Exercise-1

☞ **If required, you can use the follwoing data:**
Mass of proton m_p = 1.007276 u, Mass of $_1H_1$ atom = 1.007825 u, Mass of neutron m_n = 1.008665 u, Mass of electron = 0.0005486 u = 511 KeV/c^2, 1 u = 931 MeV/c^2. N_A = 6.023 × 10^{23}
Atomic mass of : H_2 = 2.01410 u, Be_8 = 8.00531u, B_{11} = 11.00930u, Li_7 = 7.01601u, He_4 = 4.002603u.

ONLY ONE OPTION CORRECT TYPE

SECTION (A) : PROPERTIES OF NUCLEUS

1. The mass number of a nucleus is
(1) always less than its atomic number
(2) always more than its atomic number
(3) equal to its atomic number
(4) sometimes more than and sometimes equal to its atomic number

2. The stable nucleus that has a radius 1/3 that of Os_{189} is -
(1) $_3Li_7$ (2) $_2He_4$ (3) $_5B_{10}$ (4) $_6C_{12}$

3. For uranium nucleus how does its mass vary with volume? **[JEE 2003 (Screening) 3,–1/84]**
(1) $m \propto V$ (2) $m \propto 1/V$ (3) $m \propto \sqrt{V}$ (4) $m \propto V^2$

4. The graph of $\ell n(R/R_0)$ versus $\ell n A$ (R = radius of a nucleus and A = its mass number) is
(1) a straight line (2) a parabola (3) an ellipse (4) none of them

5. 1 amu is equivalent to : **[RPMT-2000]**
(1) 931 MeV (2) 0.51eV (3) 9.31 MeV (4) 1.02 MeV

6. If mass number for an element is M and atomic number is Z, then number of neutrons will be : **[RPMT-2000]**
(1) M – Z (2) Z –M (3) M + Z (4) Z

7. Which of the following particle has similar mass to electron ? **[RPMT-2000]**
(1) Proton (2) Neutron (3) positron (4) Neutrino

8. Different atoms of same element which have different massed but have same chemical properties are called: **[RPMT-2002]**
(1) isochoric (2) isotope (3) isobar (4) isobaric

9. Mass-energy equation $E = mc^2$ was given by **[RPMT-2003]**
(1) Newton (2) Kepler (3) Einstein (4) Millikan

10. The mass numbers of nuclei A and B are respectively 135 and 5. The ratio of their radii is:**[RPMT-2011]**
(1) 1 : 3 (2) 3 : 1 (3) $\sqrt{27} : 1$ (4) $1 : \sqrt{27}$

11. If the nucleus $^{27}_{13}Al$ has a nuclear radius of about 3.6 fm, then $^{125}_{52}Te$ would have its radius approximately as : **[AIPMT-2007]**
(1) 6.0 fm (2) 9.6 fm (3) 12.0 fm (4) 4.8 fm

12. Two nuclei have their mass numbers in the ratio of 1 : 3. The ratio of their nuclear densities would be **[AIPMT-2008]**
(1) 1 : 3 (2) 3 : 1 (3) $(3)^{1/3}$: 1 (4) 1 : 1

13. A nucleus disintegrates into two nuclear parts which have their velocities in the ratio 2 : 1. The ratio of their nuclear sizes will be : **[AIEEE 2004 4/300]**

(1) $2^{1/3} : 1$ (2) $1 : 3^{1/2}$ (3) $3^{1/2} : 1$ (4) $1 : 2^{1/3}$

14. If radius of the $^{27}_{13}Al$ nucleus is estimated to be 3.6 Fermi, then the radius of $^{125}_{52}Te$ nucleus be nearly : [**AIEEE 2005 4/300]**
(1) 6 Fermi (2) 8 Fermi (3) 4 Fermi (4) 5 Fermi

15. The uncle of which one of the following pairs of nuclei are isotones :- **[AIPMT- 2005]**
(1) $_{34}Se^{74}, _{31}Ga^{71}$ (2) $_{38}Sr^{84}, _{38}Sr^{86}$ (3) $_{42}Mo^{92}, _{40}Zr^{92}$ (4) $_{20}Ca^{40}, _{16}S^{32}$

16. Range of nuclear force is approximately - **[UP CPMT-1996]**
(1) 2×10^{-10} m (2) 1.5×10^{-20} m (3) 7.2×10^{-4} m (4) 1.4×10^{-15} m

17. The order of magnitude of density of uranium nucleus is, ($m_p = 1.67 \times 10^{-27}$ kg) : **[JEE 1999, 2/200]**
(1) 10^{20} kg m^{-3} (2) 10^{17} kg m^{-3} (3) 10^{14} kg m^{-3} (4) 10^{11} kg m^{-3}

18. Which has highest penetrating power ? **[RPMT-2002]**
(1) γ-rays (2) β-rays (3) α-rays (4) Cathode rays

19. The penetrating power is minimum for **[RPMT-2003]**
(1) α – rays (2) β – rays (3) γ – rays (4) X – rays

SECTION (B) : MASS DEFECT AND BINDING ENERGY

1. Two protons are kept at a separation of 50Å. F_n is the nuclear force and F_e is the electrostatic force between them, then
(1) $F_n >> F_e$ (2) $F_n = F_e$ (3) $F_n << F_e$ (4) $F_n \approx F_e$

2. Masses of nucleus, neutron and protons are M, n_m and m_p respectively. If nucleus has been divided in to neutrons and protons, then
(1) $M = (A - Z)\, m_n + Zm_p$ (2) $M = Zm_n + (A - Z)\, m_p$
(3) $M < (A - Z)\, m_n + Zm_p$ (4) $M > (A - Z)m_n + Zm_p$

3. As the mass number A increases, the binding energy per nucleon in a nucleus
(1) increases
(2) decreases
(3) remains the same
(4) varies in a way that depends on the actual value of A.

