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① a)

Dados

$m_1 = 2\,kg$
$m_2 = 4\,kg$
$m_3 = 4\,kg$
$m_4 = 6\,kg$

$x_1 = 3\,m$
$x_2 = 4\,m$
$x_3 = -4\,m$
$x_4 = -2\,m$

$y_1 = 3\,m$
$y_2 = -2\,m$
$y_3 = -4\,m$
$y_4 = 2\,m$

F / R

$$x_{cm} = \frac{m_1 \cdot x_1 + m_2 \cdot x_2 + m_3 \cdot x_3 + m_4 x_4}{m_1 + m_2 + m_3 + m_4}$$

$$x_{cm} = \frac{2 \cdot 3 + 4 \cdot 4 + 4 \cdot (-4) + 6 \cdot (-2)}{2 + 4 + 4 + 6}$$

$$x_{cm} = \frac{6 + 16 + (-16) + (-12)}{16}$$

$$x_{cm} = \frac{6 + (-12)}{16}$$

$$x_{cm} = \frac{-6 : 2}{16 : 2} = \frac{-3}{8}$$

$$y_{cm} = \frac{m_1 \cdot y_1 + m_2 \cdot y_2 + m_3 \cdot y_3 + m_4 \cdot y_4}{M}$$

$$y_{cm} = \frac{2 \cdot 3 + 4 \cdot (-2) + 4 \cdot (-4) + 6 \cdot 2}{16}$$

$$y_{cm} = \frac{-2 + (-4)}{16}$$

$$y_{cm} = \frac{-6 : 2}{16 : 2} = \frac{-3}{8}$$

$$\boxed{\vec{r}_{cm} = x_{cm}\vec{i} + y_{cm}\vec{j}}$$

$$\vec{r}_{cm} = -\frac{3}{8} + \left(-\frac{3}{8}\right)\vec{j}$$

$$\vec{r}_{cm} = -\frac{3}{8}\vec{i} - \frac{3}{8}\vec{j}$$

b)

Dados

$m_1 = 2\,kg$
$m_2 = 4\,kg$
$m_3 = 4\,kg$
$m_4 = 6\,kg$

$v_{1x} = 3\,m/s$
$v_{1y} = 0\,m/s$

$v_{2x} = 0\,m/s$
$v_{2y} = -4\,m/s$

$v_{3x} = 0\,m/s$
$v_{3y} = 3\,m/s$

$v_{4x} = -2\,m/s$
$v_{4y} = 0\,m/s$

FIR

$$v_{cm} = \frac{v_1 m_1 + v_2 m_2 + v_3 m_3 + v_4 m_4}{m_1 + m_2 + m_3 + m_4}$$

$$\vec{v} = v_{cm}\vec{i} + v_{cm}\vec{j}$$

$$v_{cm\,x} = \frac{v_{1x} m_1 + v_{2x} m_2 + v_{3x} m_3 + v_{4x} m_4}{m_1 + m_2 + m_3 + m_4}$$

$$v_{cm\,x} = \frac{3 \cdot 2 + \overset{0}{\cancel{0 \cdot 4}} + \overset{0}{\cancel{0 \cdot 4}} + (-2) \cdot 6}{2 + 4 + 4 + 6}$$

$$v_{cm\,x} = \frac{6 - 12}{16}$$

$$v_{cm\,x} = \frac{-6 : 2}{16 : 2}$$

$$v_{cm\,x} = -\frac{3}{8}$$

$$v_{cm_y} = \frac{v_{1y} m_1 + v_{2y} m_2 + v_{3y} m_3 + v_{4y} m_4}{m_1 + m_2 + m_3 + m_4}$$

$$v_{cm_y} = \frac{0 \cdot \vec{i} + (-4) \cdot 4 + 3 \cdot 4 + 0 \cdot \vec{6}}{2 + 4 + 4 + 6} = \frac{-16 + 12}{16}$$

$$v_{cm_y} = \frac{-4}{16} = -\frac{1}{4}$$

$$\vec{v} = v_{cm_i} \vec{i} + v_{cm_j} \vec{j}$$

$$\vec{v} = -\frac{3}{8} \vec{i} + \left(-\frac{1}{4}\right) \vec{j}$$

$$\vec{v} = -\frac{3}{8} \vec{i} - \frac{1}{4} \vec{j}$$