\int y \, dm}{\int m}$
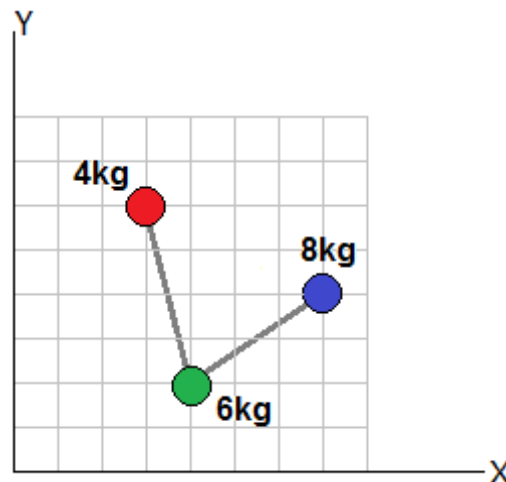
Problem 1.- Find the center of mass X_{CM} and Y_{CM} of the following object made with three masses connected with thin rods.
Ignore the mass of the rods and take each square in the grid as 1m.

Problem 1a.- Find the center of mass X_{CM} and Y_{CM} of the following object made with three masses connected with thin rods.
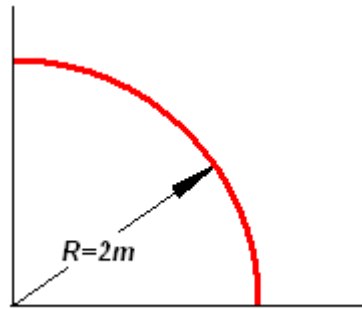Ignore the mass of the rods and take each square in the grid as 1m.

Problem 2.- Find the center of mass of a wire with the shape shown in the figure.

R=2m

Problem 3.- Find the center of mass of the plate shown in the figure, knowing that its thickness and density are uniform. It is a square of side L=2.00 with a circle cut out located at (1.50, 1.50) with a radius R=0.220 as shown in the figure. Give the answer with 3 significant figures.

2

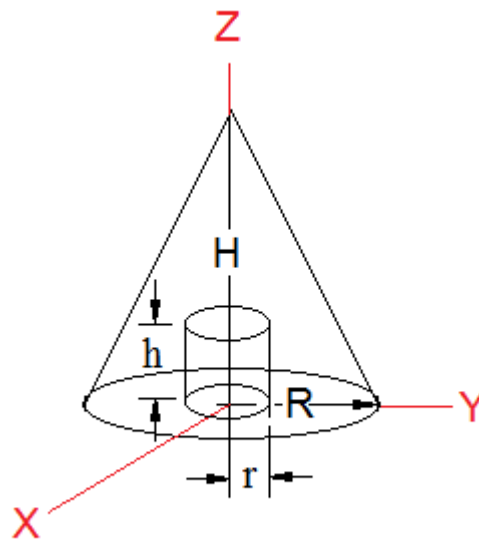(1.5,1.5)

2
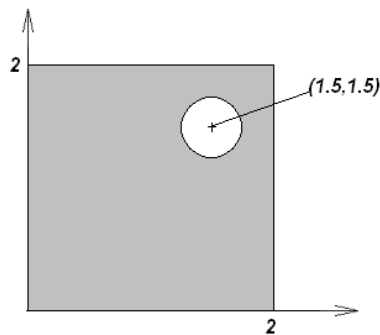
Problem 4.- Calculate the location of the center of mass of the water molecule if the mass of hydrogen is 1u and the mass of oxygen is 16u.

Y

hydrogen

0.958 Å

52.3°

oxygen

X

52.3°

0.958 Å

hydrogen
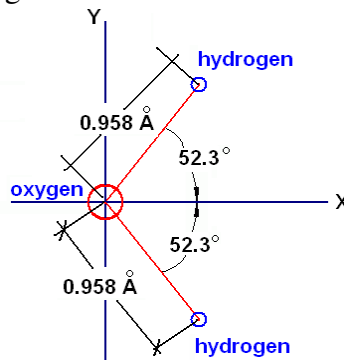
Problem 5.- Calculate the location of the center of mass of the solid cone shown in the figure. Assume it has uniform density, radius at the base R=0.2m and height H=0.8m
Suggestion: You can integrate thin disks of radius "r" to get the center of mass. Notice that the radius would be r=R(1-z/H)
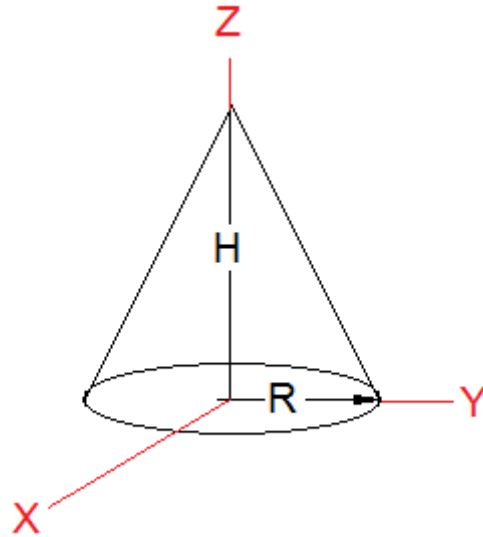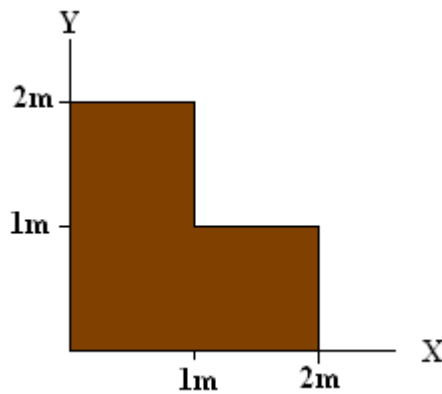