4. Which of the following is a wrong description of binding energy of a nucleus ?
(1) It is the energy required to break a nucleus into its constituent nucleons.
(2) It is the energy released when free nucleons combine to from a nucleus
(3) It is the sum of the rest mass energies of its nucleons minus the rest mass energy of the nucleus
(4) It is the sum of the kinetic energy of all the nucleons in the nucleus

5. The energy of the reaction $Li^7 + p \longrightarrow 2\,He^4$ is (the binding energy per nucleon in Li^7 and He^4 nuclei are 5.60 and 7.06 MeV respectively.)
(1) 17.3 MeV (2) 1.73 MeV
(3) 1.46 MeV (4) depends on binding energy of proton

6. Let F_{pp}, F_{pn} and F_{nn} denote the magnitudes of the nuclear force by a proton on a proton, by a proton on a neutron and by a neutron on a neutron respectively. When the separation is 1 fm,
(1) $F_{pp} > F_{pn} = F_{nn}$ (2) $F_{pp} = F_{pn} = F_{nn}$ (3) $F_{pp} > F_{pn} > F_{nn}$ (4) $F_{pp} < F_{pn} = F_{nn}$

7. The binding energies of two nuclei P_n and Q_{2n} and x and y joules. If 2x > y then the energy released in the reaction
$P_n + P_n \rightarrow Q_{2n}$, will be
(1) 2x + y (2) 2x – y (3) –(2x – y) (4) x + y

8. $_1H^1 + {_1H^1} + {_1H^2} \rightarrow X + {_1e^0}$ + energy .The emitted particle is - **[UP CPMT-1996]**
(1) Neutron (2) Proton (3) α-particle (4) Neutrino

9. In the following equation, particle X will be **[CPET-2000]**
$_6C_{11} \rightarrow {_5B_{11}} + \beta_+ + X$
(1) neutron (2) antineutrino (3) neutrino (4) proton

10. The mass of proton is 1.0073 u and that of neutron is 1.0087 u (u = atomic mass unit). The binding energy of ^4_2He is (Given:- helium nucleus mass ≈ 4.0015 u) **[AIPMT-2003]**
(1) 0.0305 J (2) 0.0305 erg (3) 28.4 MeV (4) 0.061 U

11. The mass number of a nucleus is **[AIPMT-2003]**
(1) always less than its atomic number
(2) always more than its atomic number
(3) sometimes equal to its atomic number
(4) sometimes less than and sometimes more than its atomic number

12. For the stability of any nucleus **[RPMT-2007]**
(1) binding energy per nucleon will be more (2) binding energy per nucleon will be less
(3) number of electrons will be more (4) none of the above

13. IF Mo is the mass of an oxygen isotope $_8O_{17}$, M_p asd M_n are the masses of a proton and a neutron, respectively the nuclear binding energy of the istope is **[RPMT-2008]**
(1) $(M_0 - 8M_p) C_2$ (2) $(M_o - 8M_P - 9M_n) C_2$
(3) M_oc_2 (4) $(M_o - 17 Mn) C_2$

14. If in a nuclear fusion process the masses of the fusing nuclei be m_1 and m_2 and the mass of the resultant nucleus be m_3, then **[AIPMT-2004]**
(1) $m_3 = |m_1 - m_2|$ (2) $m_3 < (m_1 + m_2)$ (3) $m_3 > (m_1 + m_2)$ (4) $m_3 = m_1 + m_2$

15. M_p denotes the mass of a proton and M_n that of a neutron. A given nucleus, of binding energy B, contains Z protons and N neutrons. The mass M (N, Z) of the nucleus is given (c is velocity of light)
[AIPMT-2004]
(1) $M(N, Z) = NM_n + ZM_p + B/c_2$ (2) $M(N, Z) = NM_n + ZM_p - B/c_2$
(3) $M(N, Z) = NM_n + ZM_p + B/c_2$ (4) $M(N, Z) = NM_n + ZM_p - B/c_2$

16. In the reaction $^2_1H + {^3_1H} \rightarrow {^4_2HE} + {^1_0n}$. If the binding energies of ^2_1H, ^3_1H and ^4_2He are respectively a, b and c (in MEV), then the energy (in MeV eleased in this reaction is) **[AIPMT- 2005]**
(1) a + b + c (2) c + a + b (3) c – (a + b) (4) a + b + c

17. The binding energy of deuteron is 2.2 MeV and that of ^4_2He is 28 MeV. If two deuterons are fused to form one ^4_2He then the energy released is :- **[AIPMT-2006]**
(1) 25.8 MeV (2) 23.6 MeV (3) 19.2 MeV (4) 30.2 MeV

18. If the binding energy per nucleon in ${}^{7}_{3}Li$ and ${}^{4}_{2}He$ nuclei are 5.60 MeV and 7.06 MeV respectively, then in the reaction

