Phsx 2220 - Homework #13

41-1. How many electron states are there in the following shells: (a) n = 4; (b) n = 1; (c) n = 3; (d) n = 2?

41-2. What are the four quantum numbers for the two electrons of the helium atom in its ground state?

43-3. Calculate the distance of closest approach for a head-on collision between a 5.30 MeV alpha particle and the nucleus of a copper atom.

43-4. Because a nucleon is confined to a nucleus, we can take the uncertainty in its position to be approximately the nuclear radius R. What does the uncertainty principle say about the kinetic energy of a nucleon in a nucleus with, say, A = 100? (Hint: take the uncertainty in momentum Δp to be the actual momentum p.)

43-5. Consider an initially pure 3.4 g sample of ^{67}Ga, an isotope that has a half-life of 78 h. (a) What is its initial decay rate? (b) What is its decay rate 48 h later?

43-6. A radioactive isotope of mercury, ^{197}Hg, decays into gold, ^{197}Au, with a disintegration constant of 0.0108 h^{-1}. (a) Calculate its half-life. What fraction of a sample will remain (b) after three half-lives and (c) after 10.0 days?

43-7. A ^{238}U nucleus emits a 4.196 MeV alpha particle. Calculate the disintegration energy Q for this process.

44-8. (a) How many atoms are contained in 1.0 kg of pure ^{235}U? (b) How much energy, in joules, is released by the complete fissioning of 1.0 kg of ^{235}U? Assume Q = 200 MeV. (c) For how long would this energy light a 100 W lamp?

44-9. Calculate the energy released in the fission reaction

$$^{235}U + n \rightarrow {}^{141}Cs + {}^{93}Rb + 2n.$$

Needed atomic and particle masses are

^{235}U	235.04392 u	^{93}Rb	92.92157 u
^{141}Cs	140.91963 u	n	1.00867 u.

44-10. Verify that the fusion of 1.0 kg of deuterium by the reaction

$$^{2}H + {}^{2}H \rightarrow {}^{3}He + n \quad (Q = +3.27 \text{ MeV})$$

could keep a 100 W lamp burning for 3×10^4 y.

44-11. Show that the energy released when three alpha particles fuse to form ^{12}C is 7.27 MeV. The atomic mass of ^{4}He is 4.0026 u, and that of ^{12}C is 12.0000 u.

44-12. The Sun has a mass of 2.0×10^{30} kg and radiates energy at the rate of 3.9×10^{26} W. (a) At what rate does the Sun transfer its mass to other forms of energy? (b) What fraction of its original mass has the Sun lost in this way since it began to burn hydrogen about 4.5×10^{9} y ago?