Name:

Unit 11 Nuclear Chemistry Practice Test

1. A sample of which radioisotope emits particles having the greatest mass?

   (1) ^{137}Cs (2) ^{53}Fe (3) ^{220}Fr (4) ^{3}H

2. Given the equation representing a nuclear reaction in which *X* represents a nuclide:

   $^{232}_{90}\mathrm{Th} \rightarrow {}^{4}_{2}\mathrm{He} + X$

   Which nuclide is represented by *X*?

   (1) $^{236}_{92}\mathrm{Ra}$ (2) $^{228}_{88}\mathrm{Ra}$ (3) $^{236}_{92}\mathrm{U}$ (4) $^{228}_{88}\mathrm{U}$

3. Which list of nuclear emissions is arranged in order from the *least* penetrating power to the greatest penetrating power?

   (1) alpha particle, beta particle, gamma ray
   (2) alpha particle, gamma ray, beta particle
   (3) gamma ray, beta particle, alpha particle
   (4) beta particle, alpha particle, gamma ray

4. Which balanced equation represents a spontaneous radioactive decay?

   (1) $14\mathrm{C} + \mathrm{Ca_3(PO_4)_2} \rightarrow 3\mathrm{CaC_2} + 2\mathrm{P} + 8\mathrm{CO}$
   (2) $^{14}_{7}\mathrm{N} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{14}_{6}\mathrm{C} + {}^{1}_{1}\mathrm{P}$
   (3) $\mathrm{H_2CO_3} \rightarrow \mathrm{H_2O} + \mathrm{CO_2}$
   (4) $^{14}_{6}\mathrm{C} \rightarrow {}^{14}_{7}\mathrm{N} + {}^{0}_{-1}\mathrm{e}$

5. Positrons and beta particles have

   (1) the same charge and the same mass
   (2) the same charge and different masses
   (3) different charges and the same mass
   (4) different charges and different masses

6. Which type of radiation has *neither* mass nor charge?

   (1) gamma (2) neutron
   (3) alpha (4) beta

7. A radioactive isotope has a half-life of 2.5 years. Which fraction of the original mass remains unchanged after 10. years?

   (1) 1/2 (2) 1/4 (3) 1/8 (4) 1/16

8. Which radioisotopes have the same decay mode and have half-lives greater than 1 hour?

   (1) Au-198 and N-16 (2) Ca-37 and Fe-53
   (3) I-131 and P-32 (4) Tc-99 and U-233

9. The dating of geological formations is an example of a beneficial use of

   (1) isomers
   (2) electrolytes
   (3) organic compounds
   (4) radioactive nuclides

10. What is the total number of years that must pass before only 25.00 grams of an original 100.0-gram sample of C-14 remains unchanged?

    (1) 2865 y (2) 5730 y
    (3) 11 460 y (4) 17 190 y

11. What is the half-life of a radioisotope if 25.0 grams of an original 200.-gram sample of the isotope remains unchanged after 11.46 days?

    (1) 2.87 d (2) 3.82 d
    (3) 11.46 d (4) 34.38 d

12. Which term represents a nuclear reaction?

    (1) combustion (2) fermentation
    (3) transmutation (4) saponification

13. Which equation represents natural transmutation?

    (1) $^{10}_{5}\mathrm{B} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{13}_{7}\mathrm{N} + {}^{1}_{0}\mathrm{n}$
    (2) $^{14}_{6}\mathrm{C} \rightarrow {}^{14}_{7}\mathrm{N} + {}^{0}_{-1}\mathrm{e}$
    (3) $\mathrm{S} + 2\mathrm{e}^{-} \rightarrow \mathrm{S}^{2-}$
    (4) $\mathrm{Na} \rightarrow \mathrm{Na}^{+} + \mathrm{e}^{-}$

14. Which nuclear equation represents a natural transmutation?

    (1) $^{9}_{4}\mathrm{Be} + {}^{1}_{1}\mathrm{H} \rightarrow {}^{6}_{3}\mathrm{Li} + {}^{4}_{2}\mathrm{He}$
    (2) $^{27}_{13}\mathrm{Al} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{30}_{15}\mathrm{P} + {}^{1}_{0}\mathrm{n}$
    (3) $^{14}_{7}\mathrm{N} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{17}_{8}\mathrm{O} + {}^{1}_{1}\mathrm{H}$
    (4) $^{235}_{92}\mathrm{U} \rightarrow {}^{231}_{90}\mathrm{Th} + {}^{4}_{2}\mathrm{He}$

15. Radioactive cobalt-60 is used in radiation therapy treatment. Cobalt-60 undergoes beta decay. This type of nuclear reaction is called

(1) natural transmutation
(2) artificial transmutation
(3) nuclear fusion
(4) nuclear fission

16. What occurs in both fusion and fission reactions?

(1) Small amounts of energy are converted into large amounts of matter.
(2) Small amounts of matter are converted into large amounts of energy.
(3) Heavy nuclei are split into lighter nuclei.
(4) Light nuclei are combined into heavier nuclei.

17. Which reaction releases the greatest amount of energy per mole of reactant?

(1) decomposition (2) esterification
(3) fermentation (4) fission

18. Given the balanced equation representing a nuclear reaction:

$^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{142}_{56}\mathrm{Ba} + {}^{91}_{36}\mathrm{Kr} + 3X + \text{energy}$

Which particle is represented by X?

