Physics 10262 - Chapter 2 – Homework 3

1. Calculate the Raman spectroscopy signal for an N_2 molecule. Assume the same molecular bounding as for the O_2 molecule discussed in class.

2. Calculate the bounding strength K for vermillion which has a Raman signal with wave number k = 343 cm^{-1}

3. Which reaction is used in reactors for producing neutrons? Name one nuclear reaction that can be used in accelerators.

4. Minium was one of the main red paint pigments available to medieval and renaissance painters.
   - **How and why** does it show in X-ray radiographs?
   - Does it show in neutron activation?
   - What possibilities does PIXE offer for studying the use of minium?

5. You do a PIXE analysis and a complementary neutron activation analysis of the red coat worn by St. Christopherus in the painting "Die vierzehn Nothelfer" by Lucas Cranach.
   - What would you see with PIXE and what would you see with neutron activation?
   - What is the advantage of PIXE?
   - What would be an advantage of neutron activation?
   - What would a radiograph of the red coat show?

6. You want to determine the isotope ratio of ^{16}O and ^{18}O as well as ^{12}C and ^{13}C in a section of a Parthenon marble column to identify its provenance. You use an isotope separator magnet with a magnetic field of 1 Tesla. Calculate the radii of the trajectory of ^{13}C, ^{16}O, and ^{18}O if the radius for ^{12}C is R=1 m.

7. You neutron-activate an ancient Greek coin (50% Au and 50% Ag) for 10 minutes. Calculate the ratio of γ-activity between the 412 keV line from Au and the 658 keV line from Ag at the end of the activation period. Calculate the ratio again after another 10 minutes of cooling time.

8. Assume neutron activation production of ^{203}Hg and ^{64}Cu which have a half life of 46.6 d and 12.7 h. Initially you have equal β^- activity for both radioactive isotopes. Calculate the relative activity $A(^{64}Cu)/ A(^{203}Hg)$ after 1 hour, 6 hours, 12 hours, 1 day, 2 days.