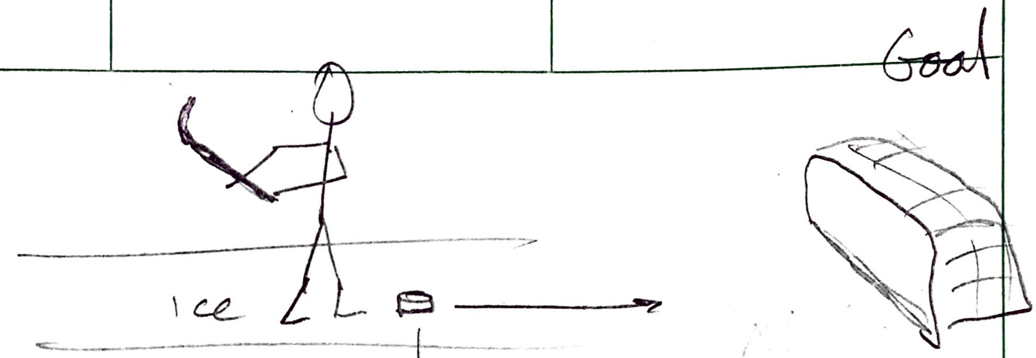
9.45



puck
$m = 0.150\,kg$
$V_i = 0$
$V_f = 45.0\,m/s$

How far does player recoil?
($m = 90.0\,kg$)

First, let's get player's recoil velocity:

$$m_{player} V_{player} + m_{puck} V_{puck} = m_{player} V_{player}' + m_{puck} V_{puck}'$$

$$0 + 0 = (90\,kg) V_{player}' + (0.150\,kg)(45\,m/s)$$

$$V_{player} = -\frac{(0.150)(45)}{90} = \underline{-0.075\,m/s}$$

Δt for puck to reach net?

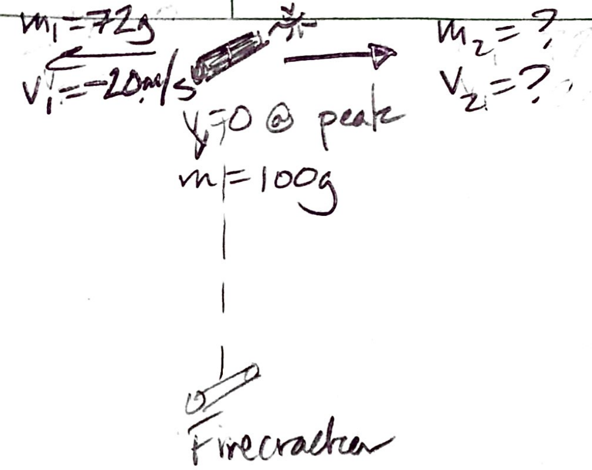
$$\Delta t = \frac{\Delta x}{V} = \frac{15\,m}{45\,m/s} = \underline{0.33\,s}$$

Δx for player in that time?

$$\Delta x = vt = (-0.075\,m/s)(0.33\,s)$$

$$= -\boxed{0.025\,m}$$

9.46



Conservation of momentum, recoil-type problem.

$(m_1 + m_2)v_i = m_1 v_1' + m_2 v_2'$

(No v_y (during brief time of explosion) so only looking at x-direction.

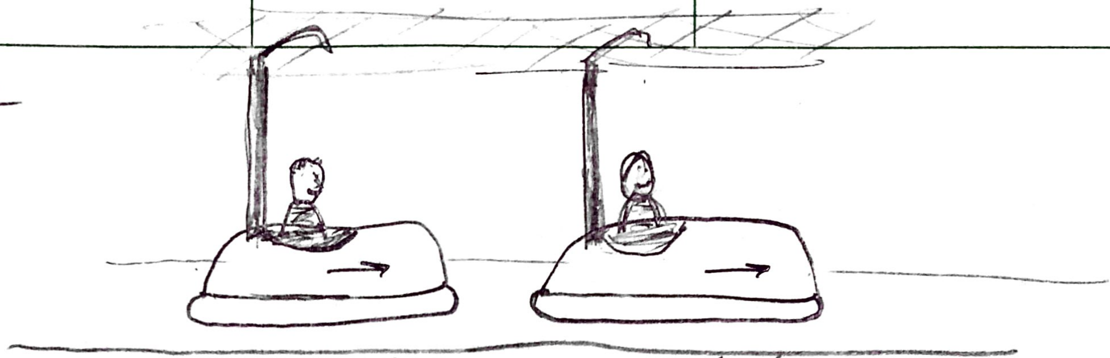
$(0.100 kg)(0) = (0.072 kg)(-20 m/s) + (0.100 - 0.072) v_2'$

$0 = -1.44 kg \cdot m/s + 0.028 v_2'$

$v_2 = + \frac{1.44 kg\, m/s}{0.028 kg} = \boxed{+51.4 m/s}$

in $+\hat{\imath}$ direction.

