Arts and Science 2206 – Quiz # 4 – Solutions

1. $\left.\begin{aligned}\Delta p_1 &= (F_1)(\Delta t_1)\\ \Delta p_2 &= (F_2)(\Delta t_2)\end{aligned}\right\}$ $F_1 = F_2$, $\Delta t_1 = \Delta t_2$ $\therefore$ $\Delta p_1 = \Delta p_2$ (c)

2. (b)

3. $K = 0.8\, E_{total}$

$(\gamma - 1)\, mc^2 = 0.8\, \gamma mc^2$

$\gamma - 1 = 0.8\gamma$

$\therefore \quad \gamma = 5$

solve for v: $\dfrac{1}{\sqrt{1 - v^2/c^2}} = 5 \Rightarrow v = 0.98\, c$

$\therefore$ momentum $p = \gamma m v = 5\,(1.67 \times 10^{-27}\ kg)(0.98)(3 \times 10^8\ m/s)$

$= 2.45 \times 10^{-18}\ kg \cdot m/s$

4. $\vec{p_i} = \vec{p_f} \Rightarrow \quad 0 = m_1 v_1 + m_2 v_2$

$\therefore v_2 = -\dfrac{m_1 v_1}{m_2} = -\dfrac{4 \cdot 2}{9} = +0.9\ m/s$

5. from spaceship's frame of reference: proper time $\Delta t_0 = 30$ years

$\Delta t = \gamma \Delta t_0 = \dfrac{\Delta t_0}{\sqrt{1 - v^2/c^2}} = \dfrac{\Delta t_0}{\sqrt{1 - 0.64}} = \dfrac{30}{0.6} = 50$ years

$\therefore$ spaceship: $20 + 30 = 50$ years

Earth: $20 + 50 = 70$ years

(NB: we could have also chosen to view the trip from the earth's frame of reference.)