Name:_____ Class: _____ Date: _____

CHAPTER 21 REVIEW

Nuclear Chemistry

SECTION 1

SHORT ANSWER Answer the following questions in the space provided.

1. _____ Based on the information about the three elementary particles in the text, which has the greatest mass?
   (a) the proton
   (b) the neutron
   (c) the electron
   (d) They all have the same mass.

2. _____ The force that keeps nucleons together is
   (a) a strong nuclear force.
   (b) a weak nuclear force.
   (c) an electromagnetic force.
   (d) a gravitational force.

3. _____ The stability of a nucleus is most affected by the
   (a) number of neutrons.
   (b) number of protons.
   (c) number of electrons.
   (d) ratio of neutrons to protons.

4. _____ If an atom should form from its constituent particles,
   (a) matter is lost and energy is taken in.
   (b) matter is lost and energy is released.
   (c) matter is gained and energy is taken in.
   (d) matter is gained and energy is released.

5. _____ For atoms of a given mass number, those with greater mass defects, have
   (a) smaller binding energies per nucleon.
   (b) greater binding energies per nucleon.
   (c) the same binding energies per nucleon as those with smaller mass defects.
   (d) variable binding energies per nucleon.

6. Based on **Figure 1.1** of the text, which isotope of He, helium-3 or helium-4,

   _____ a. has the smaller binding energy per nucleon?

   _____ b. is more stable to nuclear changes?

7. The number of neutrons in an atom of magnesium-25 is _____.

8. Nuclides of the same element have the same _____.

SECTION 1 *continued*

9. Atom X has 50 nucleons and a binding energy of 4.2×10^{-11} J. Atom Z has 80 nucleons and a binding energy of 8.4×10^{-11} J.

_____ a. The mass defect of Z is twice that of X. True or False?

_____ b. Which atom has the greater binding energy per nucleon?

_____ c. Which atom is likely to be more stable to nuclear transmutations?

10. Identify the missing term in each of the following nuclear equations. Write the element's symbol, its atomic number, and its mass number.

_____ a. ${}^{14}_{6}\mathrm{C} \rightarrow {}^{0}_{-}e + \_\_\_\_\_$

_____ b. ${}^{63}_{29}\mathrm{Cu} + {}^{1}_{1}\mathrm{H} \rightarrow \_\_\_\_\_ + {}^{4}_{2}\mathrm{He}$

11. Write the equation that shows the equivalency of mass and energy.

_____

12. Consider the two nuclides ${}^{56}_{26}\mathrm{Fe}$ and ${}^{14}_{6}\mathrm{C}$.

a. Determine the number of protons in each nucleus.

_____

b. Determine the number of neutrons in each nucleus.

_____

c. Determine whether the ${}^{56}_{26}\mathrm{Fe}$ nuclide is likely to be stable or unstable, based on its position in the band of stability shown in **Figure 1.2** of the text.

_____

PROBLEM Write the answer on the line to the left. Show all your work in the space provided.

13. _____ Neon-20 is a stable isotope of neon. Its actual mass has been found to be 19.992 44 u. Determine the mass defect in this nuclide.

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CHAPTER 21 REVIEW

Nuclear Chemistry

SECTION 2

SHORT ANSWER Answer the following questions in the space provided.

1. _____ The nuclear equation $^{210}_{84}\text{Po} \rightarrow {}^{206}_{82}\text{Pb} + {}^{4}_{2}\text{He}$ is an example of an equation that represents
   (a) alpha emission.
   (b) beta emission.
   (c) positron emission.
   (d) electron capture.

2. _____ When ${}^{a}_{b}\text{Z}$ undergoes electron capture to form a new element X, which of the following best represents the product formed?
   (a) ${}^{a-1}_{b}\text{X}$
   (b) ${}^{a+1}_{b}\text{X}$
   (c) ${}^{a}_{b+1}\text{X}$
   (d) ${}^{a}_{b-1}\text{X}$

3. _____ Which of the following best represents the fraction of a radioactive sample that remains after four half-lives have occurred?
   (a) $\left(\frac{1}{2}\right)^4$
   (b) $\left(\frac{1}{2}\right)\times 4$
   (c) $\left(\frac{1}{4}\right)$
   (d) $\left(\frac{1}{2}\right)^2 \times 4$

4. Match the nuclear symbol on the right to the name of the corresponding particle on the left.
   _____ beta particle
   _____ proton
   _____ positron
   _____ alpha particle
   (a) ${}^{1}_{1}p$
   (b) ${}^{4}_{2}\text{He}$
   (c) ${}^{0}_{-1}\beta$
   (d) ${}^{0}_{+1}\beta$

