Solutions posted

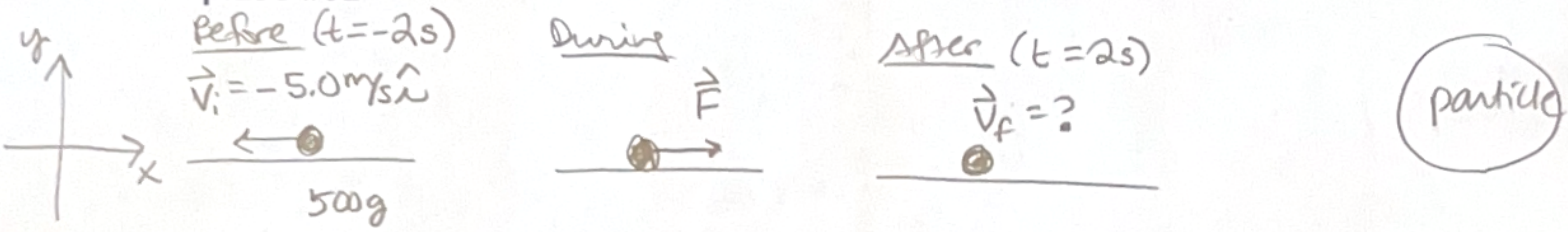
Name: ____________
Date: ____________

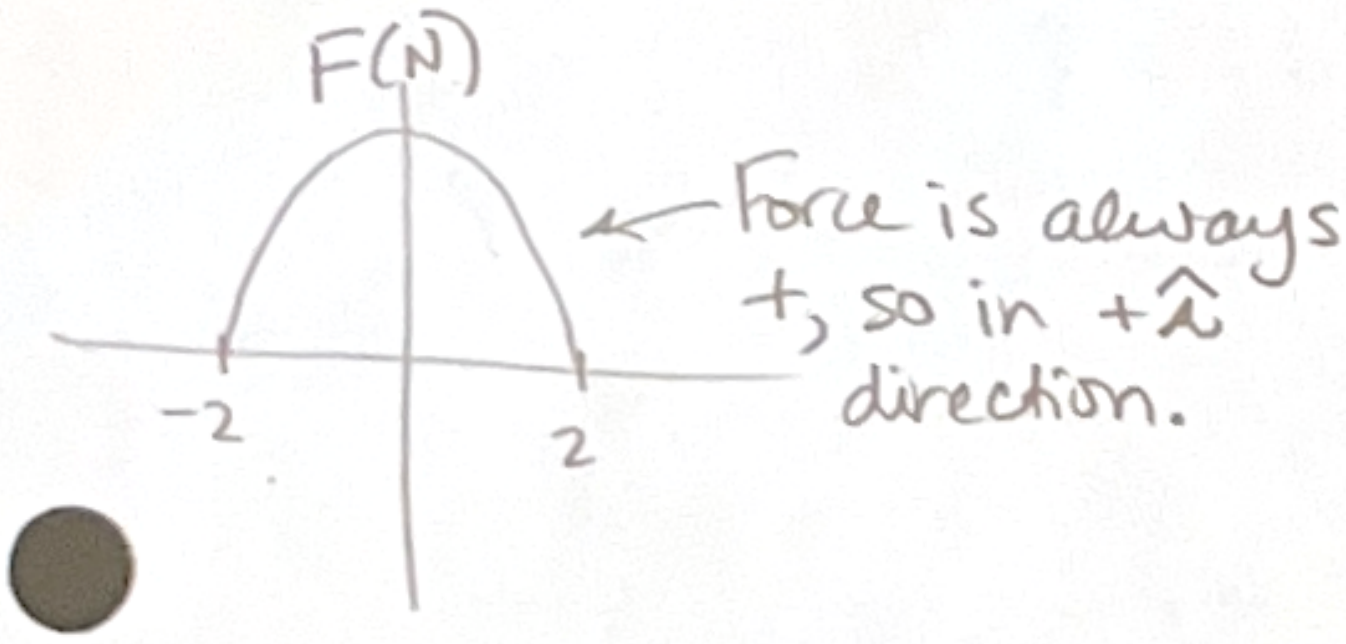
Momentum Application 4

For each problem, clearly communicate your thought process. Include:

- *Before*, *during*, *after* sketches, coordinate system, system circle
- External force & impulse analysis
- Show your solution in both ways:
  - a calculation with unit vectors
  - a large vector diagram with all components labeled with numerical values.

