

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

- (1) ${}_{88}^{226}\text{Ra} \rightarrow {}_{86}^{222}\text{Ra} + {}_2^4\text{He}$
 (2) ${}_{92}^{235}\text{U} + {}_0^1\text{n} \rightarrow {}_{35}^{87}\text{Br} + {}_{57}^{146}\text{La} + 3{}_0^1\text{n}$
 (3) ${}_1^2\text{H} + {}_1^2\text{H} \rightarrow {}_2^4\text{He}$
 (4) ${}_7^{14}\text{N} + {}_0^1\text{n} \rightarrow {}_6^{14}\text{C} + {}_1^1\text{H}$

2. The radioisotope I-131 is used to

- (1) control nuclear reactors
 (2) determine the age of fossils
 (3) diagnose thyroid disorders
 (4) trigger fission reactors

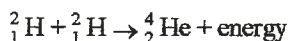
3. In the reaction ${}_{93}^{239}\text{Np} \rightarrow {}_{94}^{239}\text{Pu} + X$, what does X represent?

- (1) a proton (3) a neutron
 (2) an alpha particle (4) a beta particle

4. Artificial transmutation is brought about by using accelerated particles to bombard an atom's

- (1) inner principal energy levels
 (2) valence shells
 (3) nucleus
 (4) occupied sublevels

5. Given the reaction:



The process represented by the reaction is called

- (1) alpha decay (3) fusion
 (2) artificial transmutation (4) fission

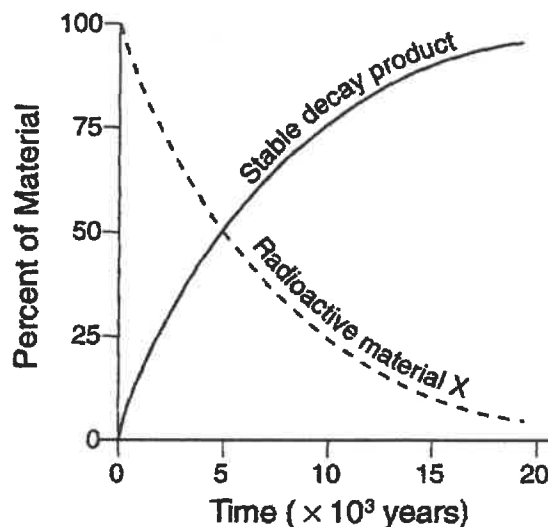
6. As ${}^{14}\text{C}$ decays to ${}^{14}\text{N}$, the number of protons in the nucleus

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

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

- (1) 50 g (3) 200 g
 (2) 100 g (4) 400 g

8. Base your answer to the following question on the graph below. The graph represents the decay of radioactive material X into a stable decay product.



If radioactive material X were heated, the length of its half-life period would

- (1) decrease (3) remain the same
 (2) increase

9. What is the half-life of sodium-25 if 1.00 gram of a 16.00-gram sample of sodium-25 remains unchanged after 237 seconds?

- (1) 47.4 s (3) 79.0 s
 (2) 59.3 s (4) 118 s

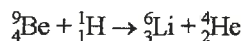
10. Exactly how much time must elapse before 16 grams of potassium-42 decays, leaving 2 grams of the original isotope?

- (1) 8×12.4 hours (3) 3×12.4 hours
 (2) 2×12.4 hours (4) 4×12.4 hours

11. Which materials are commonly used for shielding in a nuclear fission reactor?

- (1) boron and cadmium
 (2) steel and concrete
 (3) uranium and plutonium
 (4) beryllium and heavy water

12. Given the reaction:



Which type of reaction is represented?

- (1) fission (3) artificial transmutation
(2) natural transmutation (4) fusion
13. Radioactive cobalt-60 is used in radiation therapy treatment. Cobalt-60 undergoes beta decay. This type of nuclear reaction is called
- (1) nuclear fusion (3) nuclear fission
(2) artificial transmutation (4) natural transmutation
14. Nuclear fusion *differs* from nuclear fission because nuclear fusion reactions
- (1) convert mass to energy
(2) convert energy to mass
(3) form heavier isotopes from lighter isotopes
(4) form lighter isotopes from heavier isotopes
15. Alpha particles and beta particles differ in
- (1) mass, only (3) both mass and charge
(2) charge, only (4) neither mass nor charge
16. Based on Reference Table N, what fraction of a radioactive ${}^{90}\text{Sr}$ sample would remain unchanged after 56.2 years?
- (1) $\frac{1}{2}$ (3) $\frac{1}{8}$
(2) $\frac{1}{4}$ (4) $\frac{1}{16}$
17. Which of these types of nuclear radiation has the greatest penetrating power?
- (1) alpha (3) gamma
(2) neutron (4) beta
18. Which radioactive isotope is used in geological dating?
- (1) uranium-238 (3) technetium-99
(2) cobalt-60 (4) iodine-131
19. Which components of a fission reactor are used to slow neutrons during a fission reaction?
- (1) moderators (3) control rods
(2) shields (4) coolants

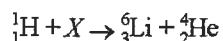
20. Which list of particles is in order of increasing mass?

