1. Given the nuclear equation:

$$^{1}_{1}\mathrm{H} + X \rightarrow {}^{6}_{3}\mathrm{Li} + {}^{4}_{2}\mathrm{He}$$

The particle represented by *X* is

A) $^{9}_{4}\mathrm{Li}$ **B)** $^{9}_{4}\mathrm{Be}$ C) $^{10}_{5}\mathrm{Be}$ D) $^{10}_{6}\mathrm{C}$

2. Which reaction is an example of natural transmutation?

A) $^{239}_{94}\mathrm{Pu} \rightarrow {}^{235}_{92}\mathrm{U} + {}^{4}_{2}\mathrm{He}$
B) $^{27}_{13}\mathrm{Al} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{30}_{15}\mathrm{P} + {}^{1}_{0}\mathrm{n}$
C) $^{238}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{239}_{94}\mathrm{Pu} + 2\ {}^{0}_{-1}\mathrm{e}$
D) $^{239}_{94}\mathrm{Pu} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{147}_{56}\mathrm{Ba} + {}^{90}_{38}\mathrm{Sr} + 3\ {}^{1}_{0}\mathrm{n}$

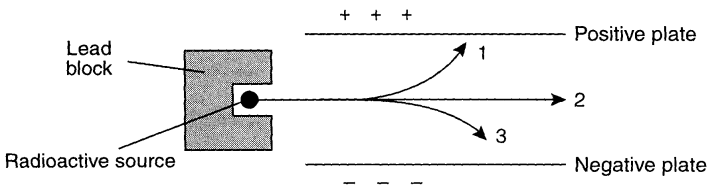
3. Given the nuclear equation:

$$^{19}_{10}\mathrm{Ne} \rightarrow X + {}^{19}_{9}\mathrm{F}$$

What particle is represented by *X*?

A) alpha B) beta
C) neutron **D) positron**

4. The diagram below represents radioactive emanations passing through an electric field.



Which type of emanation is represented by the arrow labeled 1?

A) alpha particle **B) beta particle**
C) positron D) gamma ray

5. Which nuclear equation represents beta decay?

A) $^{27}_{13}\mathrm{Al} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{30}_{15}\mathrm{P} + {}^{1}_{0}\mathrm{n}$
B) $^{238}_{92}\mathrm{U} \rightarrow {}^{234}_{90}\mathrm{Th} + {}^{4}_{2}\mathrm{He}$
C) $^{14}_{6}\mathrm{C} \rightarrow {}^{14}_{7}\mathrm{N} + {}^{0}_{-1}\mathrm{e}$
D) $^{37}_{18}\mathrm{Ar} + {}^{0}_{-1}\mathrm{e} \rightarrow {}^{37}_{17}\mathrm{Cl}$

6. According to Table *N*, which radioactive isotope is best for determining the actual age of Earth?

A) ^{238}**U** B) ^{90}Sr C) ^{60}Co D) ^{14}C

7. As a sample of the radioactive isotope ^{131}I decays, its half-life

A) decreases B) increases
C) remains the same

8. The half-life of ^{131}I is 8.07 days. What fraction of a sample of ^{131}I remains after 24.21 days?

A) $\frac{1}{2}$ B) $\frac{1}{4}$ **C)** $\frac{1}{8}$ D) $\frac{1}{16}$

9. What was the original mass of a radioactive sample that decayed to 25 grams in four half-life periods?

A) 50 g B) 100 g C) 200 g **D) 400 g**

10. What is the total number of grams of a 32-gram sample of ^{32}P remaining after 71.5 days of decay?

A) 1.0 g B) 2.0 g C) 8.0 g D) 4.0 g

11. In how many days will a 12-gram sample of $^{131}_{53}\mathrm{I}$ decay, leaving a total of 1.5 grams of the original isotope?

A) 8.0 B) 16 C) 20. **D) 24**

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

A) natural transmutation
B) artificial transmutation
C) nuclear fusion
D) nuclear fission

13. Types of nuclear reactions include fission, fusion, and

A) single replacement B) neutralization
C) oxidation-reduction **D) transmutation**

14. Which equation represents artificial transmutation?

A) $^{238}_{92}\mathrm{U} \rightarrow {}^{234}_{90}\mathrm{Th} + {}^{4}_{2}\mathrm{He}$
B) $^{234}_{90}\mathrm{Th} \rightarrow {}^{234}_{91}\mathrm{Pa} + {}^{0}_{-1}\mathrm{e}$
C) $^{218}_{84}\mathrm{Po} \rightarrow {}^{214}_{82}\mathrm{Pb} + {}^{4}_{2}\mathrm{He}$
D) $^{9}_{4}\mathrm{Be} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{12}_{6}\mathrm{C} + {}^{1}_{0}\mathrm{n}$

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

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

16. What is the primary result of a fission reaction?

A) conversion of mass to energy
B) conversion of energy to mass
C) binding together of two heavy nuclei
D) binding together of two light nuclei

17. Which equation represents a fusion reaction?

A) $H_2O(g) \rightarrow H_2O(\ell)$
B) $C(s) + O_2(g) \rightarrow CO_2(g)$
C) ${}^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n$
D) ${}^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{142}_{56}Ba + {}^{91}_{36}Kr + 3\ {}^{1}_{0}n$

18. High energy is a requirement for fusion reactions to occur because the nuclei involved

A) attract each other because they have like charges
B) attract each other because they have unlike charges
C) repel each other because they have like charges
D) repel each other because they have unlike charges

19. Given the nuclear equation:
${}^{253}_{99}Es + X \rightarrow {}^{1}_{0}n + {}^{256}_{101}Md$
Which particle is represented by X?

