[Problem View]

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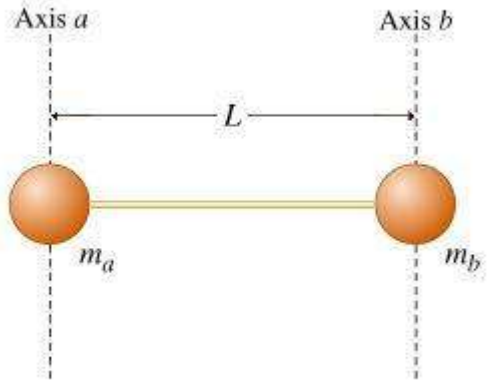
Moment of Inertia and Center of Mass for Point Particles

Ball a, of mass m_a, is connected to ball b, of mass m_b, by a massless rod of length L. The two vertical dashed lines in the figure, one through each ball, represent two different axes of rotation, axes *a* and *b*. These axes are parallel to each other and perpendicular to the rod. The moment of inertia of the two-mass system about axis *a* is I_a, and the moment of inertia of the system about axis *b* is I_b. It is observed that the ratio of I_a to I_b is equal to 3:

$$\frac{I_a}{I_b} = 3$$

Assume that both balls are pointlike; that is, neither has any moment of inertia about its own center of mass.



Part A

Find the ratio of the masses of the two balls.

Hint A.1 How to approach the problem

Find an expression for I_a and for I_b in terms of the masses m_a and m_b. Substitute these expressions into the formula given in the problem introduction and then solve for the ratio of the masses.

Part A.2 Find I_a

Find I_a, the moment of inertia of the system about axis *a*.

Hint A.2.a Formula for the moment of inertia

The formula for the moment of inertia I of an object consisting of particles with masses m_i, at distances r_i from the rotation axis is

$$I = \sum_i m_i r_i^2 .$$

Express your answer in terms of any or all of the following quantities: L, m_a, and m_b.

ANSWER: I_a = **m_a*L^2**

Express your answer numerically.

ANSWER: $\frac{m_a}{m_b}$ = *Answer not displayed*

Part B

Find d_a, the distance from ball A to the system's center of mass.

Hint B.1 **How to approach the problem**

To find d_a, compute the position of the center of mass of the system, using a coordinate system in which ball a is at the origin. In these coordinates, ball a is at distance zero from the origin, ball b is at distance L from the origin, and the center of mass is at distance d_a from the origin. Using these values in the equation for center of mass, you obtain

$$d_a = \frac{0 \cdot m_a + L m_b}{m_a + m_b}.$$

Use the result from Part A to eliminate m_a and m_b from this equation and obtain d_a in terms of L.

Part B.2 **Find m_b in terms of m_a**

What is m_b in terms of m_a?

ANSWER: m_a = *Answer not displayed*

Express your answer in terms of L, the length of the rod.

ANSWER: d_a = *Answer not displayed*