

Workbook



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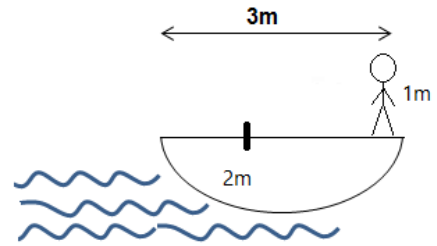
Center of Mass

Center of a Mass

Questions

1) Man on a Boat.

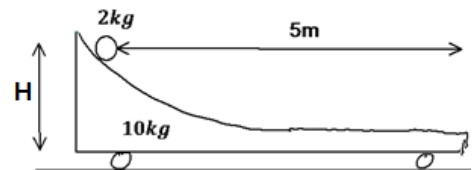
A man stands at one end of a boat of length 3m .
 The man weighs 70kg and the boat weighs 100kg .
 The man moves 2m up the boat.
 How much does the boat move?
 Ignore friction between boat and water.
 Given: $m_1 = 70\text{kg}$, $m_2 = 100\text{kg}$.



2) Ball on Ramp.

A ball is resting on a sloped ramp which is also at rest.
 The height of the ball is 1m, and it is 5m away from the edge of the ramp.
 The mass of the ramp, $m_1 = 10\text{kg}$ and the mass of the ball, $m_2 = 2\text{kg}$.

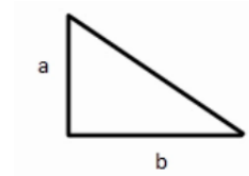
- a. Find the displacement of the ramp when the ball reaches its edge.
- b. Find the velocity of the bodies if it is given that the velocity of the ball at the edge of the ramp is only in the x direction.



Calculating the Center of Mass Using Integrals

Questions:

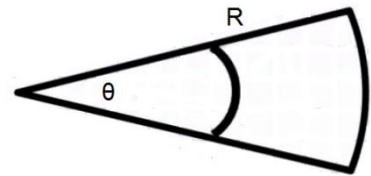
- 3) **Triangles Center of Mass.**
Find the triangle's center of mass.



- 4) **Gate Center of Mass.**
An electric gate of mass m and length l is resting on an axis, which is located a distance d from its edge. Explain why a heavy mass is attached to one end of the gate and find its mass, if its length is L .

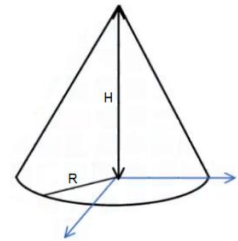


- 5) **Sector Center of Mass.**
Find the center of mass of the sector with uniform density and $\sphericalangle \theta^\circ$.

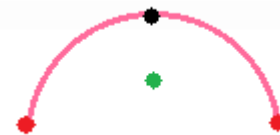


- 6) **Area of Segment.**
Find the area of a segment.

- 7) **Center of Mass of a Solid Cone.**
Find the center of mass of a solid cone with uniform density.

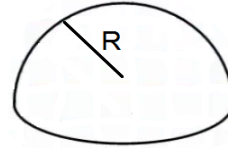


- 8) **Half Hoop with Two Masses.**
Find the center of mass of the half hoop of mass M and radius R , when at each end there is also ball of mass m attached.



9) **Center of Mass Half Sphere Full**

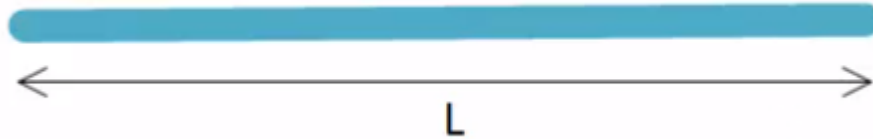
Find the center of mass of a filled half sphere.



10) **Center of Mass of a Rod**

Find the center of mass of a non-homogeneous rod of length L .

Density from left end: $\lambda(x) = \lambda_0 \frac{x}{L}$.



Answer Key

1) $x = \frac{14}{17} m$

2) a. $\Delta x_1 = -\frac{10}{12} m$

b. $u_1 = \frac{2}{\sqrt{3}} m/s, u_2 = \frac{-10}{\sqrt{3}} m/s$

3) $x_{cm} = \frac{1}{3} b$

4) $M = \frac{\frac{L}{2} m - dm}{\frac{L}{2} + d}$

5) $x_{cm} = \frac{4R \sin \frac{\theta_0}{2}}{3\theta_0}$

6) $S = \frac{\theta R^2}{2}$

7) $Z_{cm} = \frac{H}{4}$

8) $y_{cm_{Hoop}} = \frac{\sqrt{2}MR}{\pi(M + 2m)}$