$p + {}^{7}_{3}Li \rightarrow 2\,{}^{4}_{2}He$

energy of proton must be : **[AIEEE 2006 4.5/180]**

(1) 39.2 MeV (2) 28.24 MeV (3) 17.28 MeV (4) 1.46 MeV

19. If M_o is the mass of an oxygen isotope ${}_8O_{17}$, M_p and M_N are the masses of a proton and a neutron respectively, the nuclear binding energy of the isotope is : **(AIEEE 2007)**

(1) $(M_o - 8M_P)C_2$ (2) $(M_o - 8M_P - 9M_N)C_2$ (3) M_oC_2 (4) $(M_o - 17M_N)C_2$

20. Binding energy per nucleon is of the order of - **[RPET-2002]**

(1) 7.6 eV (2) 7.6 μeV (3) 7.6 MeV (4) 7.6 KeV

21. A free neutron decays to a proton but a free proton does not decay to a neutron. This is beacuse

(1) neutron is a composite particle made of a proton and an electron whereas proton is fundamental particle

(2) neutron is an uncharged particle whereas proton is a charged particle

(3) neutron has larger rest mass than the proton

(4) weak forces can operate in a neutron but not in a proton.

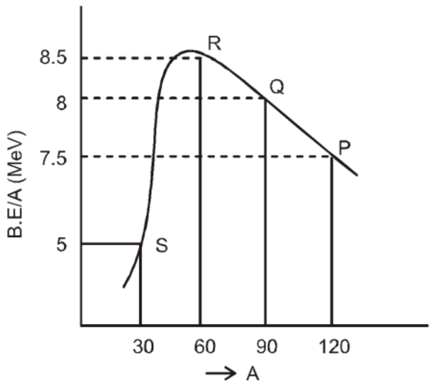
22. M_P and M_N are masses of proton and neutron, respectively, at rest. If they combine to form deuterium nucleus. The mass of the nucleus will be : **[RPMT-2006]**

(1) less than M_P (2) less than $(M_P + M_N)$

(3) less than $(M_P + 2M_N)$ (4) greater than $(M_P + 2M_N)$

23. The figure shows a plot of binding energy per nucleon (B.E/A) vs mass number (A) for nuclei. Four nuclei, P, Q, R and S are indicated on the curve. The process that would release energy is

[RPMT-2014]



(1) R → 2S (2) P → Q + S (3) P → 2R (4) Q → R + S

24. A positron of 1MeV collides with an electron of 1 MeV and gets annihilated and the reaction produces two γ-ray photons. If the effective mass of each photon is 0.0016 amu, then the energy of each γ-ray photon is about-

(1) 1.5 MeV (2) 3 MeV (3) 6 MeV (4) 2 MeV

25. Masses of two isobars ${}_{64}{}_{29}Cu$ and ${}_{64}{}_{30}Zn$ are 63.9298 u and 63.9292 u respectively. It can be concluded from these data that : **[IIT - 1997]**

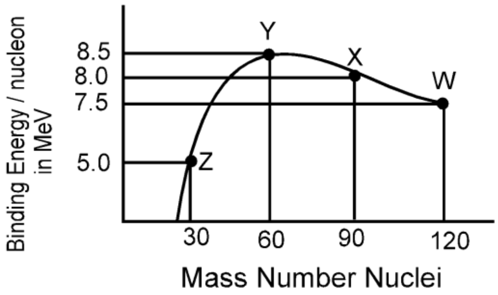
(1) Both the isobars are stable

(2) ${}_{64}Zn$ is radioactive, decaying to ${}_{64}Cu$ through β-decay

(3) ${}_{64}Cu$ is radioactive, decaying to ${}_{64}Zn$ through γ-decay

(4) ${}_{64}Cu$ is radioactive, decaying to ${}_{64}Zn$ through β-decay

26. Binding energy per nucleon vs. mass number curve for nuclei is shown in the figure. W, X, Y and Z are four nuclei indicated on the curve. The process that would release energy is : **[JEE 1999, 2/200]**



(1) Y → 2Z (2) W → X + Z (3) W → 2Y (4) X → Y + Z

SECTION (C) : RADIOACTIVE DECAY AND DISPLACEMENT LAW

1. An α-particle is bombarded on $_{14}N$. As a result, a $_{17}O$ nucleus is formed and a particle is emitted. This particle is a
(1) neutron (2) proton (3) electron (4) positron

2. A free neutron decays into a proton, an electron and :
(1) A neutrino (2) An antineutrino (3) An α-particle (4) A β-particle

3. The specific activity (per gm) of radium is nearly -
(1) 1 Bq (2) 1 Ci (3) $3.7 \times 10_{10}$ Ci (4) 1 mCi

4. When a β^--particle is emitted from a nucleus, the neutron-proton ratio :
(1) is decreased (2) is increased (3) remains the same (4) first (1) then (2)

5. In one α and 2β -emissions : **[AIPMT-1999]**
(1) mass number reduces by 2 (2) mass number reduces by 6
(3) atomic number reduces by 2 (4) atomic number remains unchanged

6. Which ray contain (+Ve) charge particle :- **[AIPMT-2001]**
(1) α-rays (2) β-rays (3) γ-rays (4) X-rays

7. Which of the following cannot be bombarded to disintegrate a nucleus - **[RPET-2002]**
(1) α-ray (2) γ-ray (3) β-ray (4) laser

8. Which of the followings is a correct statement? **[JEE 1999, 2/200]**
(1) beta rays are same as cathode rays.
(2) gamma rays are high energy neutrons.
(3) alpha particles are singly-ionized helium atoms.
(4) protons and neutrons have exactly the same mass.