Problem 5a: Calculate the location of the center of mass of the solid cone shown in the figure. Assume it has uniform density, radius at the base R=0.2m and height H=0.8m
There is a cylinder carved out at the base of radius r=0.1m and height h=0.2m

Problem 6.- Find the center of mass (x_{CM} and y_{CM}) of the following plate that has uniform thickness:


Problem 7.- Calculate the location of the center of mass of the HCl molecule if the mass of hydrogen is 1u and the mass of chlorine is 35u and the distance between the atoms is 1.3Å. In your answer, specify where the center of mass is with respect to the chlorine nucleus.

Problem 8.- How far from the center of the Earth is the center of mass of the Earth-Moon system?
Consider the distance between the center of the Earth and the center of the Moon to be 384×10^3 km, the mass of the Earth=5.98×10^{24} kg and the mass of the Moon 7.35×10^{22} kg.

Problem 9.- A metallic plate with constant thickness and density has the shape of a square with a side of 2m. A round disk of radius 0.5m is removed from the square leaving the shape shown in the figure. Calculate where the center of mass is located.
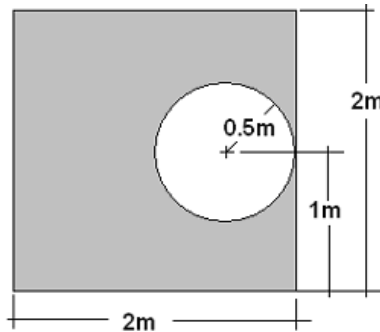

Problem 10.- Find how far from Pluto is the center of mass of the Pluto-Charon system. The mass of Pluto is 1.30×10^{22} kg, the mass of Charon is 1.51×10^{21} kg and the distance between them is 19,600 km.
Given that the radius of Pluto is 1,153 km, is the Center of Mass inside or outside Pluto?

Problem 11.- Find the center of mass of the following plate that has uniform thickness and density:
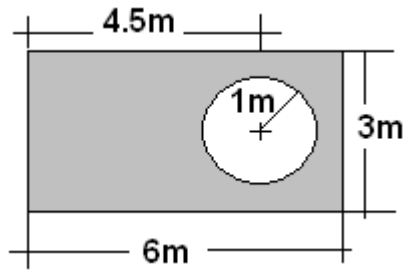
Problem 12.- Seven particles of mass 1kg each are located at the corners of an octagon as shown in the figure. Calculate the position of the center of mass (x_{CM}).
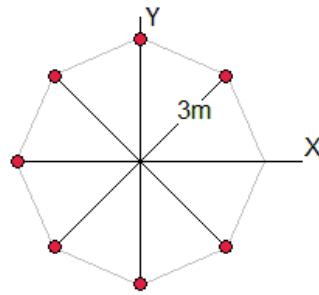

Problem 12a: A system of nine particles of mass 1kg each are located at the corners of an octagon, plus one particle at the (6,0) position as shown in the figure. Calculate the location of the center of mass of the system (X_{CM}).
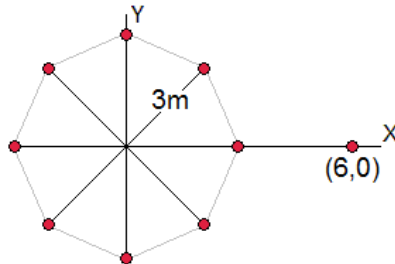

Problem 13.- A solid rocket nose has a shape that can be modeled as a cylinder with variable radius $r = 2\sqrt{x}$ as shown in the figure. Calculate the center of mass of the nose.
[Suggestion: divide the nose in infinitesimally thin disks of area πr^2]
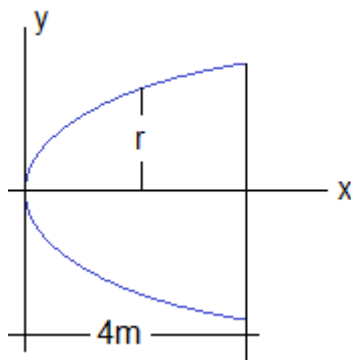
Problem 14.- Find the center of mass of the following plate that has uniform thickness and density. Take the center of the large circle to be the origin.
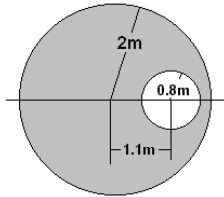
Problem 15.- Find the center of mass of the following plate that has uniform thickness and density: