Homework 3 **Due:** Start of class, September 23rd

1. A year ago, you started keeping a lucky radioactive coin in your pocket, because that's what cool people do. When you go it, you noticed you had almost a mole ($\approx 6 \times 10^{23}$) of some type of nucleus in it. Today, you've noticed a third of your lucky nuclei have decayed to something else. What is the half-life (in years) of the nuclide that makes up your lucky coin?

2. An old-timey lantern mantle has ~27nCi of activity from ^{232}Th. What mass of ^{232}Th is this?

3. You want to use ^{131}I for targeted treatment of thyroid cancer, since these tumors are partial to absorbing iodine and the low-energy βs tend to stop in the cancerous tissue. To create it, you created a lot of ^{131}Te in a very short time by irradiating ^{130}Te in a high neutron-flux reactor. How many hours after you have created the ^{131}Te sample will you have the maximum amount of ^{131}I?

4. Calculate the half-lives for α decay from ^{235}U, ^{231}Pa, ^{227}Ac, ^{223}Fr, and ^{219}At, from the ^{235}U decay chain. Compare to the experimental values listed in NNDC.
Show your calculation for one case, but use a spreadsheet or program for the others.

5. Which of these nuclei (^{144}Nd, ^{150}Nd, ^{190}Pt) is unstable to α decay? Show this with calculations.

6. Derive and plot the valley of β stability (Z_{min} vs A) using the semi-empirical mass formula and your (or your friend's/enemy's) SEMF constants from Homework 1. Include known stable nuclei on the plot. Attach any code used.

7. Consider ^{64}Cu β-decay. Plot the kinetic energy distribution of the electron using the β^- Q-value and neglecting Coulomb distortion effects. Repeat this using the β^+ Q-value. Then determine how the most-probable kinetic energy changes for both cases after including (non-relativistic) Coulomb distortion effects. Attach any code used.
*Note: You'll need to convert from p^2*dp to some function f(KE)*dKE. For this, recall from relativity* $E = \sqrt{p^2c^2 + m_0^2c^4} = T + m_0c^2$. *It will be helpful to determine dT/dp.*

8. Estimate log(ft) for electron-capture onto ^{23}Na using the table from Singh et al. Nuclear Data Sheets 1998 and separately using the Moszkowski (Phys. Rev. 1951) nomograph. Compare your answers with the experimental value of 5.09.