Though it be honest, it is
never good to bring bad news.
--Shakespeare

Unit 11 Sample Test

The test will follow the usual format, with five multiple choice questions, two required problems, one option, two balanced equations and one essay.

The following are representative of typical multiple choice questions but do not necessarily indicate topics to be addressed on your actual test.

_____1. A beta (β^-) particle is
a. a neutron
b. a negative proton
c. an electron

_____2. The nuclide $^{128}_{50}Sn$ is unstable. Which of the following decay types would be possible for this isotope?
I. beta decay (β^-) to increase the p:n ratio
II. positron emission (β^+) to decrease the p:n ratio
III. electron capture (EC) to decrease the p:n ratio
a. I only b. II only c. I and III only d. II and III only e. I, II, and III

_____3. A sample of radioactive material undergoing nuclear decay is found to contain only potassium and calcium. The sample could be decaying via
I. beta (β^-) decay
II. alpha (α) decay
III. electron capture (EC)
a. I only b. II only c. I and III only d. II and III only e. I, II, and III

_____4. The half-life of an isotope is.....related to the rate constant for the decomposition of the isotope.
a. inversely
b. directly
c. not
d. exponentially

_____5. The type of radioactivity that removes excess energy from the nucleus without changing the atomic number or mass number is called
a. α emission
b. β^- emission
c. γ emission
d. electron capture
e. none of these

The next section consists of representative problems which might be found in the required section. Two problems will be given.

6. The launch of the Cassini space probe that arrived at Saturn in 2004 was controversial because of the power source required for extended travel far from the available energy of the Sun. 33 kg of $^{238}PuO_2$ was carried on board so that the heat released by its decay could supply energy to the probe via thermoelectric converters. The half-life of Pu-238 is 88 years. The isotope decays by alpha emission at a rate about 250 times that of Pu-239, which is used in weapons.

a. Write a balanced decay equation for Pu-238.

_____

The rapid decay rate of Pu-238 gives about 6×10^{11} decays/s/g.

_____b. How many decays/s would there be for the amount of Pu-238 carried on the probe?

The exact masses for the atoms involved in the decay process are given below:

Pu-238 = 238.0495 He-4 = 4.00260 U-234 = 234.0409

_____c. How much energy, in Joules, would be given off during a <u>single</u> decay event?

_____d. How much energy is released each second by the decay of the 33 kg of $^{238}PuO_2$ carried aboard Cassini?

7. Strontium-90, one of the most hazardous isotopes produced in nuclear fission, has a half-life of 29 years.

_____a. Based on the isotopic mass, what is the most likely decay mode for Sr-90?

b. Write a balanced decay equation for Sr-90 based on your answer to (a)

_____

_____c. Calculate the rate constant, k, for Sr-90

_____d. What mass of a 10.0 g sample of Sr-90 will remain after 10 years (to the nearest 1 year)?

The next section consists of representative problems such as might be found in the "options" section. Each student is expected to select one problem from this section to work on.

8. A sample of bristle-cone pine wood is found to have only 42% of the C-14 content of a living pine tree. Carbon-14 decays to produce nitrogen-14.

a. Write a balanced decay equation for the decay of carbon-14.

_____

b. Approximately how old is the wood? (half-life of C-14 = 5730 yr.)

9. The natural steady-state ratio of H-3 (tritium) to H-1 in ground water is $1/1.48 \times 10^{12}$. The minimum ratio detectable by present means is $0.01/1.48 \times 10^{12}$.

_____a. What is the likely decay pathway for tritium?

_____b. Calculate the maximum age detectable by tritium decay with present methods. The half-life of tritium is 12.3 yr.

[continued on next page]

10. Write balanced equations for these decays and bombardments:

a. Mo-99 decays by β^- emission

_____

b. N-15 is formed by bombardment of O-15

_____

c. Fe-54 decays by α emission and the ejection of a neutron

_____

d. Neutron-initiated fission of Pu-239 gives Sn-132, another nucleus, and an excess of 4 neutrons

_____

e. After one α and 2 β^- emissions, Po-218 becomes....

_____

The next section consists of representative reactions to complete and write balanced net-ionic equations for. Note that some reactions do not occur in aqueous solution and thus molecular equations are all that would be needed. In some cases no reaction may occur, based on either solubility rules or the activity series. In those cases, no products are required in the reaction. NR written to the right of the arrow will suffice. Each student is expected to choose two from this section. Phase symbols ((s), (aq) etc.) are required.

(*all reactions occur in aqueous solution*)

11. acidified potassium dichromate solution is poured over granulated tin metal; tin(II) ions and Cr(III) ions are some of the products

_____

_____

_____

12. copper + zinc nitrate $\rightarrow$ _____

_____

_____

type:_____

[more on following page]

13. sulfuric acid + barium hydroxide → _____

_____

_____

type:_____

14. solid calcium oxide + hydrochloric acid → _____

_____

_____

type: _____

The final section of the test will consist of one essay question selected from the following topics:

--- comparison of fission and fusion
--- determining the half-life of an isotope
--- control of fission reactions

Answers