9.47



$m_1 = 400\,kg$ $\quad$ $m_2 = 400\,kg$

$v_1 = 6.00\,m/s$ $\quad$ $v_2 = 5.60\,m/s$

mass of riders negligible, & this is an <u>elastic</u> collision we've been told, so:

$$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$$

&

$$\tfrac{1}{2} m_1 v_1^2 + \tfrac{1}{2} m_2 v_2^2 = \tfrac{1}{2} m_1 v_1'^2 + \tfrac{1}{2} m_2 v_2'^2$$

Manipulating equations (tedious!)

$$\cancel{m_1} v_1 + \cancel{m_2} v_2 = \cancel{m_1} v_1' + \cancel{m_2} v_2'$$

$$6 + 5.6 = 11.6 = v_1' + v_2', \text{ so } \underline{v_2' = 11.6 - v_1'}$$

$$\cancel{\tfrac{1}{2} m_1} v_1^2 + \cancel{\tfrac{1}{2} m_2} v_2^2 = \cancel{\tfrac{1}{2} m_1} v_1'^2 + \cancel{\tfrac{1}{2} m_2} v_2'^2$$

$$6^2 + 5.6^2 = v_1'^2 + v_2'^2$$

$$67.36 = v_1'^2 + (11.6 - v_1')^2$$

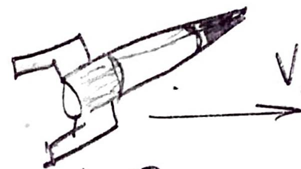
$$2 v_1'^2 - 23.2 v_1' + 67.2 = 0$$

Solutions: 5.6 & 6.0.

Only solution that makes sense physically is $\boxed{5.6\ m/s\ \text{for}\ v_1'}$. Substitute into $v_2' = 11.6 - v_1'$ to get

$$v_2 = 11.6 - 5.6 = \boxed{6.0\ m/s}$$

9.57

$m = 200\,kg$  $\vec{v}_i = (121\hat{i} + 38\hat{j})$ m/s

Explodes into 3 pieces.

$m_1 = 78\,kg$ @ $-321\hat{i} + 228\hat{j}$
$m_2 = 56\,kg$ @ $16\hat{i} - 88\hat{j}$

Find Velocity of m_3.

Cons of momentum, where

$\Sigma p_i = \Sigma p_f$ <u>in each</u> <u>dimension</u>.

Can split it up into x & y calculations (separate), or can solve w/ i-j analysis. Either way, you solve for each axis independently.

$\vec{p}_1{}' = 78 \cdot -321i + 228j = -25038i + 17784j$
$p_2{}' = 56 \cdot 16i - 88j = 896i - 4928j$
$p_3 = \underbrace{(200 - (78 + 56))}_{66\,kg} \cdot V_x i + V_y \hat{j}$

$p_{initial} = (200\,kg) \cdot 121i + 38j = \underline{\underline{24200}}i + \underline{\underline{7600}}j$

x direction: $p_i = p_1{}' + p_2{}' + p_3{}'$
$24200i = -25038 + 896 + p_3{}'$
$p_3{}' = 48342$ kg m/s
$p_3{}' = m_3 v_3$, so $V_{3x} = \frac{48342}{66\,kg} = \boxed{732 \text{ m/s } \hat{i}}$

y direction: $p_i = p_1{}' + p_2{}' + p_3{}'$
$7600 = 17784 + -4928 + p_3{}'$
$p_3{}' = -5256$
$p_3{}' = m_3 v_3$, so $V_{3y} = -\frac{5256}{66\,kg} = \boxed{-79.6 \text{ m/s } \hat{j}}$

$V_3{}' = \boxed{(732i + -79.6j) \text{ m/s}}$