1. p.290 #61





Ext Forces + Impulse

$\vec{F} \longrightarrow \vec{J}_1 \rightarrow$ significant

$\vec{F}_G$ assumed $\rightarrow \vec{J}_2$) cancel

$\vec{n}$ assumed $\rightarrow \vec{J}_3$

$$\Sigma\vec{J} = \vec{J}_1 = \int_{t_1}^{t_2} \vec{F}\,dt$$

$$= \int_{-2}^{2} (4-t^2)\,\hat{\imath}\,dt$$

$$= \left[4t - \tfrac{1}{3}t^3\right]_{-2}^{2} \hat{\imath}$$

$$= \left(\left[4(2) - \tfrac{1}{3}(2)^3\right] - \left[4(-2) - \tfrac{1}{3}(-2)^3\right]\right)\hat{\imath}$$

$$= \left[\left(8 - \tfrac{8}{3}\right) - \left(-8 + \tfrac{8}{3}\right)\right]\hat{\imath}$$

$$= \left(8 - \tfrac{8}{3} + 8 - \tfrac{8}{3}\right)\hat{\imath}$$

$$= 10.67\hat{\imath}$$

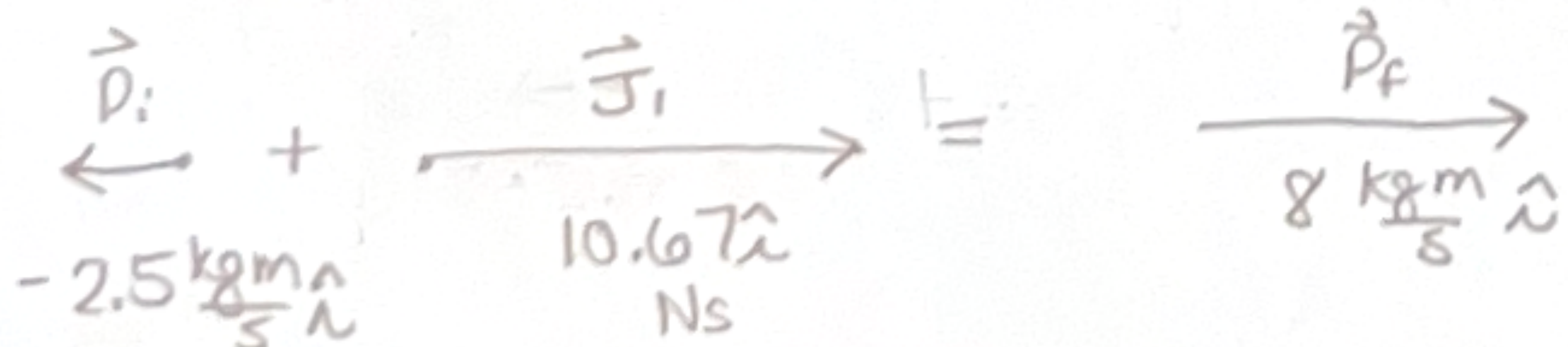
$$\vec{p}_i + \Sigma\vec{J} = \vec{p}_f$$

$$m\vec{v}_i + \vec{J}_1 = m\vec{v}_f$$

$$(.5\,\text{kg})(-5.0\,\text{m/s}\,\hat{\imath}) + 10.67\hat{\imath} = (.5\,\text{kg})\vec{v}_f$$

