ASTRONOMY 1102 – 1

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Answers to HW1, Fall 1999

1) Always use units that are consistent so that your answer comes out in the desired units. A Light year is a distance (use km), the speed of light is a rate of motion or distance per unit time (use km/s) and the year is a unit of time (use s, so that the answer will be in km).
1 Light Year = speed of light (in km per second) x 1 year (in seconds)
1 LY $= 3 \times 10^5$ km/s $\times 3.15 \times 10^7$ s $= (3 \times 3.15) \times 10^5 \times 10^7 \approx 10 \times 10^{5+7}$ km $= 10^{13}$ km.

2) time for collision = distance to be travelled/speed
time for collision:

$$t_{\rm coll} = \frac{2.5 \times 10^6 {\rm LY}}{80 {\rm km/s}} = \frac{2.5 \times 10^6 \times 10^{13} {\rm km}}{8 \times 10^1 {\rm km/s}}$$

$$= 25/8 \times 10^{5+13-1} {\rm s} \approx 3 \times 10^{17} {\rm s} \approx 10^{10} {\rm yr}.$$

3) In class it was shown that 2500 Calories $\approx 10^7$ joule, and that one kg of matter was equivalent to

$$E_{\rm 1kg} = 1{\rm kg}(3 \times 10^8 {\rm m/s})^2 = 9 \times 10^{16} {\rm joule} \approx 10^{17} {\rm joule}.$$

Time to use up $E_{\rm 1kg}$ at a rate of 10^7 joules/day is

$$t_{\rm 1kg} = \frac{10^{17} {\rm joule}}{10^7 {\rm joules/day}} = 10^{10} {\rm days} \approx 3 \times 10^7 {\rm years}.$$

4) To compare I do not need to calculate the energies in joules. It is sufficient to note that

$$KE_{\rm truck} = \frac{1}{2} m_{\rm truck} v_{\rm truck}^2 = \frac{1}{2} 2 m_{\rm car} (v_{\rm car}/2)^2 = \frac{1}{2} (\frac{1}{2} m_{\rm car} v_{\rm car}^2) = \frac{1}{2} KE_{\rm car}$$

5) The density of air is much less than the density of water, so the rate at which your atoms & molecules lose energy by colliding with air molecules is much less than the rate of loss in water. The energy exchange rate with air is therefore *slower* than in water: you cool slowly and your metabolism can make up for the losses. In water you lose energy and freeze faster (recall the Titanic).