- (1) electron \rightarrow proton \rightarrow alpha particle
(2) alpha particle \rightarrow electron \rightarrow proton
(3) proton \rightarrow alpha particle \rightarrow electron
(4) proton \rightarrow electron \rightarrow alpha particle
21. Given the equation:
- $${}^{14}_7\text{N} + {}^4_2\text{He} \rightarrow X + {}^{17}_8\text{O}$$
- When the equation is balanced correctly, which particle is represented by X?
- (1) ${}^1_1\text{H}$ (3) ${}^1_0\text{n}$
(2) ${}^2_1\text{H}$ (4) ${}^0_{-1}\text{e}$
22. Which statement best describes gamma radiation?
- (1) It has a mass of 4 and a charge of +2.
(2) It has a mass of 0 and a charge of -1.
(3) It has a mass of 0 and a charge of 0.
(4) It has a mass of 1 and a charge of 1.
23. According to Reference Table N, which radioactive isotope will retain only one-eighth ($\frac{1}{8}$) its original radioactive atoms after approximately 43 days?
- (1) iodine-131 (3) gold-198
(2) phosphorus-32 (4) radon-222
24. After 32 days, 5 milligrams of an 80-milligram sample of a radioactive isotope remains unchanged. What is the half-life of this element?
- (1) 8 days (3) 16 days
(2) 2 days (4) 4 days
25. Which reaction is an example of natural transmutation?
- (1) ${}^{239}_{94}\text{Pu} + {}^1_0\text{n} \rightarrow {}^{147}_{56}\text{Ba} + {}^{90}_{38}\text{Sr} + 3{}^1_0\text{n}$
(2) ${}^{238}_{92}\text{U} + {}^1_0\text{n} \rightarrow {}^{239}_{94}\text{Pu} + 2{}^0_{-1}\text{e}$
(3) ${}^{239}_{94}\text{Pu} \rightarrow {}^{235}_{92}\text{U} + {}^4_2\text{He}$
(4) ${}^{27}_{13}\text{Al} + {}^4_2\text{He} \rightarrow {}^{30}_{15}\text{P} + {}^1_0\text{n}$
26. Approximately what fraction of an original Co-60 sample remains after 21 years?
- (1) $\frac{1}{2}$
(2) $\frac{1}{4}$
(3) $\frac{1}{8}$
(4) $\frac{1}{16}$
27. Which substance can be used as both a coolant and a moderator in a nuclear reactor?
- (1) heavy water (3) helium
(2) carbon dioxide (4) graphite

28. Which statement best describes what happens in a fission reaction?

- (1) Energy is released and less stable elements are formed.
- (2) Light nuclei form into heavier nuclei.
- (3) Energy is absorbed and more stable elements are formed.
- (4) Heavy nuclei split into lighter nuclei.

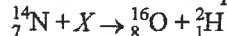
29. Given the nuclear equation:



The particle represented by X is

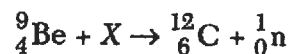
- (1) ${}^{10}_6\text{C}$
 - (2) ${}^9_4\text{Be}$
 - (3) ${}^9_4\text{Li}$
 - (4) ${}^{10}_5\text{Be}$
30. How many days are required for 200. grams of radon-222 to decay to 50.0 grams?
- (1) 1.91 days
 - (2) 3.82 days
 - (3) 7.64 days
 - (4) 11.5 days
31. What is the number of half-life periods required for a sample of a radioactive material to decay to one-sixteenth its original mass?
- (1) 8
 - (2) 16
 - (3) 3
 - (4) 4
32. Which fissionable elements are produced in breeder reactors?
- (1) carbon-14 and oxygen-17
 - (2) cesium-137 and radon-222
 - (3) lithium-6 and hydrogen-3
 - (4) uranium-233 and plutonium-239

33. Given the nuclear equation:



What is particle X ?

- (1) a deuteron
 - (2) an alpha particle
 - (3) a beta particle
 - (4) a triton
34. The decay of which radioisotope can be used to estimate the age of the fossilized remains of an insect?
- (1) Rn-222
 - (2) C-14
 - (3) I-131
 - (4) Co-60
35. Given the nuclear reaction:



What is the identity of particle X ?

- (1) alpha particle
 - (2) beta particle
 - (3) proton
 - (4) neutron
36. Which equation represents a fusion reaction?
- (1) ${}^2_1\text{H} + {}^3_1\text{H} \rightarrow {}^4_2\text{He} + {}^1_0\text{n}$
 - (2) ${}^{235}_{92}\text{U} + {}^1_0\text{n} \rightarrow {}^{142}_{56}\text{Ba} + {}^{91}_{36}\text{Kr} + 3{}^1_0\text{n}$
 - (3) $\text{H}_2\text{O}(\text{g}) \rightarrow \text{H}_2\text{O}(\ell)$
 - (4) $\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$

37. Radioisotopes used for medical diagnosis must have

- (1) long half-lives and be slowly eliminated by the body
- (2) short half-lives and be quickly eliminated by the body
- (3) short half-lives and be slowly eliminated by the body
- (4) long half-lives and be quickly eliminated by the body