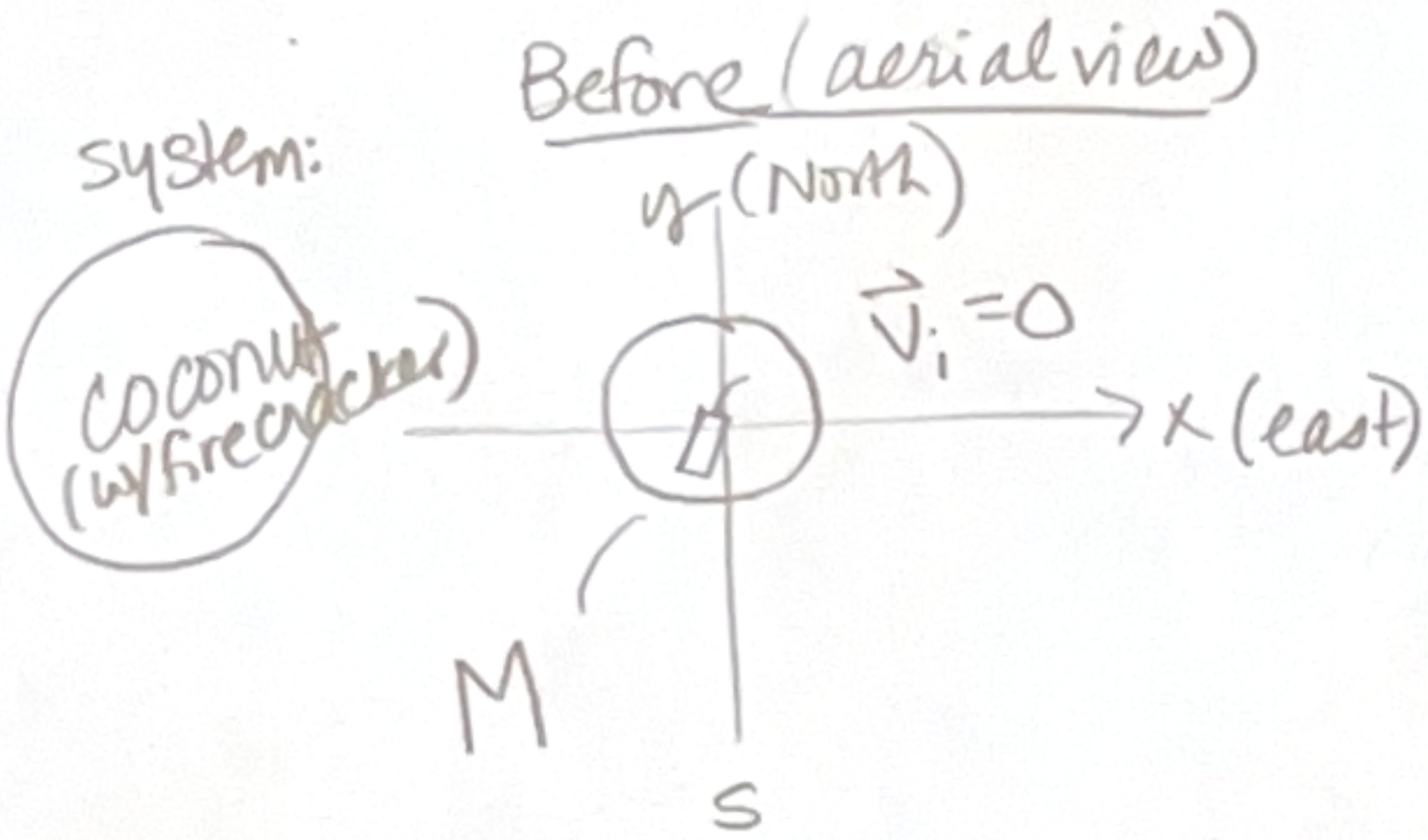
$$\boxed{16\,\tfrac{\text{m}}{\text{s}}\,\hat{\imath} = \vec{v}_f}$$

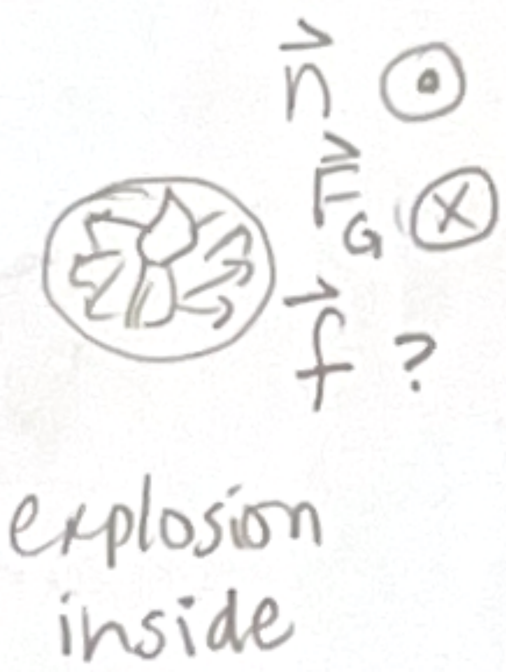
$$\vec{p}_i \quad + \quad \vec{J}_1 \quad = \quad \vec{p}_f$$