5. Label each of the following statements as True or False. Consider the U-238 decay series in **Figure 2.7** of the text. For the series of decays from U-234 to Po-218, each nuclide
   _____ a. shares the same atomic number
   _____ b. differs in mass number from others by multiples of 4
   _____ c. has a unique atomic number
   _____ d. differs in atomic number from others by multiples of 4

SECTION 2 *continued*

6. _____ Identify the missing term in the following nuclear equation. Write the element's symbol, its atomic number, and its mass number.

$$\_?\_ \rightarrow {}^{231}_{90}\mathrm{Th} + {}^{4}_{2}\mathrm{He}$$

7. Lead-210 undergoes beta emission. Write the nuclear equation showing this transmutation.

_____

8. Einsteinium is a transuranium element. Einsteinium-247 can be prepared by bombarding uranium-238 with nitrogen-14 nuclei, releasing several neutrons, as shown by the following equation:

$${}^{238}_{92}\mathrm{U} + {}^{14}_{7}\mathrm{N} \rightarrow {}^{247}_{99}\mathrm{Es} + {}^{1}_{\chi 0}n$$

What must be the value of x in the above equation? Explain your reasoning.

_____

_____

_____

PROBLEMS Write the answer on the line to the left. Show all your work in the space provided.

9. _____ Phosphorus-32 has a half-life of 14.3 days. How many days will it take for a sample of phosphorus-32 to decay to one-eighth its original amount?

10. _____ Iodine-131 has a half-life of 8.0 days. How many grams of an original 160 mg sample will remain after 40 days?

11. _____ Carbon-14 has a half-life of 5715 years. It is used to determine the age of ancient objects. If a sample today contains 0.060 mg of carbon-14, how much carbon-14 must have been present in the sample 11 430 years ago?

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CHAPTER 21 REVIEW

Nuclear Chemistry

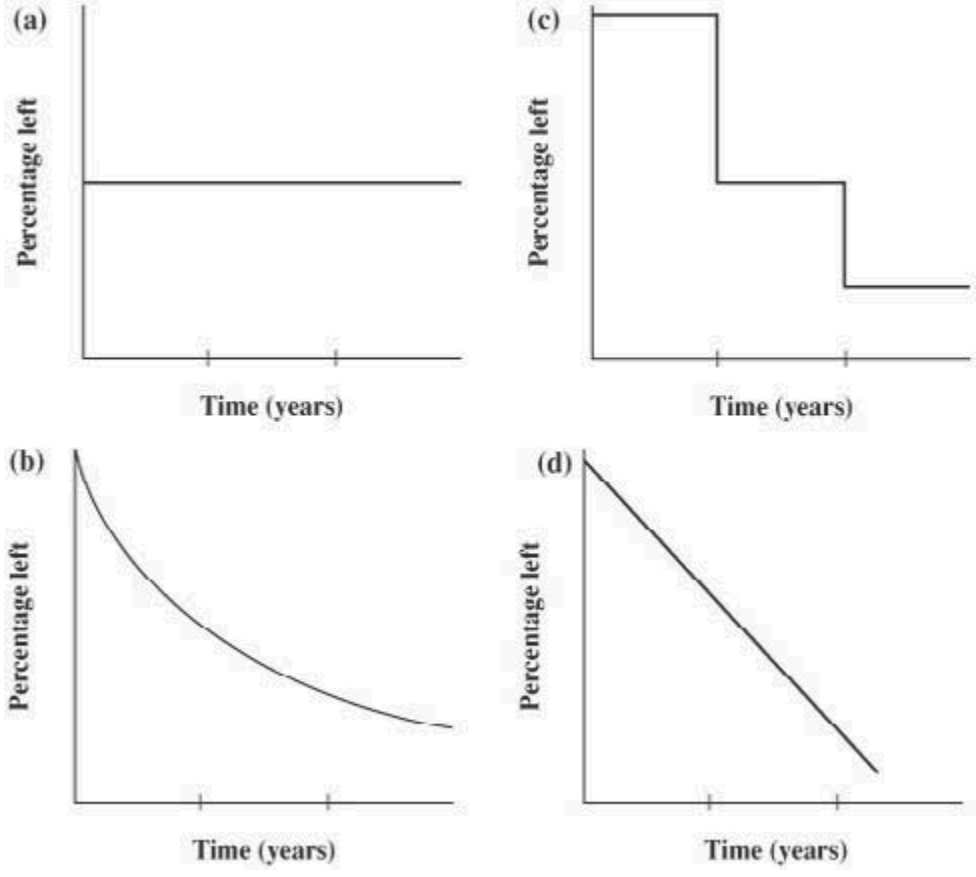
SECTION 3

SHORT ANSWER Answer the following questions in the space provided.

1. _____ The radioisotope cobalt-60 is used for all of the following applications except
   (a) killing food-spoiling bacteria.
   (b) preserving food.
   (c) treating heart disease.
   (d) treating certain kinds of cancers.