9. A deutron is bombared on $_8O_{16}$ nucleus then α-particle is emitted then product nucleus is :- **[AIPMT-2002]**
(1) $_7N_{13}$ (2) $_5B_{10}$ (3) $_4Be_9$ (4) $_7N_{14}$

10. An α – particle is bombarded on N_{14} As. a result, a O_{17} -nucleus is formed and a particle X is emitted. The particle X is **[RPMT-2003]**
(1) neutron (2) proton (3) electron (4) positron

11. In the reaction $_{92}X_{234} \longrightarrow {}_{87}Y_{222}$ How many α-particles and β-particles are emitted? **[RPMT-2003]**
(1) 3 and 5 (2) 5 and 3 (3) 3 and 3 (4) 3 and 1

12. Which of the following radiations has the least wavelength? **[AIEEE 2003 4/300]**
(1) γ-rays (2) β-rays (3) α-rays (4) X-rays

13. 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 : **[AIEEE 2003 4/300]**

(1) $\frac{4u}{238}$ (2) $-\frac{4u}{234}$ (3) $\frac{4u}{234}$ (4) $-\frac{4u}{238}$

14. A nucleus with Z = 92 emits the following in a sequence : α, α, β^-, β^-, α, α, α, α; β^-, β^-, α, β^+, β^+, α. The Z of the resulting nucleus is : **(AIEEE 2003 4/300]**

(1) 76 (2) 78 (3) 82 (4) 74

15. A nuclear reaction given by $_zX^A \rightarrow {}_{z+1}Y^A + {}_{-1}e^0 + \overline{\nu}$ represents **[AIPMT-2003]**

(1) β-decay (2) γ-decay (3) fusion (4) fission

16. in radioactive decay process the negatively charged emitted β – particles are **[RPMT-2008]**

(1) the electrons present inside the nucleus
(2) the electrons produced inside as a result of the decay of nautrons inside the nucleus
(3) the electrons produced as a result of collisions between atoms
(4) the electrons orbiting around the nucleus

17. Ub the disintegration series $^{238}_{92}U \xrightarrow{\alpha} X \xrightarrow{\beta^-} Y^A_z$ the values of Z and A respectively will be **[RPMT-2009]**

(1) 92, 236 (2) 88, 230 (3) 90, 234 (4) 91, 234

18. A nucleus represented by thesymbol ^A_zX has :- **[AIPMT-2004]**

(1) Z protons and A – Z neutrons (2) Z protons and A neutrons
(3) A protons and Z – A neutrons (4) Z protons and A – Z PROTONS

19. In radioactive decay process, the negatively charged emitted β-particles are : **[AIPMT-2007]**

(1) the electrons present inside the nucleus
(2) the electrons produced as a result of the decay of neutrons inside the nucleus
(3) the electrons produced as a result of collisions between atoms
(4) the electrons orbiting around the nucleus

20. A nuclear transformation is denoted by X(n, α) → ^7_3Li. Which of the following is the nucleus of element X? **[AIEEE 2005 4/300]**

(1) $^{12}_6C$ (2) $^{10}_5B$ (3) ^9_5B (4) $^{11}_4Be$

21. When $_3Li_7$ nuclei are bombarded by protons, and the resultant nuclei are $_4Be_8$, the emitted particles will be **[AIEEE 2006 4.5/180]**

(1) neutrons (2) alpha particles (3) beta particles (4) gamma photons

22. The 'rad' is the correct unit used to report the measurement of **[AIEEE 2006 4.5/180]**

(1) the rate of decay of radioactive source
(2) the ability of a beam of gamma ray photons to produce ions in a target
(3) the energy delivered by radiation to a target.
(4) the biological effect of radiation

23. In gamma ray emission from a nucleus : **[AIEEE-2007 3/120,–1]**

(1) both the neutron number and the proton number change
(2) there is no change in the proton number and the neutron number
(3) only the neutron number changes
(4) only the proton number changes

24. Bombardment of a neutron $_0n_1 + {}_5B_{10} \rightarrow {}_2He_4$ + x on boron, forms a nucleus x with emission of α particle Nuclear x is - **[RPMT-2000]**

(1) $_6C_{12}$ (2) $_3Li_6$ (3) $_3Li_7$ (4) $_4Be_9$

25. $_{22}$Ne nucleus, after absorbing energy, decays into two α-particles and an unknown nucleus. The unknown nucleus is : **[JEE 1999, 2/200]**

(1) Nitrogen (2) Carbon&14 (3) Boron&12 (4) Oxygen

26. Consider a sample of a pure beta-active material
(1) All the beta particles emitted have the same energy
(2) The beta particles originally exist inside the nucleus and are ejected at the time of beta decay
(3) The antineutrino emitted in a beta decay has zero rest mass and hence zero momentum.
(4) The active nucleus changes to one of its isobars after the beta decay

