# JEE Main Level Practice Test-18

## Topic : Radioactivity & Nuclear Physics Time: 75 Min Marking +4 –1

**Section - A : MCQs with Single Option Correct**

**1.** A radioactive element is being produced in proportion to its current population and twice as fast as it decays. If the mean life of the element is 1 hour, find the time taken for activity to increase by 50%. (Assume some initial population) :
(A) 45 minutes (B) 35 minutes (C) 24 minutes (D) 14 minutes

**2.** A radioactive material with decay constant $\lambda$ is produced at a rate of $p$ nuclei per second. The number of nuclei $N$ present $t$ second after the production started is given as :

(A) $N = \frac{p(1-e^{-\lambda t})}{\lambda}$ (B) $N = \frac{p(1-e^{-\lambda t})}{2\lambda}$ (C) $N = \frac{2p(1-e^{-\lambda t})}{\lambda}$ (D) $N = \frac{p(1+e^{-\lambda t})}{\lambda}$

**3.** A certain radioactive element disintegrates with a decay constant of $7.9 \times 10^{-10}$/s. At a given instant of time, if the activity of the sample is equal to $55.3 \times 10^{11}$ disintegration/second, then number of nuclei at that instant of time is :
(A) $7.0 \times 10^{21}$ (B) $4.27 \times 10^{13}$ (C) $4.27 \times 10^{3}$ (D) $6 \times 10^{23}$

**4.** A sample of a radioactive element half-life is 30 s contains a million nuclei at a certain instant of time. How many nuclei will be left after 10 s ?
(A) $3.33 \times 10^{5}$ (B) $3.78 \times 10^{5}$ (C) $7.94 \times 10^{5}$ (D) $1.26 \times 10^{5}$

**5.** A radioactive sample of half-life 10 days contains $1000x$ nuclei. Number of original nuclei present after 5 days is :
(A) $707x$ (B) $750x$ (C) $500x$ (D) $250x$

**6.** A radioactive material of half-life $T$ was kept in a nuclear reactor at two different instants. The quantity kept second time was twice of that kept first time. If now their present activities are $A_1$ (first) and $A_2$ (second) respectively then their age difference is equals to :

(A) $\frac{T}{\ln 2}\ln\frac{2A_1}{A_2}$ (B) $T\ln\frac{A_1}{A_2}$ (C) $\frac{T}{\ln 2}\ln\frac{A_2}{2A_1}$ (D) $T\ln\frac{A_2}{2A_1}$

**7.** If 10% of a radioactive material decays in 5 days, then the amount of the original material left after 20 days is approximately :
(A) 60% (B) 65% (C) 70% (D) 75%

**8.** Which of the following cannot be emitted by radioactive substances during their decay ?
(A) Protons (B) Neutrinos (C) Helium nuclei (D) Electrons

**9.** When $U^{238}$ nucleus originally at rest, decays by emitting an alpha particle having a speed $u$, the recoil speed of the residual nucleus is :

(A) $\frac{4u}{238}$ (B) $-\frac{4u}{234}$ (C) $\frac{4u}{234}$ (D) $-\frac{4u}{238}$

**10.** An $\alpha$-particle of energy 5 MeV is scattered through 180° by a fixed uranium nucleus. The distance of the closest approach is of the order of :
(A) 1 Å (B) $10^{-10}$ cm (C) $10^{-12}$ cm (D) $10^{-15}$ cm

**11.** The binding energy per nucleon of deuteron $(^2_1\text{H})$ and helium nucleus $(^4_2\text{He})$ is 1.1 MeV and 7 MeV respectively. If two deuteron nuclei react to form a single helium nucleus, then the energy released is :

(A) 13.9 MeV (B) 26.9 MeV (C) 23.6 MeV (D) 19.2 MeV

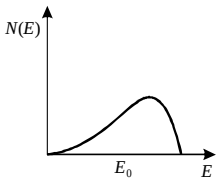
**12.** A nuclear transformation is denoted by X $(n, \alpha) \rightarrow {}^7_3\text{Li}$. Which of the following is the nucleus of element $X$ ?

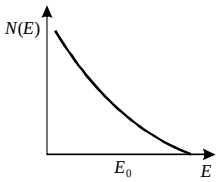
(A) ${}^{12}_6\text{C}$ (B) ${}^{10}_5\text{B}$ (C) ${}^{9}_5\text{B}$ (D) ${}^{11}_4\text{Be}$

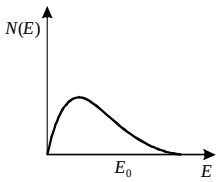
**13.** The intensity of gamma radiation from a given source is $I$. On passing through 36 mm of lead, it is reduced to $I/8$. The thickness of lead, which will reduce the intensity to $I/2$ will be :

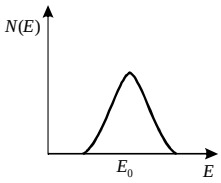
(A) 6mm (B) 9mm (C) 18mm (D) 12mm

**14.** The energy spectrum of β-particles [number $N(E)$ as a function of β-energy $E$] emitted from a radioactive source is :

(A) 


(B) 


(C) 


(D) 


**15.** When ${}_3\text{Li}^7$ nuclei are bombarded by protons and the resultant nuclei are ${}_4\text{Be}^8$, the emitted particles will be :

