1. Calculate the age of a sample that you have dated using the potassium argon technique getting a \( \frac{^{40}\text{Ar}}{^{40}\text{K}} \) ratio of \( 8.73 \times 10^{-6} \).

(10 pts)

2. Explain how you can determine if you have \(^{40}\text{Ar}\) diffusion from atmospheric \(^{40}\text{Ar}\) into your sample. How can you correct for it? What is the origin of atmospheric \(^{40}\text{Ar}\)?

(10 pts)

3. Using the potassium argon method, the footprints of early hominoids in the volcanic ashes of eastern Africa have been dated to be 3,500,000 years old. Calculate and compare the ratio of \(^{40}\text{Ar}\) and \(^{40}\text{K}\) abundances using both, first the exact mother daughter relation for radioactive nuclei and second the linear approximation.

(15 pts)
4. Compare the radioactive decay chains of $^{235}\text{U}$ and $^{238}\text{U}$. Assume you have some uranium enriched stalagmite material from an ancient cave. You extract 1g $^{238}\text{U}$ and 0.1g $^{235}\text{U}$. Determine how many atoms of $^{238}\text{U}$ and $^{235}\text{U}$ you have. Calculate how much $^{234}\text{U}$ and $^{231}\text{Pa}$ you would expect to find in the sample if it is 500,000, 1,000,000, and 2,000,000 years old.

5. A Gigantopithecus tooth found in the sediments of Longgupo Cave in central China has been dated to 1.05 million years of age using the uranium thorium method. The ratio for $^{234}\text{U}/^{238}\text{U}$=1.96. What would you expect for the ratio $^{230}\text{Th}/^{238}\text{U}$?

6. For thermoluminescence dating of a presumably ancient piece of pottery, you have activated your pottery sample with an external $\beta$-dose of 5Gy. Your plateau ratio is $R=0.25$. What is the paleodose of the sample?
7. You decide to turn your 20 year old Hongkong souvenir of a Chinese porcelain statue into a priceless piece from the Qin dynasty (221-207 BC). To convince the authorities you need to match the TL test requirements by exposing the statue to a certain dose of gamma radiation. What is the necessary dose required?

(10 pts)

8. Suppose your gamma radiation is provided by a source ($10^8$ Bq) of $^{40}$K and has an energy of 1.46 MeV ($1\text{eV}=1.66\cdot10^{-19}\text{J}$), which is fully absorbed in the statue. Your statue has a weight of 25g. How long does it take you to expose your sample to the necessary dose?

(15 pts)

Good Luck, I hope you enjoyed the class!