Collisions and the Conservation of Momentum

$P = mv$

A 200kg bumper car going 10m/s hits a 300kg bumper car going -5m/s. If the first car bounces back at -7.5m/s what is the velocity of the 2nd car after the collision?

$\vec{P}_0 = \vec{P}$

$m_1 v_{10} + m_2 v_{20} = m_1 v_1 + m_2 v_2$

$200 \times 10 + 300(-5) = 200 \times (-7.5) + 300 \cdot v_2$ (+)

$2000 - 1500 = -1500 + 300 \cdot v_2$

$2000 - 1500 + 1500 = 300 v_2$

$\frac{2000}{300} = v_2 = 6.7 \frac{m}{s}$

b) **the kinetic energy before the collision.**
c) **the kinetic energy after the collision.**
d) **Which type of collision is shown?**
e) **Energy lost at collision?**

b) $K_0 = \frac{1}{2} m_1 v_{10}^2 + \frac{1}{2} m_2 v_{20}^2 = \frac{1}{2} \cdot 200 \cdot (10)^2 + \frac{1}{2} \cdot 300 (-5)^2 = 13,750 \text{ J}$

c) $K = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 = \frac{1}{2} \cdot 200 (-7.5)^2 + \frac{1}{2} \cdot 300 \cdot (6.7)^2 = 12,292 \text{ J}$

d) Collision is Inelastic

e) $\Delta E = K - K_0 = (12,292 - 13,750) \text{ J} = -1458 \text{ J}$

Collisions and the Conservation of Momentum

A 10kg chunk of putty moving at 10.0 m/s collides with and sticks to a 20.0kg bowling ball that is initially at rest. The bowling ball with its putty passenger will then be set in motion with what velocity?

$\vec{P}_0 = \vec{P}$ — Same $v_1 = v_2 = v_{1,2}$

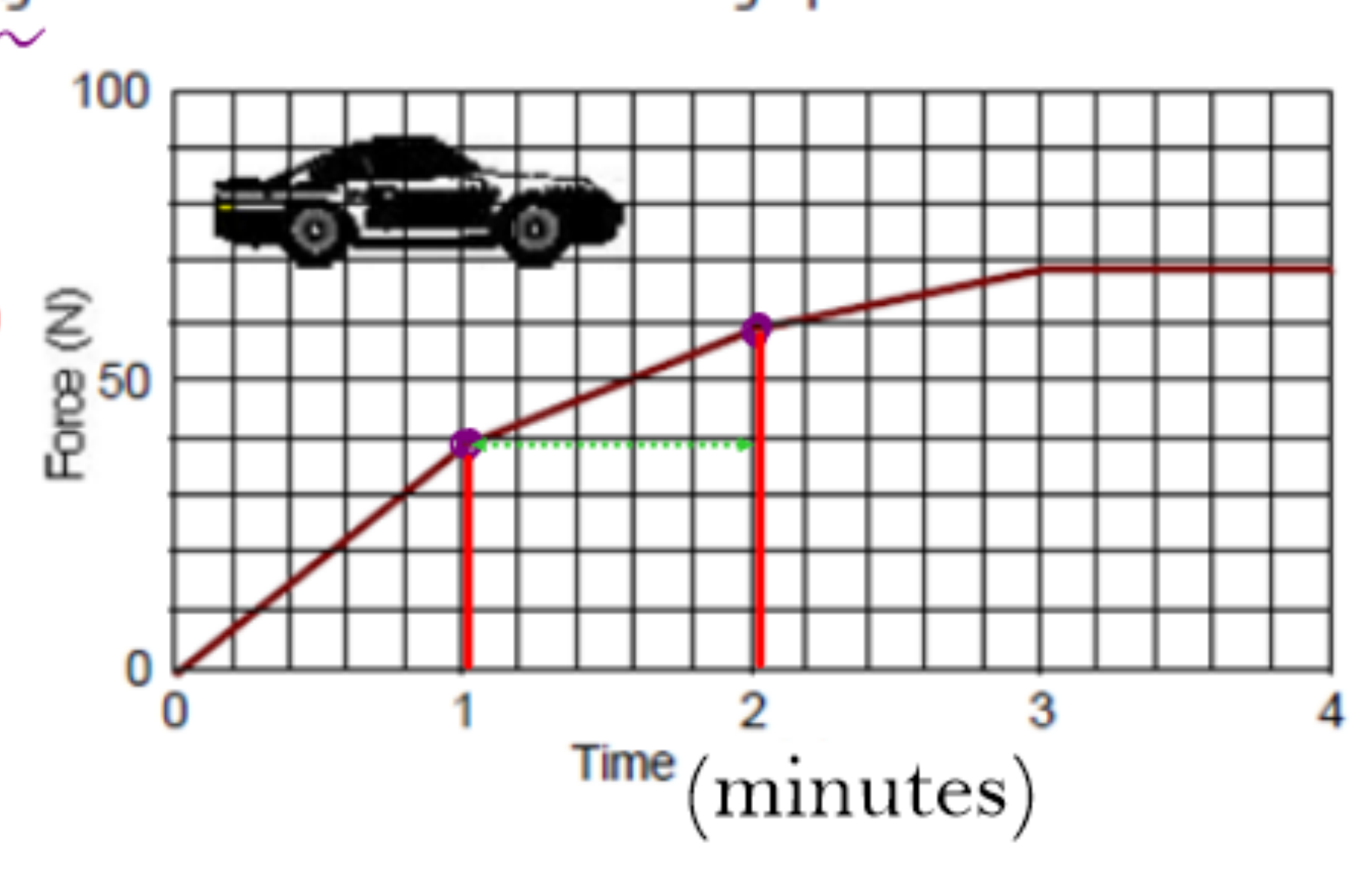
$m_1 v_{10} + m_2 v_{20} = m_1 v_1 + m_2 v_2$