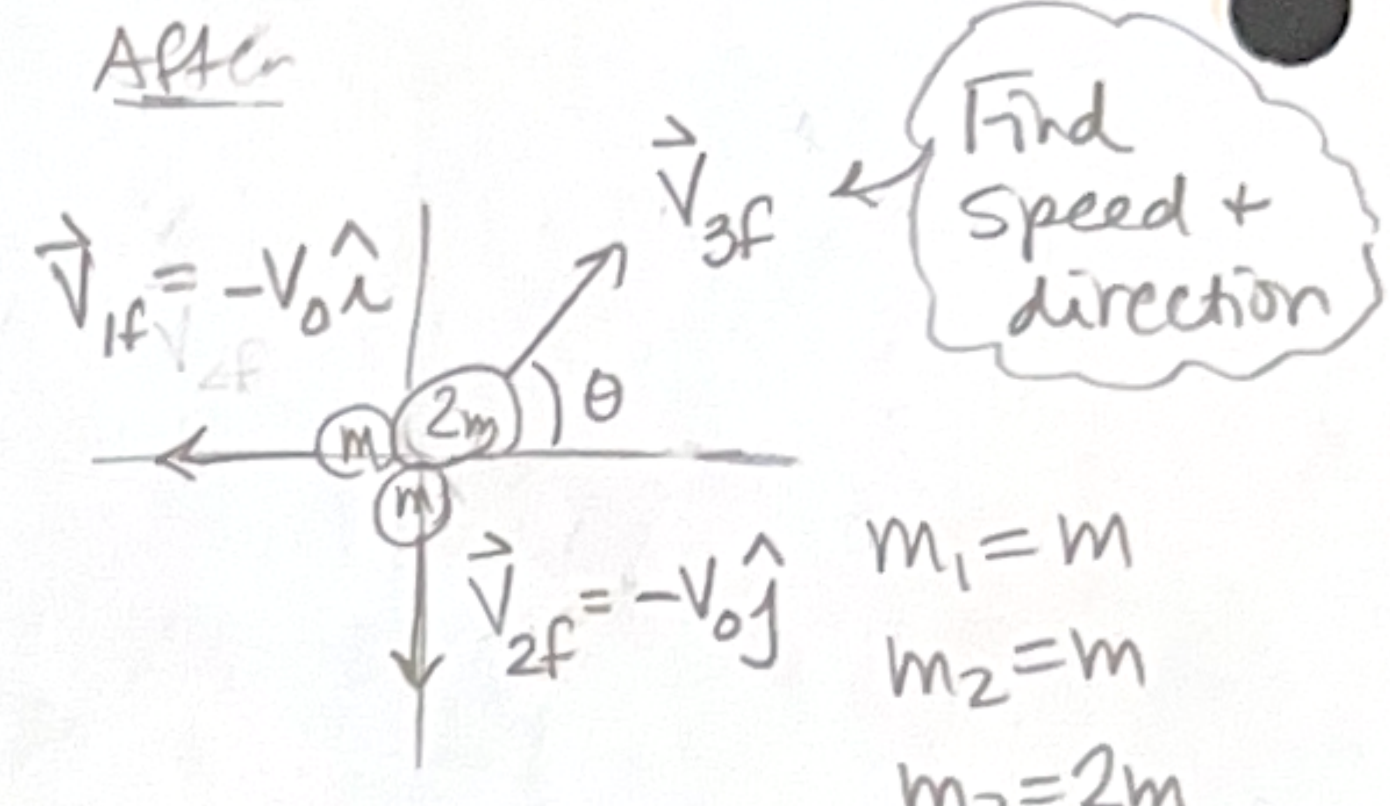


2. p.289 #47

system:







$m_1 = m$
$m_2 = m$
$m_3 = 2m$

$M = (m + m + 2m)$
$= 4m$

ext forces + impulse

$\left.\begin{array}{l}\vec{F}_G \rightarrow \vec{J}_1 \\ \vec{n} \rightarrow \vec{J}_2\end{array}\right)$ cancel

$\vec{f} \rightarrow \vec{J}_3$: negligible

$\Sigma\vec{J} = 0$

Find $\vec{v}_{3f}$:

$$\vec{p}_i + \Sigma\vec{J} = \vec{p}_f$$

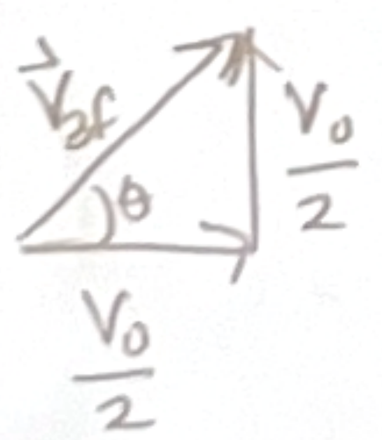
$$0 + 0 = m_1\vec{v}_{1f} + m_2\vec{v}_{2f} + m_3\vec{v}_{3f}$$

$$0 = m(-v_0\hat{\imath}) + m(-v_0\hat{\jmath}) + 2m\vec{v}_{3f}$$

$$mv_0\hat{\imath} + mv_0\hat{\jmath} = 2m\vec{v}_{3f}$$

$$\boxed{\left(\frac{v_0}{2}\right)\hat{\imath} + \left(\frac{v_0}{2}\right)\hat{\jmath} = \vec{v}_{3f}}$$