27. X + n → α + $_3Li_7$ then X will be :- **[AIPMT-2001]**
(1) $^{10}_{5}B$ (2) $^{9}_{5}B$ (3) $^{11}_{4}B$ (4) $^{4}_{2}He$

28. M_n and M_p represent the mass of neutron and proton respectively An element having mass M has N neutron and Z-protons, then the correct relation will be :- **[AIPMT-2001]**
(1) M < {N.m_n + Z.M_p} (2) M > {N.m_n + Z.M_p} (3) M = {N.m_n + Z.M_p} (4) M = N {.m_n + M_p}

29. In the nucleus of an atom, neutrons are in excess, then emitted particles are : **[RPMT-2001]**
(1) neutron (2) electron (3) proton (4) positron

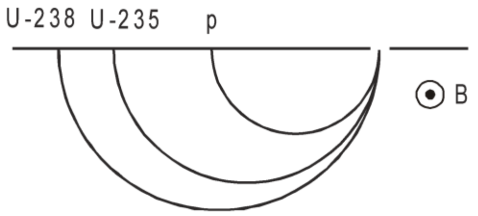
30. A nuclei X with mass number A and charge number Z, disintegrates into one α-particle and one β-particle. The resulting R has atomic mass and atomic number, equal to : **[RPMT-2005]**
(1) (A – Z) and (Z – 1) (2) (A – Z) and (Z – 2) (3) (A – 4) and (A – 2) (4) (A – 4) and (Z – 1)

31. In gamma ray emission from a nucleus **[RPMT-2008]**
(1) both the neutron number and the proton number change
(2) there is no change in the proton number and the neutron number
(3) only the neutron number changes
(4) only the proton number changes

32. Which one of the following is a possible nuclear reaction ? **[RPMT-2007]**
(1) $^{10}_{5}B + ^{4}_{2}He \longrightarrow ^{13}_{7}N + ^{1}_{1}H$ (2) $^{23}_{11}Na + ^{1}_{1}H \longrightarrow ^{20}_{10}Ne + ^{4}_{2}He$
(3) $^{239}_{93}Np \longrightarrow ^{239}_{94}pu + B_{-} + \bar{v}$ (4) $^{11}_{7}N + ^{1}_{1}H \longrightarrow ^{12}_{6}C + B_{-} + \bar{v}$

33. In an α-decay the Kinetic energy of α particle is 48 MeV and Q-value of the reaction is 50 MeV. The mass number of the mother nucleus is:- (Assume that daughter nucleus is in ground state)
(1) 96 (2) 100 (3) 104 (4) none of these

34. Protons and singly ionized atoms of U_{235} & U_{238} are passed in turn (which means one after the other and not at the same time) through a velocity selector and then enter a uniform magnetic field. The protons describe semicircles of radius 10 mm. The separation between the ions of U_{235} and U_{238} after describing semicircle is given by



(1) 60 mm (2) 30 mm (3) 2350 mm (4) 2380 mm

35. Which of the following processes represents a gamma decay?
(1) $_AX_Z + \gamma \longrightarrow _AX_{Z-1} + a + b$ (2) $_AX_Z + _1n_0 \longrightarrow _{A-3}X_{Z-2} + c$
(3) $_AX_Z \longrightarrow _AX_Z + f$ (4) $_AX_Z + e_{-1} \longrightarrow _AX_{Z-1} + g$

36. A nucleus with mass number 220 initially at rest emits an α-particle. If the Q value of the reaction is 5.5 MeV, calculate the kinetic energy of the α-particle **[JEE 2003 (Screening) 3,–1/84]**
(1) 4.4 MeV (2) 5.4 MeV (3) 5.6 MeV (4) 6.5 MeV

SECTION (D) : STATISTICAL LAW OF RADIOACTIVE DECAY

1. In one average-life
(1) half the active nuclei decay
(2) less than half the active nuclei decay
(3) more than half the active nuclei decay
(4) all the nuclei decay

2. A freshly prepared radiocative source of half-life 2 h emits radiation of intensity which is 64 times the permissible safe level. The minimum time after which it would be possible to work safely with this source is -
(1) 6 h (2) 12 h (3) 24 h (4) 128 h

3. 10 grams of $_{57}$Co kept in an open container decays β–particle with a half-life of 270 days. The weight of the material inside the container after 540 days will be very nearly -
(1) 10 g (2) 7.5 g (3) 5 g (4) 2.5 g

4. After a time equal to four half lives, the amount of radioacitve material remaining undecayed is -
(1) 6.25 % (2) 12.50 % (3) 25.0 % (4) 50.0 %

5. The decay constant of the parent nuclide in Uranium series is λ. Then the decay constant of the stable end product of the series will be -
(1) λ/238 (2) λ/206 (3) λ/208 (4) zero

6. The half life of thorium (Th_{232}) is 1.4×10^{10} years. Then the fraction of thorium atoms decaying per year is very nearly -
(1) 1×10^{-11} (2) 4.95×10^{-11} (3) 0.69×10^{-11} (4) 7.14×10^{-11}

7. The half life of ^{215}At is 100 µs. The time taken for the radioactivity of a sample of ^{215}At to decay to 1/16th of its initial value is : **[JEE 2002 (Screening) 2 × 3, –1 = 6/90]**
(1) 400 µs (2) 6.3 µs (3) 40 µs (4) 300 µs