$10 \times 10 + 20 \times 0 = 10 v_{1,2} + 20 v_{1,2}$ (zero)

$100 = v_{1,2}(10 + 20)$

$v_{1,2} = 3.3 \frac{m}{s}$

A toy car, 3.0 kg exerts the force shown on the graph.



$m = 3 \text{ kg}$

$F \cdot \Delta t = \Delta P$

height × base = $y \cdot x$ = Area

Express all answers in standard S.I. units.

(a) What is the change in speed from 1 to 2 minutes?

(b) What is the change in speed from 2 to 3 minutes?

(c) If the final velocity at 3 minutes is 10 m/s, then what is the initial velocity at 2 minutes?

(d) If the initial velocity is of the car is 5 m/s at 1 minute, then what is the velocity of the car at 2 minutes?

(e) If the car starts from rest at 0 minutes, then what is the velocity of the car after the first 4 minutes?

(f) What is the momentum of the car at 3 minutes if the car started from rest?

(a)

$F \cdot \Delta t = \Delta P$

$\frac{(b_1 + b_2)}{2} \times h = P - P_0$

$\frac{(0.04 + 0.06)}{2} \times 60 = mv - mv_0$

$3 = m(v - v_0)$

$\rightarrow 3 = m \Delta v$

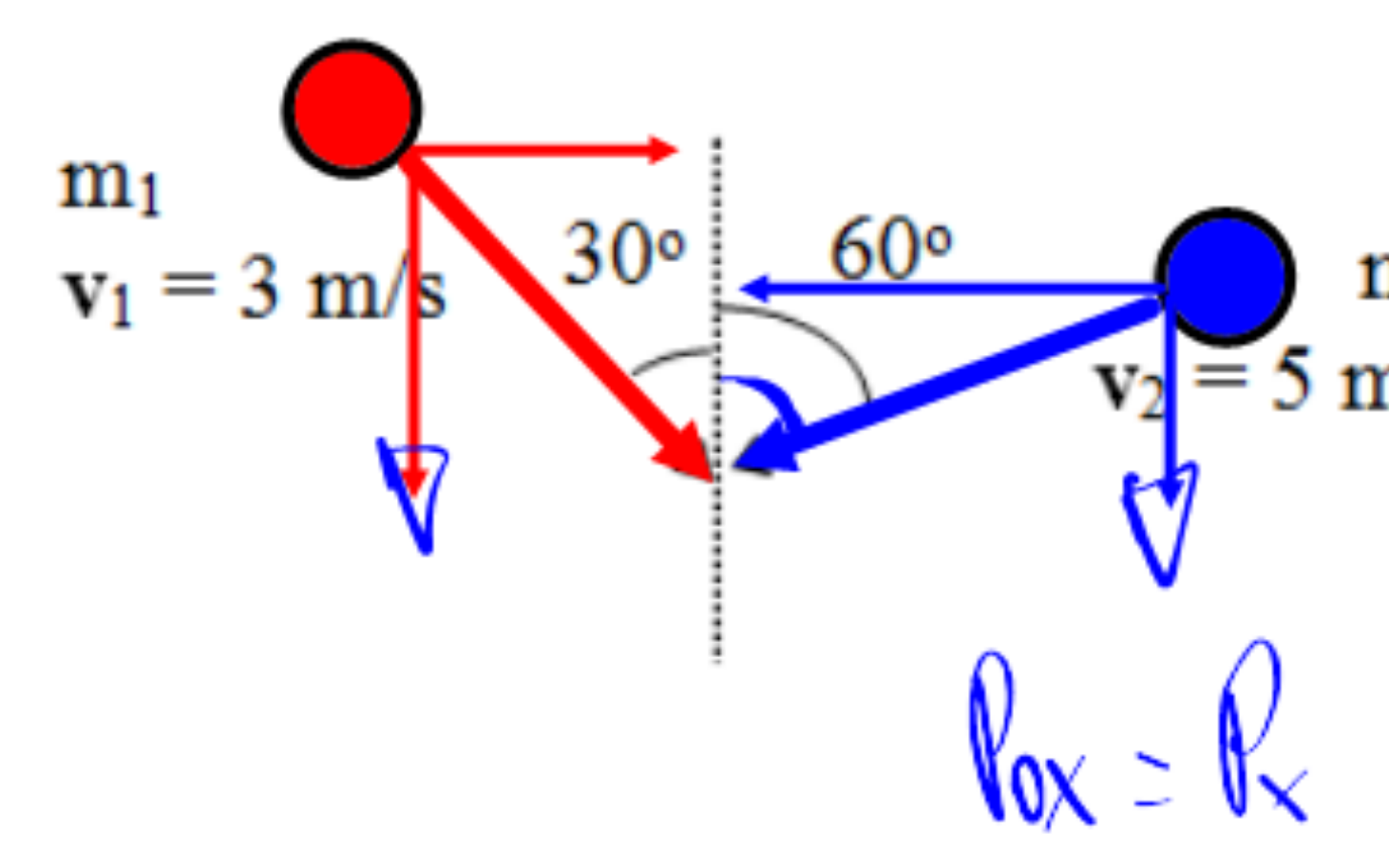
(a) $F \cdot \Delta t = \Delta P$ Easier

$F \cdot \Delta t = \Delta mv$

$F \cdot \Delta t = m \Delta v$

$\rightarrow 3 = 3 \cdot \Delta v$

Two equal masses in a perfectly inelastic collision



$m_1 = m_2 = m$

$v_1 = v_2 = v_{1,2} = ?$

$P_{0x} = P_x$ ✓ ✓ $m_1 = m_2 = m$

$m_1 v_{10x} + m_2 v_{20x} = m_1 v_{1x} + m_2 v_{2x}$

$m \cdot 3 \sin(30°) - m \cdot 5 \sin(60°) = m v_{1x} + m v_{2x}$

$1.5m - 4.33m = 2 \cdot v_x m$

$\frac{-2.83}{2} = v_x$ ($\frac{m}{s}$)