Find speed + direction.



$$v_{3f}^2 = \left(\frac{v_0}{2}\right)^2 + \left(\frac{v_0}{2}\right)^2$$

$$v_{3f} = \sqrt{\frac{2v_0^2}{4}}$$

$$v_{3f} = \sqrt{\frac{v_0^2}{2}}$$

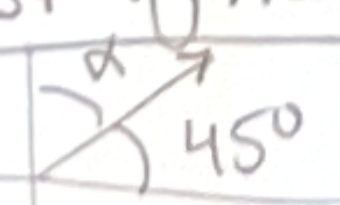
$$v_{3f} = \frac{v_0}{\sqrt{2}}$$

$$\tan\theta = \frac{\left(\frac{v_0}{2}\right)}{\left(\frac{v_0}{2}\right)} = 1$$

$\theta = 45°$

so $\alpha = 45°$ E of N

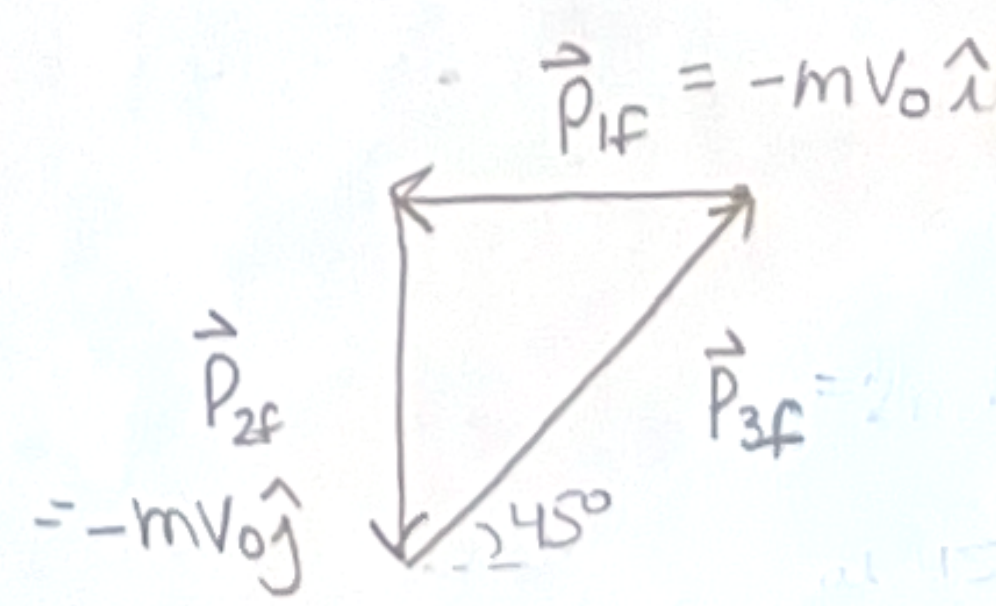
The speed is $\frac{v_0}{\sqrt{2}}$ at 45° east of north



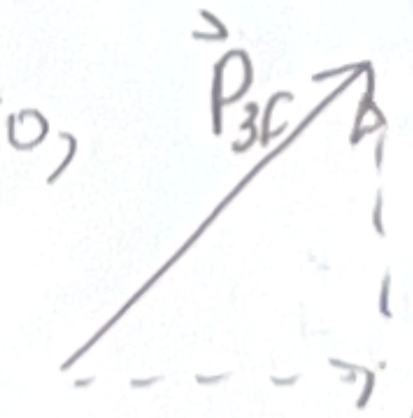
using vectors

$$\vec{p}_i + \vec{J}_1 = \vec{p}_f$$

$$0 + 0 =$$



so,



$$\vec{p}_{3f} = +mv_0\hat{\imath} + mv_0\hat{\jmath}$$

$$\vec{v}_{3f} = \frac{(mv_0\hat{\imath} + mv_0\hat{\jmath})}{2m}$$

$$\vec{v}_{3f} = \left(\frac{v_0}{2}\right)\hat{\imath} + \left(\frac{v_0}{2}\right)\hat{\jmath}$$