

Solutions

Each answer shows the steps, then the **result**.

2.1

- centre of mass is the mass-weighted mean position:

$$x_{cm} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2} = \frac{(1 \text{ kg})(0) + (1 \text{ kg})(4 \text{ m})}{2 \text{ kg}}$$

- $x_{cm} = \mathbf{2 \text{ m}}$

2.2

- centre of mass is the mass-weighted mean position:

$$x_{cm} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2} = \frac{(2 \text{ kg})(0) + (6 \text{ kg})(8 \text{ m})}{8 \text{ kg}}$$

- $x_{cm} = \mathbf{6 \text{ m}}$

2.3

- At the 50 cm mark (its midpoint)

2.4

- No – only a net external force can move the center of mass

3.1 B

- the net external force drives the center of mass

3.2 B

- equal masses give the midpoint:

$$x_{cm} = \frac{x_1 + x_2}{2} = \frac{2 \text{ m} + 6 \text{ m}}{2} = 4 \text{ m}$$

3.3

(a)

- centre of mass is the mass-weighted mean position:

$$x_{cm} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2} = \frac{(4 \text{ kg})(1 \text{ m}) + (2 \text{ kg})(7 \text{ m})}{6 \text{ kg}}$$

- $x_{cm} = \mathbf{3 \text{ m}}$

(b)

- closer to the 4 kg mass (2 m from it, 4 m from the 2 kg mass): the larger mass carries more weight in the average

3.4

(a)

- It keeps moving as before (stays at rest if it was at rest)

(b)

- Throwing is an internal force, and internal forces cannot move the center of mass