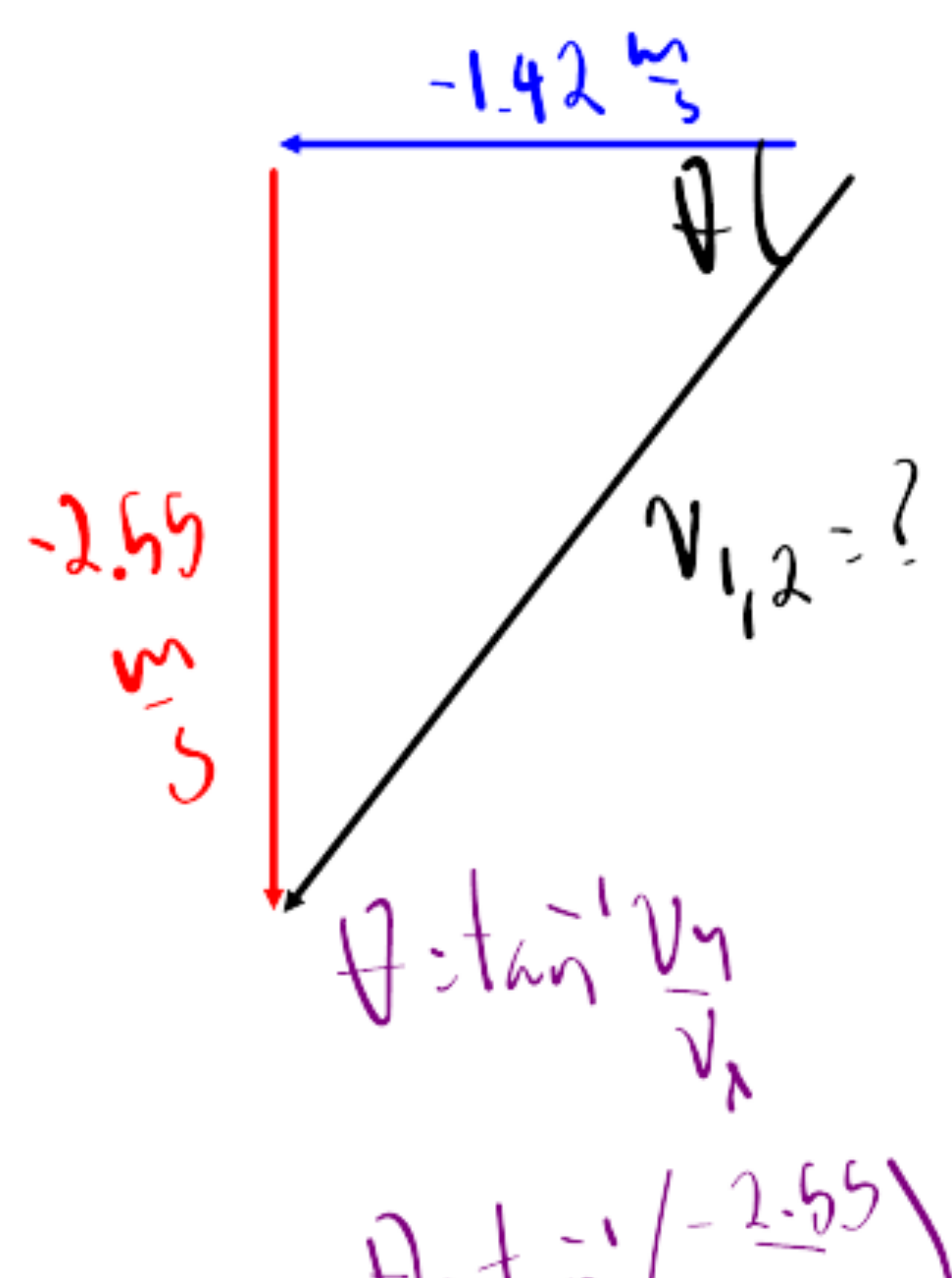
$v_x = -1.42 \frac{m}{s}$ (W)

$P_{0y} = P_y$

$-m \cdot 3 \cos(30°) - m \cdot 5 \cos(60°) = 2m v_y$

$\frac{-5.10}{2} \frac{m}{s} = v_y$

$-2.55 \frac{m}{s} = v_y$ (South)



$v_{1,2}^2 = v_x^2 + v_y^2$

$v_{1,2} = \sqrt{1.42^2 + 2.55^2} = 2.92 \frac{m}{s}$

$\theta = \tan^{-1} \frac{v_y}{v_x}$

$\theta = \tan^{-1}\left(\frac{-2.55}{-1.42}\right) = 60.9°$ S of W