CHAPTER

11 Nuclear Chemistry*

1. Which of the following nuclear reactions will generate an isotope?
(a) β-particle emission
(b) Neutron particle emission
(c) Positron emission
(d) α-particle emission *(2007)*

2. A radioactive element gets spilled over the floor of a room. Its half-life period is 30 days. If the initial velocity is ten times the permissible value, after how many days will it be safe to enter the room?
(a) 100 days (b) 1000 days
(c) 300 days (d) 10 days *(2007)*

3. In the transformation of $^{238}_{92}\text{U}$ to $^{234}_{92}\text{U}$, if one emission is an α-particle, what should be the other emission(s)?
(a) Two β^-
(b) Two β^- and one β^+
(c) One β^- and one γ
(d) One β^+ and one β^- *(2006)*

4. A photon of hard gamma radiation knocks a proton out of $^{24}_{12}\text{Mg}$ nucleus to form
(a) the isotope of parent nucleus
(b) the isobar of parent nucleus
(c) the nuclide $^{23}_{11}\text{Na}$
(d) the isobar of $^{23}_{11}\text{Na}$ *(2005)*

5. Hydrogen bomb is based on the principle of
(a) nuclear fission (b) natural radioactivity
(c) nuclear fusion (d) artificial radioactivity. *(2005)*

6. The half-life of a radioisotope is four hours. If the initial mass of the isotope was 200 g, the mass remaining after 24 hours undecayed is
(a) 1.042 g (b) 2.084 g
(c) 3.125 g (d) 4.167 g *(2004)*

7. Consider the following nuclear reactions:
$$^{238}_{92}M \rightarrow {}^{X}_{Y}N + 2\,{}^{4}_{2}\text{He}\ ;\ {}^{X}_{Y}N \rightarrow {}^{A}_{B}L + 2\beta^+$$
The number of neutrons in the element L is
(a) 142 (b) 144
(c) 140 (d) 146 *(2004)*

8. The half-life of a radioactive isotope is three hours. If the initial mass of the iosotope were 256 g, the mass of it remaining undecayed after 18 hours would be
(a) 4.0 g (b) 8.0 g
(c) 12.0 g (d) 16.0 g *(2003)*

9. The radionucleide $^{234}_{90}\text{Th}$ undergoes two successive β-decays followed by one α-decay. The atomic number and the mass number respectively of the resulting radionucleide are
(a) 92 and 234 (b) 94 and 230
(c) 90 and 230 (d) 92 and 230 *(2003)*

10. β-particle is emitted in radioactivity by
(a) conversion of proton to neutron
(b) form outermost orbit
(c) conversion of neutron to proton
(d) β-particle is not emitted. *(2002)*

11. If half-life of a substance is 5 yrs, then the total amount of substance left after 15 years, when initial amount is 64 grams is
(a) 16 g (b) 2 g
(c) 32 g (d) 8 g *(2002)*

ANSWER KEY

1. (b) **2.** (a) **3.** (a) **4.** (c) **5.** (c) **6.** (c) **7.** (b) **8.** (a) **9.** (c) **10.** (c) **11.** (d)

GNot included in the syllabus of JEE Main since 2008.

Explanations

1. **(b) :** The atoms of the some elements having same atomic number but different mass numbers are called isotopes.

$${}^{A}_{Z}X \xrightarrow{-\alpha} {}^{A-4}_{Z-2}Y; \quad {}^{A}_{Z}X \xrightarrow{-\beta} {}^{A}_{Z+1}Y$$

$${}^{A}_{Z}X \xrightarrow{-{}^{1}_{0}n} {}^{A-1}_{Z}X\ ; \quad {}^{A}_{Z}X \xrightarrow{+\beta^{+}} {}^{A}_{Z-1}Y$$

2. **(a) :** Let A be the activity for safe working.

Given $A_0 = 10\,A$, $A_0 \propto N_0$ and $A \propto N$

$$t = \frac{2.303}{\lambda}\log\frac{N_0}{N} = \frac{2.303}{\lambda}\log\frac{A_0}{A}$$

$$= \frac{2.303}{0.693/30}\log\frac{10A}{A} = \frac{2.303\times 30}{0.693}\log 10$$

$$= \frac{2.303\times 30}{0.693} = 99.69 \text{ days} \approx 100 \text{ days}$$

3. **(a) :** ${}^{238}_{92}\text{U} \xrightarrow{-\alpha} {}^{234}_{90}A \xrightarrow{-\beta} {}^{234}_{91}B \xrightarrow{-\beta} {}^{234}_{92}\text{U}$

Thus in order to get ${}^{234}_{92}\text{U}$ as end product 1α and 2β particles should be emitted.

4. **(c) :** ${}^{24}_{12}\text{Mg} + \gamma \rightarrow {}^{23}_{11}\text{Na} + {}^{1}_{1}p$

5. **(c) :** Hydrogen bomb is based on the principal of nuclear fusion. In hydrogen bomb, a mixture of deuterium oxide and tritium oxide is enclosed in a space surrounding an ordinary atomic bomb. The temperature produced by the explosion of the atomic bomb initiates the fusion reaction between ${}^{3}_{1}\text{H}$ and ${}^{2}_{1}\text{H}$ releasing huge amount of energy.

6. **(c) :** $t_{1/2} = 4$ hours

$$n = \frac{T}{t_{1/2}} = \frac{24}{4} = 6\ ; \quad N = N_0\left(\frac{1}{2}\right)^n \Rightarrow N = 200\times\left(\frac{1}{2}\right)^6 = 3.125 \text{ g}$$

7. **(b) :** ${}^{238}_{92}M \rightarrow {}^{230}_{88}N + 2\,{}^{4}_{2}\text{He}$

$${}^{230}_{88}N \rightarrow {}^{230}_{86}L + 2\beta^{+}$$

Therefore, number of neutrons in element $L = 230 - 86 = 144$

8. **(a) :** $t_{1/2} = 3$ hours, $n = T/t_{1/2} = 18/3 = 6$

$$N = N_0\left(\frac{1}{2}\right)^n = 256\left(\frac{1}{2}\right)^6 = 4.0 \text{ g}$$

9. **(c) :** ${}^{234}_{90}\text{Th} \xrightarrow{-2\beta} {}^{234}_{92}X \xrightarrow{-\alpha} {}^{230}_{90}\text{Th}$

Elimination of 1α and 2β particles give isotope.

10. **(c) :** Since the nucleus does not contain β-particles, it is produced by the conversion of a neutron to a proton at the moment of emission.

$${}_{0}n^{1} \rightarrow {}_{+1}p^{1} + {}_{-1}e^{0}$$

11. **(d) :** $t_{1/2} = 5$ years, $n = \dfrac{T}{t_{1/2}} = \dfrac{15}{5} = 3$

$$n = N_0\left(\frac{1}{2}\right)^n = 64\left(\frac{1}{2}\right)^3 = 8 \text{ g}$$