

(SP9-2) a) momentum.

$$\vec{F}_{\text{net}} = \frac{d\vec{p}}{dt} = 0$$

$$\Rightarrow \Delta \vec{p} = 0$$

$$b) \quad \vec{p} = \vec{p}_1 + \vec{p}_2$$

$$= m_1 \vec{v}_1 + m_2 \vec{v}_2$$

$$\vec{p} = p \hat{i} \quad \text{Call } p_x, "p" \quad v_y, v_z \text{ are zero.}$$

$$p = m_1 \frac{dx_1}{dt} + m_2 \frac{dx_2}{dt}$$

$$c) \quad p = \frac{d}{dt} (m_1 x_1) + \frac{d}{dt} (m_2 x_2)$$

$$= \frac{d}{dt} (m_1 x_1 + m_2 x_2)$$

$$d) \quad x_{\text{cm}} = \frac{m_1 x_1 + m_2 x_2}{M}$$

$$x_{\text{cm}} M = m_1 x_1 + m_2 x_2$$

$$\circ p = \frac{d}{dt} (x_{\text{cm}} M) = M \frac{dx_{\text{cm}}}{dt} = M v_{\text{cm}}$$

(SP9-3)

$$x_{\text{cm}} = \frac{\sum m_i x_i}{M} = \frac{(3.0 \text{ kg})(3.0 \text{ m}) + (4.0 \text{ kg})(-2.0 \text{ m}) + (1.0 \text{ kg})(2.0 \text{ m})}{(3.0 + 4.0 + 1.0) \text{ kg}}$$

$$= 0.375 \text{ m.}$$

$$y_{\text{cm}} = \frac{\sum m_i y_i}{M} = \frac{(3.0 \text{ kg})(-2.0 \text{ m}) + (4.0 \text{ kg})(4.0 \text{ m}) + (1.0 \text{ kg})(2.0 \text{ m})}{(3.0 + 4.0 + 1.0) \text{ kg}}$$

$$= 1.50 \text{ m}$$

$$\vec{r}_{\text{cm}} = \underline{0.38 \text{ m}} \hat{i} + \underline{1.5 \text{ m}} \hat{j}$$

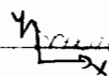
-0.5 UNITS

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(SP9-4)



$$\vec{r}_{\text{sun}} = 0\hat{i}$$



earth.



$$1.496 \times 10^8 \text{ km}$$

$$\vec{r}_{\text{earth}} = 1.496 \times 10^8 \text{ km} \hat{i}$$

$$x_{\text{cm}} = \frac{\sum m_i x_i}{M} = \frac{m_{\text{earth}} (1.496 \times 10^8 \text{ km})}{m_{\text{earth}} (329340 + 1)}$$

$$= 454 \text{ km}$$

CM is only 454 km from the centre of the sun.

(which is smaller than the sun's radius!)

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$$\frac{\sum m_i x_i}{\sum m_i}$$

$$\frac{m_s x_s + m_e x_e}{m_s + m_e}$$