2. _____ All of the following contribute to background radiation exposure except
   (a) radon in homes and buildings.
   (b) cosmic rays passing through the atmosphere.
   (c) consumption of irradiated foods.
   (d) minerals in Earth's crust.

3. _____ Which one of the graphs shown below best illustrates the decay of a sample of carbon-14? Assume each division on the time axis represents 5715 years.



SECTION 3 *continued*

4. Match the item on the left with its description on the right.

_____ Geiger-Müller counter

_____ scintillation counter

_____ film badge

_____ radioactive tracers

(a) device that uses film to measure the approximate radiation exposure of people working with radiation

(b) instrument that converts scintillating light to an electric signal for detecting radiation

(c) meter that detects radiation by counting electric pulses carried by gas ionized by radiation

(d) radioactive atoms that are incorporated into substances so that movement of the substances can be followed by detectors

5. Which type of radiation is easiest to shield? Why?

_____

_____

6. One technique for dating ancient rocks involves uranium-235, which has a half-life of 710 million years. Rocks originally rich in uranium-235 will contain small amounts of its decay series, including the nonradioactive lead-206. Explain the relationship between a sample's relative age and the ratio of lead-206 to uranium-235 in the sample.

_____

_____

PROBLEMS Write the answer on the line to the left. Show all your work in the space provided.

7. _____ The technetium-99 isotope has a half-life of 6.0 h. If a 100. mg sample of technetium-99 were injected into a patient, how many milligrams would still be present after 24 h?

8. _____ A Geiger-Müller counter, used to detect radioactivity, registers 14 units when exposed to a radioactive isotope. What would the counter read, in units, if that same isotope is detected 60 days later? The half-life of the isotope is 30 days.

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CHAPTER 21 REVIEW

Nuclear Chemistry

SECTION 4

SHORT ANSWER Answer the following questions in the space provided.

1. Match each of the following statements with the process(es) to which they apply, using one of the choices below:

   (1) fission only (3) both fission and fusion

   (2) fusion only (4) neither fission nor fusion

   _____ a. A very large nucleus splits into smaller pieces.

   _____ b. The total mass before a reaction is greater than the mass after a reaction.

   _____ c. The rate of a reaction can be safely controlled for energy generation in suitable vessels.

   _____ d. Two small nuclei form a single larger one.

   _____ e. Less-stable nuclei are converted to more-stable nuclei.

2. Match the reaction type on the right to the statement(s) that applies to it on the left.

   _____ It requires very high temperatures.

   _____ It is used in nuclear reactors to make electricity.

   _____ It occurs in the sun and other stars.

   _____ It is used in atomic bombs.

   (a) uncontrolled fusion
   (b) uncontrolled fission
   (c) controlled fusion
   (d) controlled fission

3. Match the component of a nuclear power plant on the right to its use on the left.

   _____ limits the number of free neutrons

   _____ is used to slow down neutrons

   _____ drives an electric generator

   _____ provides neutrons by its fission

   _____ removes heat from the system safely

   _____ prevents escape of radiation

   (a) moderator
   (b) fuel rod
   (c) control rod
   (d) shielding
   (e) coolant
   (f) turbine

4. _____ A chain reaction is any reaction in which
   (a) excess reactant is present.
   (b) the material that starts the reaction is also a product.
   (c) the rate is slow.
   (d) many steps are involved.

SECTION 4 *continued*

5. As a star ages, does the ratio of He atoms to H atoms in its composition become larger, smaller, or remain constant? Explain your answer.

_____

_____

_____

_____

6. The products of nuclear fission are variable; many possible nuclides can be created. In the feature "An Unexpected Finding," in the text, it was noted that Meitner showed radioactive barium to be one product of fission. Following is an incomplete possible nuclear equation for the production of barium-141:

$$^{235}_{92}\mathrm{U} + {}^{1}_{0}n \rightarrow {}^{141}_{56}\mathrm{Ba} + \underline{\ ?\ } + 4\,{}^{1}_{0}n + \text{energy}$$

_____ a. Determine the missing fission product formed. Write the element's symbol, its atomic number, and its mass number.

_____ b. Is it likely that this isotope in part a is unstable?

7. Small nuclides can undergo fusion.

_____ a. Complete the following nuclear equation by identifying the missing term. Write the element's symbol, its atomic number, and its mass number.

$$^{3}_{1}\mathrm{H} + {}^{7}_{3}\mathrm{Li} \rightarrow \underline{\ ?\ } + \text{energy}$$

b. When measured exactly, the total mass of the reactants does not add up to that of the products in the reaction represented in part a. Why is there a difference between the mass of the products and the mass of the reactants? Which has the greater mass, the reactants or the products?

_____

_____

_____

8. What are some current concerns regarding development of nuclear power plants?

_____

_____

_____

_____