Year 11 Physics Extra Questions Work, Energy and Momentum ***SOLUTIONS***

1. $K = \frac{1}{2}mv^2 = \frac{1}{2}\times 125\times 11.9^2 = 8.85\times 10^3$ J (3 s.f.)

2. a) First calculate the weight F of the weights.

   $F = mg = 0.20\times 9.8 = 1.96$ N

   $W = Fs = 1.96\times 1.0 = 2.0$ J (2 s.f.)

   b) 2.0 J because of conservation of energy (the amount of work done is amount of potential energy gained)

3.

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

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

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

   $\therefore \vec{p}_f = \Delta\vec{p} + \vec{p}_i = 153 + 0 = 153$ 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) $p = mv$ {considering only magnitudes}

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

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

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

4.

   a) $\Delta\vec{v} = \vec{v}_{final} - \vec{v}_{int\,ial} = \overset{2.5}{\longleftarrow} - \overset{2.5}{\longrightarrow} = \overset{2.5}{\longleftarrow} + \overset{2.5}{\longleftarrow} = \overset{5.0}{\Longleftarrow}$

   The change in velocity of the ball is 5.0 ms^{-1} away from the wall.

   b) $\vec{p} = m\vec{v}$

   $\therefore$ The change momentum of the ball is $2.1\times 5.0 = 11$ kg ms^{-1} (2 s.f.) away from the wall.

   c) $\vec{F} = \dfrac{\Delta\vec{p}}{\Delta t} = \dfrac{11}{0.10} = 110$ N (2 s.f.) away from the wall

   d) 110 N (2 s.f.) away from the ball.

5. According to conservation of momentum, final = initial.

   $\therefore m_i v_i = m_f v_f$

   $\therefore v_f = \dfrac{m_i v_i}{m_f}$

   $\therefore v_f = \dfrac{8.2\times 10^3 \times 2.2}{8.2\times 10^3 + 3\times 10^3} = \dfrac{18040}{11200} = 1.61$ ms^{-1}

   The final speed of the train is 1.6 ms^{-1} (2 s.f.)

6. **Q4 (Ball)**

Initial Kinetic energy:

$K = \frac{1}{2} mv^2 = 0.5 \times 2.1 \times 2.5^2 = 6.6$ J

Final Kinetic energy:

$K = \frac{1}{2} mv^2 = 0.5 \times 2.1 \times 2.5^2 = 6.6$ J

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

Q5 (Train)

Initial Kinetic energy:

$K = \frac{1}{2} mv^2$

$\therefore K = 0.5 \times 8.2 \times 10^3 \times 2.2^2$

$\therefore K = 19844$ J

Final Kinetic energy:

$K = \frac{1}{2} mv^2$

$\therefore K = 0.5 \times 11200 \times 1.61^2$

$\therefore K = 14516$ J

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