Physics 10262 - Chapter 3 – Homework 5

1. What distinguishes the $^{40}Ar/^{40}K$ dating method from the $^{39}Ar/^{40}Ar$ dating technique?

[5pts]

2. What defines the timescale for the age determination by the K-Ar and by the U-Th method?

[5pts]

3. What event starts the clock for the accumulation of thermoluminescence in an ancient pottery sample?

[5pts]

4. For thermoluminescence dating of a presumably ancient piece of pottery, you have activated your pottery sample with an external β-dose of 5Gy. Your plateau ratio is R=0.25. What is the paleodose of the sample?

[10pts]

5. Calculate the annual dose D of a fine grain pottery sample. What is the annual dose if the sample has been found in relatively wet environment conditions (f=0.5, w=0.1). Determine the age of the sample from problem 4 both with and without wetness corrections.

[15pts]

6. Suppose your pottery sample shows a paleodose of 10Gy, but from radiocarbon dating you know that the age is 1500 years. It is most likely that the example was accidentally exposed to sunlight for a short period of time. Estimate the bleaching time (κ=0.33).

[10pts]

7. You decide to turn your 20 year old Hong Kong 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?

[15pts]

8. Suppose your gamma radiation is provided by a source (10^6 Bq) of ^{40}K and has an energy of 1.46 MeV ($1eV=1.66\cdot10^{-19}$ 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?

[15pts]

9. A Neanderthal skeleton was found in rubble of flint stone material in the Kebara cave in Israel. Both flint stone and skeleton material was used to determine the age of the site and the period in which the cave was inhabited by Neanderthal people.
   - The flint stone material was dated using thermoluminescence techniques. The annual dose of the flint stone material was determined to be $D = 2\cdot10^{-4}$ Gy/y. The paleodose was measured to be P =50 Gy. Determine the age of the flint stone material.
   - The skeleton was dated using the uranium thorium method. The ratio of the uranium isotopes was found to be $^{234}U/^{238}U=0.5$. Assuming the skeleton is as old as the flint stone, what would you expect for the ratio $^{230}Th/^{238}U$?

[20pts]