(7.23) The jerk $\vec{j}$ is $\vec{j} = \frac{d\vec{a}}{dt}$.

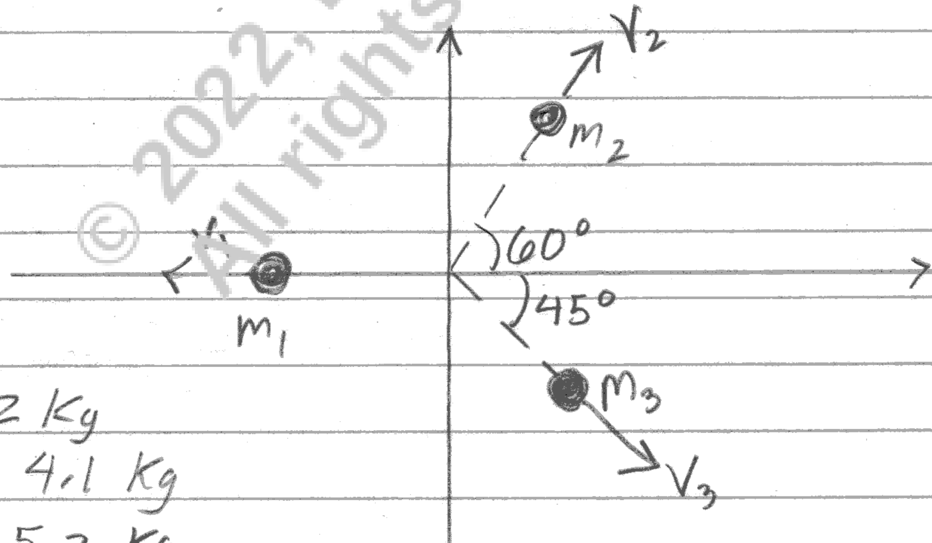
From the 2nd law $\vec{F} = m\vec{a}$ so

$$\frac{d\vec{F}}{dt} = m\frac{d\vec{a}}{dt} = m\vec{j} \quad \text{or}$$

$$\boxed{\vec{j} = \frac{1}{m}\frac{d\vec{F}}{dt}}.$$ Now since $\vec{F} = \frac{d\vec{p}}{dt}$

this is also $\boxed{\vec{j} = \frac{1}{m}\frac{d^2\vec{p}}{dt^2}}$.

(7.25) A single object explodes, into 3 chunks. See Fig. 7.14.



$m_1 = 2$ Kg
$m_2 = 4.1$ Kg
$m_3 = 5.2$ Kg.
$V_1 = 1.5 \times 10^3 \frac{m}{s}$
$V_2 = 4.2 \times 10^3$ m/s
$V_3 = 1.6 \times 10^3$ m/s

Was the original single object at rest?

7.25 cont.

Use cons. of momentum.

The final momentum of the system is

$$-m_1 V_1 \hat{i} + m_2 V_2 \cos 60° \hat{i} + m_2 V_2 \sin 60° \hat{j}$$
$$+ m_3 V_3 \cos 45° \hat{i} - m_3 V_3 \sin 45° \hat{j}$$

Check $\hat{i}$ components.

$$0 \stackrel{?}{=} -m_1 V_1 + m_2 V_2 \cos 60° + m_3 V_3 \cos 45°.$$

$$-(2)(1{,}500) + (4.1)(4200) \cos 60° + (5.2)(1600) \cos 45°$$

$= -3000 + 8610 + 5883 = 11493$ kg m/s
which is not zero, so no the original object was not at rest.

So its original momentum was say

$\vec{P}_i = m(V_x \hat{i} + V_y \hat{j})$ where $m = m_1 + m_2 + m_3$

or 11.3 kg. So $V_x = \frac{11493}{11.3} = 1017 \frac{m}{s}$.

Find V_y.

7.25 cont.

Check $\hat{j}$ components

$$m_2 V_2 \sin 60^\circ - m_3 V_3 \sin 45^\circ$$

$$= (4.1)(4200)\sin 60^\circ - (5.2)(1600)\sin 45^\circ$$

$$= 9029.8 \ \text{kg}\frac{\text{m}}{\text{s}} \quad \text{so}$$

$$V_y = \frac{9029.8}{11.3} = 799.1 \ \text{m/s}$$

so initially the particle had velocity

$$\boxed{\vec{V}_i = 1017\hat{i} + 799.1\hat{j} \ \text{m/s}}$$