8. Two identical samples (same material and same amount) P and Q of a radioactive substance having mean life T are observed to have activities A_P & A_Q respectively at the time of observation. If P is older than Q, then the difference in their ages is:
(1) $T\,\ell n\left(\frac{A_P}{A_Q}\right)$ (2) $T\,\ell n\left(\frac{A_Q}{A_P}\right)$ (3) $\frac{1}{T}\,\ell n\left(\frac{A_P}{A_Q}\right)$ (4) $T\left(\frac{A_P}{A_Q}\right)$

9. Two radioactive sources *A* and *B* initially contain equal number of radioactive atoms. Source *A* has a half-life of 1 hour and source *B* has a half-life of 2 hours. At the end of 2 hours, the ratio of the rate of disintegration of *A* to that of *B* is :
(1) 1 : 2 (2) 2 : 1 (3) 1 : 1 (4) 1 : 4

10. If 10% of a radioactive material decays in 5 days then the amount of original material left after 15 days is about -
(1) 65% (2) 73% (3) 70% (4) 63%

11. The half-life of radioactive Polonium (Po) is 138.6 days. For ten lakh Polonium atoms, the number of disintegrations in 24 hours is - **[REE – 1999]**
(1) 2000 (2) 3000 (3) 4000 (4) 5000

12. Half-lives of two radioacitve substances A and B are respectively 20 min and 40 min. Initially the samples of A and B have equal number of nuclei. After 80 min the ratio of remaining number of A and B nuclei is : **[AIPMT-1998]**
(1) 1 : 16 (2) 4 : 1 (3) 1 : 4 (4) 1 : 1

13. A nucleus $_nX_m$ emits one α and two β particles. The resulting nucleus is : **[AIPMT-1998]**
(1) $_nX_{m-4}$ (2) $_{n-2}y_{m-4}$ (3) $_{n-4}Z_{m-4}$ (4) none of these

14. Half life of radioactive element is 12.5 Hour and its quantity is 256 gm. After how much time its \quantity will remain 1 gm :- **[AIPMT-2001]**

(1) 50 Hrs (2) 100 Hrs (3) 150 Hrs (4) 200 Hrs

15. If half life of a substance is 38 days and its quantity is 10.38 g. Then quantity remaining left after 19 days will be : **[RPMT-2000]**
(1) 0.151g (2) 7.0 g (3) 0.51g (4) 0.16 g

16. Remaining quantity (in %) of radioactive element after 5 half lives : **[RPMT-2000]**
(1) 4.125% (2) 3.125% (3) 31.1% (4) 42.125%

17. When neutrons are bvaomardexd on $_5B_{10}$ then $+_0n_1 \longrightarrow X + _2He_4$, X is : **[RPMT-2000]**
(1) $_3Li_7$ (2) $_3Li_6$ (3) $_5Be_8$ (4) $_2Li_7$

18. A sample of radioactive element containing $4 \times 10_{16}$ active nuclei. Half life of element is 10 days, then number of decayed nuclei after 30 days:- **[AIPMT-2002]**
(1) $0.5 \times 10_{16}$ (2) $2 \times 10_{16}$ (3) $3.5 \times 10_{16}$ (4) $1 \times 10_{16}$

19. A sample of radioactive element has a mass of 10 gm at an instant t = 0. The approximate mass of this element in the sample after two mean lives is :_ **[AIPMT-2003]**
(1) 1.35 gm (2) 2.50 gm (3) 3.70 gm (4) 6.30 gm

20. The decay constant of a radioactive substance is λ. The life and mean life of substance are respectively given by **[RPMT-2003]**
(1) $\frac{1}{\lambda}$ and $\frac{\log_e 2}{\lambda}$ (2) $\frac{\log_e 2}{\lambda}$ and $\frac{1}{\lambda}$ (3) $\frac{\lambda}{\log_e 2}$ and $\frac{1}{\lambda}$ (4) $\frac{\lambda}{\log_e 2}$ and 2λ

21. The half life of a certain radioactive substance is 12 days. The time taken for $\frac{7}{8}$ th of sample to decay is **[RPMT-2003]**
(1) 36 days (2) 12 days (3) 4 days (4) 24 days

22. If N_0 is the original mass of the substance of half-life period $t_{l/2}$ = 5 years, then the amount of substance left after 15 years is : **[AIEEE 2002 4/300]**
(1) $N_0 / 8$ (2) $N_0 / 16$ (3) $N_0 / 2$ (4) $N_0 / 4$

23. Atom bomb was first made by
(1) Otto hahn (2) Fermi (3) Oppentieimer (4) Taylor

24. A radioactive element has half life of 3.6 days. In what time will it be left 1/32nd undecayed? **[RPMT-2005]**
(1) 4 days (2) 12 days (3) 18 days (4) 24 days

25. If a sample of 16 g radioactive substance disintegrate to 1g in 120 days, then what will be the half-life of the sample ? **[RPMT-2006]**
(1) 15 days (2) 7.5 days (3) 30 days (4) 60 days

26. n α-particles per second are being emitted by N atoms os a radioactive element. The half-life of element will be **[RPMT-2007]**
(1) $\left(\frac{n}{N}\right)$s (2) $\left(\frac{N}{n}\right)$s (3) $\frac{0.693N}{n}$ s (4) $\frac{0.693n}{N}$ s