A) ${}^{4}_{2}He$ B) ${}^{0}_{-1}e$ C) ${}^{1}_{0}n$ D) ${}^{0}_{+1}e$

20. Given the nuclear reaction:

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

What does *X* represent in this reaction?

A) ${}^{31}_{15}P$ **B)** ${}^{32}_{15}P$ C) ${}^{31}_{16}P$ D) ${}^{32}_{16}P$

21. In a nuclear fusion reaction, the mass of the products is

A) less than the mass of the reactants because some of the mass has been converted to energy
B) less than the mass of the reactants because some of the energy has been converted to mass
C) more than the mass of the reactants because some of the mass has been converted to energy
D) more than the mass of the reactants because some of the energy has been converted to mass

22. Which isotope is most commonly used in the radioactive dating of the remains of organic materials?

A) ^{14}C B) ^{16}N C) ^{32}P D) ^{37}K

23. Which radioisotope is used in medicine to treat thyroid disorders?

A) cobalt-60 **B) iodine-131**
C) phosphorus-32 D) uranium-238

24. Radioisotopes used for medical diagnosis must have

A) long half-lives and be quickly eliminated by the body
B) long half-lives and be slowly eliminated by the body
C) short half-lives and be quickly eliminated by the body
D) short half-lives and be slowly eliminated by the body

25. Base your answer to the following question on the information below.

The fossilized remains of a plant were found at a construction site. The fossilized remains contain $\frac{1}{16}$ the amount of carbon-14 that is present in a living plant.

Complete the nuclear equation for the decay of C-14. Your response must include the atomic number, the mass number, and the symbol of the missing particle.

$$^{14}_{6}\mathrm{C} \rightarrow {}^{0}_{-1}\mathrm{e} + \_\_\_\_\_$$

26. Base your answer to the following question on the information below.

Some radioisotopes used as tracers make it possible for doctors to see the images of internal body parts and observe their functions. The table below lists information about three radioisotopes and the body part each radioisotope is used to study.

Medical Uses of Some Radioisotopes

Radioisotope	Half-life	Decay Mode	Body Part
^{24}Na	15 hours	beta	circulatory system
^{59}Fe	44.5 days	beta	red blood cells
^{131}I	8.1 days	beta	thyroid

It could take up to 60. hours for a radioisotope to be delivered to the hospital from the laboratory where it is produced. What fraction of an original sample of ^{24}Na remains unchanged after 60. hours?

27. Base your answer to the following question on the information below.

The radioisotopes carbon-14 and nitrogen-16 are present in a living organism. Carbon-14 is commonly used to date a once-living organism.

Complete the nuclear equation for the decay of C-14. Include *both* the atomic number and the mass number of the missing particle.

$$^{14}_{6}\mathrm{C} \rightarrow {}^{0}_{-1}\mathrm{e} + \_\_\_\_\_$$

28. Base your answer to the following question on the reading passage below and on your knowledge of chemistry.

A Glow in the Dark, and Scientific Peril

The [Marie and Pierre] Curies set out to study radioactivity in 1898. Their first accomplishment was to show that radioactivity was a property of atoms themselves. Scientifically,that was the most important of their findings, because it helped other researchers refine their understanding of atomic structure. More famous was their discovery of polonium and radium. Radium was the most radioactive substance the Curies had encountered. Its radioactivity is due to the large size of the atom, which makes the nucleus unstable and prone to decay, usually to radon and then lead, by emitting particles and energy as it seeks a more stable configuration.Marie Curie struggled to purify radium for medical uses, including early radiation treat-ment for tumors. But radiums bluish glow caught peoples fancy, and companies in theUnited States began mining it and selling it as a novelty: for glow-in-the-dark light pulls, for instance, and bogus cure-all patent medicines that actually killed people.What makes radium so dangerous is that it forms chemical bonds in the same way as calcium, and the body can mistake it for calcium and absorb it into the bones. Then, it can bombard cells with radiation at close range, which may cause bone tumors or bone-marrow damage that can give rise to anemia or leukemia.

– Denise Grady, The New York Times, October 6, 1998

If a scientist purifies 1.0 gram of radium-226, how many years must pass before only 0.50 gram of the original radium-226 sample remains unchanged?

Answer Key
nuclear review

1. **B**
2. **A**
3. **D**
4. **B**
5. **C**
6. **A**
7. **C**
8. **C**
9. **D**
10. **A**
11. **D**
12. **A**
13. **D**
14. **D**
15. **B**
16. **A**
17. **C**
18. **C**
19. **A**
20. **B**
21. **A**
22. **A**
23. **B**
24. **C**
25. $^{14}_{7}\mathrm{N}$.
26. Examples: $\frac{1}{16}$ *or* 0.0625 *or* $6\frac{1}{4}\%$
27. $^{14}_{7}\mathrm{N}$
28. 1600