On the following problems show all your work. Partial credit will be given, if earned. Write your answers in the blanks provided. Include units with your answers.

(18 pts) 1. Carbon-14 (\(^{14}\text{C}\)) has a half-life of 5730 years. A fossil specimen is found that has 160 decays/s from the carbon-14 that is in the specimen. (Note: 1 year = 3.156\(\times\)10\(^7\) s.)

a) How many \(^{14}\text{C}\) nuclei are currently in the fossil specimen? Ans. ______________

b) If the specimen is 20,000 years old, how many \(^{14}\text{C}\) nuclei were in the specimen when the animal died?

Ans. ______________
(18 pts) 2. When light of wavelength 300 nm falls on a certain metal surface, the maximum kinetic energy of the emitted photoelectrons is 2.20 eV. What is the maximum wavelength of light that will produce photoelectrons from this surface?

Ans. ________________

(18 pts) 3. A photon of wavelength 0.0940 nm strikes a free electron that is initially at rest and the photon is scattered backwards at an angle of 180° from its original direction. (Give your answer in keV. 1 keV = 10³ eV.)

a) What is the energy of the scattered photon?  

Ans. ________________

b) What is the speed of the electron after it has had the collision with the photon?

Ans. ________________
(18 pts) 4.

a) An electron in a hydrogen atom has energy $E = -0.850 \text{ eV}$. In the Bohr model description of the atom, what is the de Broglie wavelength of this electron?

Ans. ________________

b) An atom is initially in a state with energy $-12.0 \text{ eV}$. What is the energy of the atom after it absorbs a photon that has wavelength 310 nm?

Ans. ________________

c) In the quantum mechanical description of a hydrogen atom, for an electron in a $l = 5$ state, what is the smallest possible angle between the orbital momentum vector and the $+z$-axis?

Ans. ________________
(14 pts) 5. The nucleus $^{15}_6\text{C}$ undergoes $\beta^-$ decay. In $\beta^-$ decay the emitted particle is an electron. The atomic mass of $^{15}_6\text{C}$ is 15.010599 u. Other atomic masses are in the copy of Table 30.2 from the textbook that is on the formula sheet. How much energy (in MeV) is released in the decay of a $^{15}_6\text{C}$ nucleus?

Ans. ________________

(14 pts) 6. Calculate the binding energy in MeV for the nucleus $^{11}_5\text{B}$. Note that Table 10.2 from the textbook is on the formula sheet.

Ans. ________________