27. In a sample of radioactive material, what percentage of the initial number of active nuclei will decay during one mean life ? **[RPMT-2007]**
(1) 37% (2) 50% (3) 63% (4) 69.3%

28. If the half-life of any sample of radioactive substance is 4 days, then the fraction of sample will remain undecayed after 2 days, will be **[RPMT-2007]**

(1) $\sqrt{2}$ (2) $\frac{1}{\sqrt{2}}$ (3) $\frac{\sqrt{2}-1}{\sqrt{2}}$ (4) $\frac{1}{2}$

29. A nucleus with Z = 92 emits the following in a sequence :$\alpha\ \beta^-$, β^-, $\alpha\ \alpha\ \alpha\ \alpha$; β^-, β^-, α, β^+, β^+, α : The Z of the resulting nucless is **[RPMT-2008]**
(1) 76 (2) 80 (3) 82 (4) 74

30. If a radioacitve substance decays $\frac{1}{16}$th of its original amount in 2 h, then the half-life of that substance is **[RPMT-2009]**
(1) 15 min (2) 30 min (3) 45 min (4) None of these

31. If N_0 is the original mass of the substance of half-life period $T_{1/2}$ = 5 ye, then the amount of substance left after 15 yr is **[RPMT-2009]**
(1) N_0 /8 (2) N_0/16 (3) N_0/2 (4) N_0/4

32. The half life of radium is about 1600 years. Of 100g of radium existing now, 25g will remain undocked after :- **[AIPMT-2004]**
(1) 6400 years (2) 2400 years (3) 3200 years (4) 4800 years

33. In a radioacive material the activity at time t_1 is R_1 and at a later time t_2, it is R_2. If the decay constnat of the material is λ, then **[AIPMT-2006]**
(1) $R_1 = R_2\ e^{-\lambda(t_1-t_2)}$ (2) $R_1 = R_2\ e^{\lambda(t_1-t_2)}$ (3) $R_1 = R_2\ (t_1 / t_2)$ (4) $R_1 = R_2$

34. Atom bomb was first made by
(1) Otto hahn (2) Fermi (3) Oppentieimer (4) Taylor

35. Two radioactive materials X_1 and X_2 have decay constants 5λ and λ respectively. If initially they have the same number of nuclei, than the ratio of the number of nuclei of X_1 to that of X_2 will be $\frac{1}{e}$ after a time **[AIPMT-2008]**
(1) λ (2) $\frac{1}{2}\lambda$ (3) $\frac{1}{4\lambda}$ (4) $\frac{e}{\lambda}$

36. Starting with a sample of pure $_{66}$Cu, 7/8 of it decays into Zn in 15 minutes. The corresponding half-life is: **[AIEEE 2005 4/300]**
(1) 10 minute (2) 15 minute (3) 5 minute (4) $7\frac{1}{2}$ minute

37. Activity of Po sample is 5 millicuries.Half-life of Po is 138 days, what amount of Po was initially taken. (Avogadro's no. = 6.02×10^{26} Per k mole) **[AIPMT-2006]**
(1) 3.18×10^{15} atoms (2) 3.18×10^{13} atoms (3) 3.18×10^{16} atoms (4) 3.18×10^{14} atoms

38. The half-life period of a radioactive element X is same as the mean-life time of another radioactive element Y. Initially both of them have the same number of atoms. Then **[JEE 1999, 2/200]**
(1) X and Y have the same decay rate initially (2) X and Y decay at the same rate always
(3) Y will decay at a faster rate than X (4) X will decay at a faster rate than Y

39. A radioactive element ThA ($_{84}Po_{216}$) can undergo α and β are type of disintegrations with half-lives, T_1 and T_2 respectively. Then the half-life of ThA is
(1) $T_1 + T_2$ (2) $T_1 T_2$ (3) $T_1 - T_2$ (4) $\frac{T_1T_2}{T_1+T_2}$

40. The mean lives of radioactive substance are 1620 years and 405 years for α-emission and β-emission respectively. Then the time in which three-fourth of a sample will decay is -
(1) 224 years (2) 324 years (3) 449 years (4) 810 years

41. Two radioactive materials X_1 and X_2 have decay constants 10λ and λ respectively. If initially they have the same number of nuclei, then the ratio of the number of nuclei of X_1 to that of X_2 will be 1/e after a time.
[JEE 1999, 2/200]
(1) $1/(10\lambda)$ (2) $1/(11\lambda)$ (3) $11/(10\lambda)$ (4) $1/(9\lambda)$

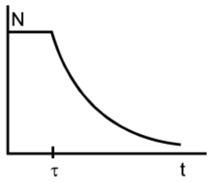
42. A sample of radioactive material has mass *m*, decay constant λ, and molecular weight *M*. Avogadro constant = N_A. The initial acitvity of the sample is :
(1) λm (2) $\frac{\lambda m}{M}$ (3) $\frac{\lambda m N_A}{M}$ (4) mN_Ae^{λ}

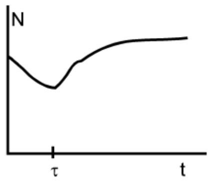
43. Activity of a radioactive element is 10^3 dis/sec. Its half life is 1 sec. After 3 sec. its activity will be :
[RPMT-2002]
(1) 1000 dis/sec (2) 250 dis/sec (3) 125 dis/sec (4) none of these

