Answer on Question #73283, Physics / Mechanics | Relativity

Question. A girl is sitting with her dog at the left end of a boat of length $10.0\ m$. The mass of the girl, her dog and the boat are $60.0\ kg$, $30.0\ kg$ and $100.0\ kg$ respectively. The boat is at rest in the middle of the lake. Calculate the centre of mass of the system. If the dog moves to the other end of the boat, the girl staying at the same place, how far and in what direction does the boat move?

Given. $m_g = 60.0\ kg; m_d = 30.0\ kg; m_b = 100.0\ kg; l = 10.0\ m$

Find. $x, s-?$

Solution.

According to the formula of the center of mass of the system

$$x = \sum_{i=1}^{n} (m_i \cdot x_i) \Big/ \left(\sum_{i=1}^{n} m_i \right),$$

we get

$$x = \frac{m_g \cdot x_g + m_d \cdot x_d + m_b \cdot x_b}{m_g + m_d + m_b} = \frac{60 \cdot 0 + 30 \cdot 0 + 100 \cdot 5}{60 + 30 + 100} = 2.63\ m\ from\ the\ left\ end\ of\ the\ boat.$$

According to the momentum conservation principle

$$(m_g + m_b) \cdot v - m_d \cdot V = 0$$

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$$(m_g + m_b) \cdot \frac{s}{t} - m_d \cdot \frac{l - s}{t} = 0 \quad \rightarrow \quad (m_g + m_b)s + m_d s = m_d l \quad \rightarrow \quad s = \frac{m_d l}{m_g + m_d + m_b} =$$

$$= \frac{30 \cdot 10}{60 + 30 + 100} = 1.58\ m$$

The boat is moving in the opposite direction to the dog's movement.

Answer. $x = 2.63\ m; s = 1.58\ m.$