(1) $^{0}_{-1}\mathrm{e}$ (2) $^{1}_{1}\mathrm{H}$ (3) $^{4}_{2}\mathrm{H}$ (4) $^{1}_{0}\mathrm{n}$

19. In which reaction is mass converted to energy by the process of fission?

(1) $^{14}_{7}\mathrm{N} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{14}_{6}\mathrm{C} + {}^{1}_{1}\mathrm{H}$
(2) $^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{87}_{35}\mathrm{Br} + {}^{146}_{57}\mathrm{La} + 3\,{}^{1}_{0}\mathrm{n}$
(3) $^{226}_{88}\mathrm{Ra} \rightarrow {}^{222}_{86}\mathrm{Ra} + {}^{4}_{2}\mathrm{He}$
(4) $^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He}$

20. Which isotope is used to treat cancer?

(1) C-14 (2) U-238
(3) Co-60 (4) Pb-206

21. Which radioisotope is used to treat thyroid disorders?

(1) Co-60 (2) I-131
(3) C-14 (4) U-238

22. The decay of which radioisotope can be used to estimate the age of the fossilized remains of an insect?

(1) Rn-222 (2) I-131
(3) Co-60 (4) C-14

23. A serious risk factor associated with the operation of a nuclear power plant is the production of

(1) acid rain
(2) helium gas
(3) greenhouse gases, such as CO_2
(4) radioisotopes with long half-lives

24. Which type of reaction produces energy and intensely radioactive waste products?

(1) fusion of tritium and deuterium
(2) fission of uranium
(3) burning of heating oil
(4) burning of wood

25. Given the fusion reaction:

$$^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \rightarrow X + \text{energy}$$

Which particle is represented by X?

(1) $^{1}_{1}\mathrm{H}$ (2) $^{3}_{2}\mathrm{He}$ (3) $^{3}_{1}\mathrm{H}$ (4) $^{4}_{2}\mathrm{He}$

26. Given the nuclear reaction:

$$^{32}_{16}\mathrm{S} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{1}_{1}\mathrm{H} + X$$

What does X represent in this reaction?

(1) $^{31}_{15}\mathrm{P}$ (2) $^{32}_{15}\mathrm{P}$ (3) $^{31}_{16}\mathrm{P}$ (4) $^{32}_{16}\mathrm{P}$

27. Which balanced equation represents nuclear fusion?

(1) $^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He}$
(2) $2\mathrm{H_2} + \mathrm{O_2} \rightarrow 2\mathrm{H_2O}$
(3) $^{6}_{3}\mathrm{Li} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{3}_{1}\mathrm{H} + {}^{4}_{2}\mathrm{He}$
(4) $\mathrm{CaO} + \mathrm{CO_2} \rightarrow \mathrm{CaCO_2}$

28. As a radioactive element emits gamma radiation only, the atomic number of the element

(1) decreases (2) increases
(3) remains the same

Base your answers to questions **29** through **32** on the information below and on your knowledge of chemistry.

In 1896, Antoine H. Becquerel discovered that a uranium compound could expose a photographic plate wrapped in heavy paper in the absence of light. It was shown that the uranium compound was spontaneously releasing particles and high-energy radiation. Further tests showed the emissions from the uranium that exposed the photographic plate were *not* deflected by charged plates.

29. Identify the type of nuclear reaction that occurs when an alpha or a beta particle is spontaneously emitted by a radioactive isotope.

30. Determine the number of neutrons in an atom of U-233.

31. Complete the nuclear equation below for the alpha decay of U-238.

$$^{238}_{92}\mathrm{U} \rightarrow {}^{4}_{2}\mathrm{He} + \_\_\_\_\_$$

32. Identify the highly penetrating radioactive emission that exposed the photographic plates.

Base your answers to questions **33** through **35** on the information below and on your knowledge of chemistry.

Elements with an atomic number greater than 92 can be artificially produced in nuclear reactions by bombarding a naturally occurring nuclide with a different nuclide. One of these elements is roentgenium, Rg. The equation below represents a nuclear reaction that produces Rg-272.

$$^{209}_{83}\mathrm{Bi} + {}^{64}_{28}\mathrm{Ni} \rightarrow {}^{272}_{111}\mathrm{Rg} + {}^{1}_{0}\mathrm{n}$$

33. Based on the Periodic Table, classify the element produced by this nuclear reaction as a metal, metalloid, nonmetal, or noble gas.

34. Determine the number of neutrons in an atom of Rg-272.

35. State the location and the total charge of the protons in a Ni-64 atom.

Base your answers to questions **36** through **39** on the information below and on your knowledge of chemistry.

A breeder reactor is one type of nuclear reactor. In a breeder reactor, uranium-238 is transformed in a series of nuclear reactions into plutonium-239.

The plutonium-239 can undergo fission as shown in the equation below. The *X* represents a missing product in the equation.

$$^{1}_{0}\mathrm{n} + {}^{239}_{94}\mathrm{Pu} \rightarrow X + {}^{94}_{36}\mathrm{Kr} + 2{}^{1}_{0}\mathrm{n}$$

36. Write a notation for the nuclide represented by missing product *X* in this equation.

37. Compare the amount of energy released by 1 mole of completely fissioned plutonium-239 to the amount of energy released by the complete combustion of 1 mole of methane.

38. Based on Table *N,* identify the decay mode of the plutonium radioisotope produced in the breeder reactor.

39. Determine the number of neutrons in an atom of the uranium isotope used in the breeder reactor.
