Due: Wednesday, 25-April-2007 at the beginning of class. Remember that this is to be your own work.

1) Volcanism was much more common in the distant past than today, and in some cases, specific events can be dated. A volcanic eruption melts a large area of rock and all gases are expelled. After cooling, $^{40}\text{Ar}$ accumulates from the ongoing decay of $^{40}\text{K}$ in the rock ($t_{1/2} = 1.25 \times 10^9$ yr). When a piece of rock is analyzed, it is found to contain 1.38 mmol $^{40}\text{K}$ and 1.14 mmol $^{40}\text{Ar}$. How long ago did the rock cool? (Note that mmol = 10$^{-3}$ mole.)[You should have been able to figure that out!]

2) The isotopic mass of $^{210}\text{Rn}$ is 209.989669 amu. When it decays by electron capture it emits 2.368 MeV. What is the isotopic mass of the resulting nuclide? (Hint: write the balanced nuclear equation first.)

3) The half-life of $^{132}\text{Te}$ is 3.26 days. This isotope decays by beta emission to an highly unstable intermediate that decays rapidly to a stable product by beta emission.
   a) What is the ultimate product obtained from $^{132}\text{Te}$? Write a balanced equation for the reaction.
   b) Gaseous $\text{H}_2\text{Te}$ is made with $^{132}\text{Te}$. When the tellerium isotope decays, the $\text{H}_2\text{Te}$ produces $\text{H}_2$ and the ultimate decay product of $^{132}\text{Te}$. Write a balanced equation for the formation of stable products from $\text{H}_2^{132}\text{Te}$.
   c) If a pure sample of 0.01375 moles of $\text{H}_2\text{Te}$ made entirely of $^{132}\text{Te}$ is placed in an evacuated 1.75-L flask, how much $\text{H}_2\text{Te}$ remains after 109.0 hours? If the temperature is 27°C, what is the pressure in the flask?

4) The starship Voyager, like many other vessels of the newly designed 24th-century fleet, uses antimatter as fuel.
   a) How much energy is released when 1.00 g each of $^1\text{H}$ and anti-hydrogen annihilate each other? (Hint: One can write this as $^1\text{H} + ^1\text{H} \rightarrow 2 \gamma$ [where $^1\text{H}$ is anti-hydrogen])
   b) Suppose the engines can only utilize 33% of this value. What would be the minimum grams of zinc needed for the standard voltaic cell $\text{Zn}|\text{Zn}^{2+}||\text{Cu}^{2+}|\text{Cu}$ to obtain this same amount of electrical energy?