Year 11 Physics Assignment Work, Energy and Momentum ***SOLUTIONS***

1.

a) $\vec{F} = \dfrac{\Delta \vec{p}}{\Delta t}$

$\therefore \Delta \vec{p} = \vec{F}\Delta t = 150 \times 1.02 = 153 \text{ kgms}^{-1}$

$\Delta \vec{p} = \vec{p}_f - \vec{p}_i$

$\therefore \vec{p}_f = \Delta \vec{p} + \vec{p}_i = 153 + 0 = 153 \text{ kgms}^{-1}$

The final momentum of the astronaut is 153 kgms^{-1} away from the spacecraft (3 s.f.)

b) The final momentum of the spacecraft is 153 kgms^{-1} away from the astronaut (3 s.f.)

c) $p = mv$ $\{\text{considering only magnitudes}\}$

$\therefore v = \dfrac{p}{m} = \dfrac{153}{90} = 1.7 \text{ ms}^{-1}$ (2 s.f.)

d) $p = mv$ $\{\text{considering only magnitudes}\}$

$\therefore v = \dfrac{p}{m} = \dfrac{153}{1600} = 0.0956 \text{ ms}^{-1}$ (3 s.f.)

2. **Q4 (Ball)**

Initial Kinetic energy:
$K = ½\, mv^2 = 0.5 \times 2.1 \times 2.5^2 = 6.6$ J

Final Kinetic energy:
$K = ½\, mv^2 = 0.5 \times 2.1 \times 2.5^2 = 6.6$ J

Change in kinetic energy = 0 J $\therefore$ Elastic collision as kinetic energy is conserved

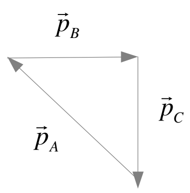
Q5 (Train)

Initial Kinetic energy:
$K = ½\, mv^2$
$\therefore K = 0.5 \times 8.2 \times 10^3 \times 2.2^2$
$\therefore K = 19844$ J

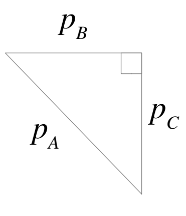
Final Kinetic energy:
$K = ½\, mv^2$
$\therefore K = 0.5 \times 11200 \times 1.61^2$
$\therefore K = 14516$ J

Change in kinetic energy = -5328 J $\therefore$ Not elastic collision as kinetic energy is lost.

3. Since the initial momentum was zero, the total final momentum should be vectorially zero:



So considering only magnitudes, we have a right angled triangle:

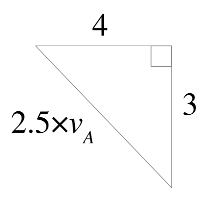


$p_A = m_A v_A = 2.5 \times v_A$

$p_B = m_B v_B = 1 \times 4 = 4 \text{ kgms}^{-1}$

$p_C = m_C v_C = 0.5 \times 6 = 3 \text{ kgms}^{-1}$

$\therefore$



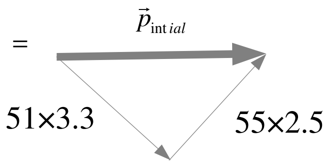
Using pythagoras, $2.5 \times v_A = \sqrt{4^2 + 3^2} = \sqrt{25} = 5$

$\therefore v_A = \dfrac{5}{2.5} = 2 \text{ ms}^{-1}$

The final speed of fragment A is 2 ms^{-1} (1 s.f.)

4.

$$\vec{p}_{initial} = m_A \vec{v}_{A_{initial}} + m_B \vec{v}_{B_{initial}} =$$



$$= \sqrt{168.3^2 + 137.5^2} \quad \{\text{pythagoras}\}$$

$$= 217 \text{ kgms}^{-1}$$

Momentum is conserved so the final momentum of their mass is the same as the initial momentum.

$$\vec{p}_{final} = (m_A + m_B)\vec{v}_{final} = \vec{p}_{initial}$$

$$\therefore (51 + 55)v = 217$$

$$\therefore v = \frac{217}{106} = 2.1 \text{ ms}^{-1}$$

Their combined mass is moving at 2.1 ms^{-1}.