Quiz Solutions

1. (a) First find γ: $\gamma = \frac{1}{\sqrt{1-(2/3)^2}} = 1.342$ -- Now let T = $T_{Francis}$ and $T_o = T_{Maria}$

So $T = \gamma T_o$ and we want $T - T_o = (\gamma-1)T_o = 1$ s and we are looking to find T (not T_o !!!)
This gives us $T_o = 2.93$ s so $T = \gamma T_o = 3.93$ s
(b) You should all have gotten this - Maria sees Francis moving (relative to herself at rest) and therefore she sees his clocks running slow.
(c) Francis will see Maria to be 1.8 m tall because lengths perpendicular to relative motion are not affected by relativity. The spacecraft will appear contracted by the factor γ, so that its length will be 50/1.342 = 37.3 m long.

2. (a) $E = 200\ E_o$, so $\gamma = 200$. Then $K = (\gamma - 1)E_o = 199$ (0.511 MeV) = 101.7 MeV;
Also, since $\gamma = 200$, we find $\beta = 0.9999875$, so v = 0.9999875 c. Finally, $p = \gamma mv = 200$ $(0.511 MeV/c^2)(0.9999875\ c) = 102.2$ MeV/c. [Note: this can also be found from $E^2 = E_o^2 + p^2c^2$, so that $p^2c^2 = (E^2 - E_o^2) = (200E_o)^2 - E_o^2 = 39999\ (0.511\ MeV)^2 = 10444\ MeV^2$, giving pc = same value]
(b) New v must be 0.99999375 c, so that the new $\gamma = 282.8$. Therefore the final $E = 282.8E_o$ and the additional energy is $82.8\ E_o = 42.3$ MeV.