(A) alpha particles (B) beta particles (C) gamma photons (D) neutrons

**16.** An alpha nucleus of energy $1/2\ mv^2$ bombards a heavy nuclear target of charge $Ze$. Then the distance of closest approach for the alpha nucleus will be proportional to :

(A) $v^2$ (B) $1/m$ (C) $1/v^4$ (D) $1/Ze$

**17.** If the binding energy per nucleon in ${}^7_3\text{Li}$ and ${}^4_2\text{He}$ nuclei are 5.60 MeV and 7.06 MeV respectively, then in the reaction:

$p + {}^7_3\text{Li} \rightarrow 2\,{}^4_2\text{He}$ energy of proton must be :

(A) 28.24 MeV (B) 17.28 MeV (C) 1.46 MeV (D) 39.2 MeV

**18.** In gamma ray emission from a nucleus :

(A) both the neutron number and the proton number change
(B) there is no change in the proton number and the neutron number
(C) only the neutron number changes
(D) only the proton number changes

**19.** If $M_\text{O}$ is the mass of an oxygen isotope ${}_8\text{O}^{17}$, $M_p$ and $M_n$ are the masses of a proton and a neutron, respectively, the nuclear binding energy of the isotope is :

(A) $(M_\text{O} - 8M_p)c^2$ (B) $(M_\text{O} - 8M_p - 9M_n)c^2$ (C) $M_\text{O}c^2$ (D) $(M_\text{O} - 17M_n)c^2$

**20.** Which of the following are the constituents of the nucleus?

(A) Electrons and protons (B) Neutrons and protons
(C) Electrons and neutrons (D) Neutrons and positrons

**Section- B: INTEGER Answer Type Questions**

**21.** Radioactive material $A$ has decay constant $8\lambda$ and material $B$ has decay constant $\lambda$. Initially they have same number of nuclei. The time after which, the ratio of number of nuclei of material $B$ to that $A$ will be $\frac{1}{e}$ is $\frac{1}{N\lambda}$ find $N$ ?

**22.** A stationary nucleus disintegrates suddenly in two nuclei $X$ and $Y$. The ratio of the kinetic energy of the two nuclei $X$ and $Y$ after the disintegration is 1 : 2, the ratio of the radii of the nuclei $X$ and $Y$ will be $2^{1/n}$ find $n$.

**23.** A mixture consists of two radioactive materials $A_1$ and $A_2$ with half-lives of 20s and 10s, respectively. Initially, the mixture has 40g of $A_1$ and 160g of $A_2$. The amount of the two in the mixture will become equal after time $t$. Find $t$ (in second).

**24.** A radioactive substance decays at 1/32 of its initial activity in 25 days. Calculate its half life (in days).

**25.** A radioactive sample decays by two modes by $\alpha$ decay and by $\beta$-decay. 66.6% of times it decays by $\alpha$-decay and 33.3% of times, it decays by $\beta$-decay. If half life of sample is 60 years then what will be half life of sample, if it decays only by $\alpha$-decay (in years).

**26.** A nucleus with $Z = 92$ emits the following in a sequence : $\alpha, \alpha, \beta^-, \beta^-, \alpha, \alpha, \alpha, \alpha, \beta^-, \beta^-, \alpha, \beta^+, \beta^+, \alpha$. Calculate the atomic number of the resulting nucleus.

**27.** Calculate the approximate ratio of mass densities of nuclei of $^{40}Ca$ and $^{16}O$.

**28.** A radioactive material decays by simultaneous emission of two particles with respective half lives 1620 and 810 years. Calculate the time (in years) after which one-fourth of the material remains present.

**29.** A radioactive isotope has a half life of $T$ years. Its activity decreases to 3.125% of the initial value in $nT$ years. Find $n$.

**30.** A radio active element $P$ disintegrates into $Q$ which successively disintegrates in to $R$ as $P \xrightarrow{\lambda} Q \xrightarrow{2\lambda} R$. At $t = 0$ the number of nuclei of $P$, $Q$ and $R$ the $N_0$, 0, 0 respectively. At time $t_1$ number of nuclei of $P$, $Q$ and $R$ are $N_1$, $N_2$ and $N_3$ respectively. Calculate the ratio of $N_1$ to $N_2$. When $N_2$ is maximum.

# Answer Key

## Topic : Radioactivity & Nuclear Physics — ANSWER KEY

**Section - A : MCQs with Single Option Correct**

| | | | |
|---|---|---|---|
| **1.** (C) | **2.** (A) | **3.** (A) | **4.** (C) |
| **5.** (A) | **6.** (C) | **7.** (B) | **8.** (A) |
| **9.** (C) | **10.** (C) | **11.** (C) | **12.** (B) |
| **13.** (D) | **14.** (C) | **15.** (C) | **16.** (B) |
| **17.** (B) | **18.** (B) | **19.** (B) | **20.** (B) |

**Section- B: INTEGER Answer Type Questions**

| | | | |
|---|---|---|---|
| **21.** [7] | **22.** [3] | **23.** [40] | **24.** [5] |
| **25.** [90] | **26.** [78] | **27.** [1] | **28.** [1080] |
| **29.** [5] | **30.** [2] | | |