1. Calculate the wavelength of a:  
- γ-ray photon with $E=1.46$ MeV  
- X-ray photon with $E=54.0$ keV  
- UV photon with $E=10.6$ eV  
- Visible light with $E=2.2$ eV  
- Infrared light with $E=0.1$ eV  
- Radio waves with $E=10^{-7}$ eV

2. Calculate the energies and frequencies of the photons of the Balmer series in a Hydrogen atom up to $n=4$.

3. Vermeer typically used in his paintings seven principal pigments, one of them lead white (PbCO$_3$) and another Vermillion (red) HgS. Calculate what characteristic X-rays you would expect from the K$_\alpha$ and K$_\beta$ transitions for the two heavy element components Pb (lead) and Hg (mercury). Use the simplified formalism given in class and compare with the numbers quoted in the web-based tabulations.

4. The Silver isotope $^{109}$Ag has a mass number $A=109$, what is its number of neutrons?  
The Silver isotope $^{104}$Ag cannot maintain its stability because of the deflective Coulomb forces between its 47 positively charged protons, what is the neutron number?  
How many electrons does a neutral silver atom have?  
Calculate the energies and the wave length for the characteristic K$_\alpha$ and K$_\beta$ transitions of silver?

5. The radioactive fluorine isotope $^{18}$F decays by what mechanism to $^{18}$O (oxygen)?  
The radioactive gold isotope $^{198}$Au decays by what mechanism to $^{198}$Hg (mercury)?  
The radioactive radium isotope $^{226}$Ra decays by what mechanism to $^{222}$Rn (radon)?

6. The Aluminum isotope $^{26}$Al decays by β$^+$ decay to?  
The Gadolinium isotope $^{148}$Gd decays by α decay to?  
The Carbon isotope $^{14}$C decays by β$^-$ decay to?
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7. Calculate the decay constant $\lambda$ for the:
   Bismuth isotope $^{108}$Bi with a half life of $3.7 \times 10^5$ y;
   Potassium isotope $^{40}$K with a half life of $1.28 \times 10^9$ y;
   Carbon isotope $^{14}$C with a half life of $5.73 \times 10^3$ y;
   Cobalt isotope $^{60}$Co with a half life of 5.27 y

8. The body of Ramses II contained $3.4 \times 10^{20}$ particles of the Potassium isotope $^{40}$K and $1.6 \times 10^{15}$ particles of the radioactive Carbon $^{14}$C at the moment of his death. How many $^{40}$K and $^{14}$C particles are left in the mummy after 3290 years in the tomb?

9. Calculate the present $^{14}$C and $^{40}$K activity of the mummy of Ramses II and in the mummy of Oetzi, the iceman found in the Alps, who presumably was murdered 3300 BC. Assume the same initial $^{14}$C and $^{40}$K content for both Ramses and Oetzi.

10. The Shroud of Turin is supposed to be 1980 years old. Critics argue that the shroud is a medieval fake sold to crusading knights 700 years ago. Assuming that the initial $^{14}$C/$^{12}$C ratio was $2.1 \times 10^{-12}$, what ratio would you expect from a $^{14}$C radiocarbon measurement for both of the proposed ages.