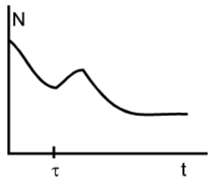
44. A 280 days old sample of a radioactive substance has activity of 6000 dps. In next 140 days activity falls to 3000 dps. Then initial activity of sample would have been **[JEE 2004 (Screening) 3, –1/84]**
(1) 9000 (2) 24000 (3) 12,000 (4) 18,000

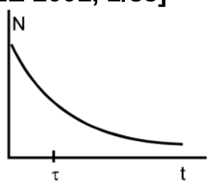
45. A radioactive sample at any instant has its disintegration rate 5000 disintegrations oer minute. After 5 min, the rate is 1250 disintegrations per min. then the decay constant (per – minute) is **[RPMT-2008]**
(1) 0.4 In 2 (2) 0.2 In2 (3) 0.1 In 2 (4) 0.8 In2

46. A radioactive sample consists of two distinct species having equal number of atoms initially. The mean life time of one species is τ and that of the other is 5τ. The decay products in both cases are stable. A plot is made of total number of radioactive nuclei as a function of time. Which of the following figures best represents the form of this plot? **[JEE 2001, 1/35]**

(1) 

(2) 

(3) 

(4) 

47. A radioactive sample S_1 having an activity of 5μCi has twice the number of nuclei as another sample S_2 which has an activity of 10μCi. The half lives of S_1 and S_2 can be **[JEE 2008, 3/163]**
(1) 20 years and 5 years, respectively (2) 20 years and 10 years, respectively
(3) 10 years each (4) 5 years each

48. Radioactivity is -
(1) irreversible process (2) spontaneous disintegration process
(3) not effected by temperature or pressure (4) process obeying all of the above

SECTION (E) : NUCLEAR FISSION AND FUSION

1. If mass of the fissionable material is less than the critical mass, then
(1) fission and chain reactions both are impossible
(2) fission is possible but chain reaction is impossible
(3) fission is impossible but chain reaction is possible
(4) fission and chain reaction both are possible.

2. Which of the following materials is used for controlling the fission
(1) heavy water (2) graphite (3) cadmium (4) Berillium oxide

3. Atomic reactor is based on
(1) controlled chain reaction (2) uncontrolled chain reaction
(3) nuclear fission (4) nuclear fusion

4. Thermal neutron means
(1) neutron being heated

(2) the energy of these neutrons is equal to the energy of neutrons in a heated atom
(3) these neutron have energy of a neutron in a nucleus has at normal temperature
(4) such neutrons gather energy released in the fission process

5. $_{92}U^{235}$ nucleus absorbs a slow neutron and undergoes fission into $_{54}X^{139}$ and $_{38}Sr^{94}$ nuclei.The other particles porduced in this fission process are
(1) 1 β and 1 α (2) 2 β and 1 neutron (3) 2 neturons (4) 3 neutrons

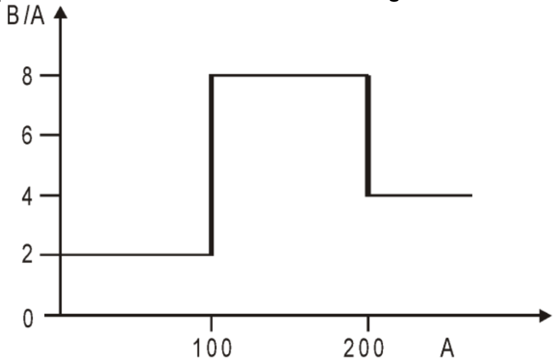
6. Two lithium $_6Li$ nuclei in a lithium vapour at room temperature do not combine to form a carbon $_{12}C$ nucleus because
(1) a lithium nucleus is more tightly bound than a carbon nucleus
(2) carbon nucleus is an unstable particle
(3) it is not energetically favourable
(4) Coulomb repulsion does not allow the nuclei to come very close

7. Choose the statement which is true.
(1) The energy released per unit mass is more in fission than in fusion
(2) The energy released per atom is more in fusion than in fission.
(3) The energy released per unit mass is more in fusion and that per atom is more in fission.
(4) Both fission and fusion produce same amount of energy per atom as well as per unit mass.

8. Fusion reaction is possible at high temperature because -
(1) atoms are ionised at high temperature
(2) molecules break-up at high temperature
(3) nuclei break-up at high temperature
(4) kinetic energy is high enough to overcome repulsion between nuclei.

9. In a uranium reactor whose thermal power is P = 100 MW, if the average number of neutrons liberated in each nuclear splitting is 2.5. Each splitting is assumed to release an energy E = 200 MeV. The number of neutrons generated per unit time is -
(1) $4 \times 10^{18}\ s^{-1}$ (2) $8 \times 10^{23}\ s^{-1}$ (3) $8 \times 10^{19}\ s^{-1}$ (4) $\frac{125}{16} \times 10^{18}\ s^{-1}$

10. Assume that the nuclear binding energy per nucleon (B/A) versus mass number (A) is as shown in the figure. Use this plot to choose the correct choice given below. **[JEE 2008, 4/163]**



(1) Fusion of two nuclei with mass numbers lying in the range of 1 < A < 50 will release energy
(2) Fusion of two nuclei with mass numbers lying in the range of 51 < A < 100 will release energy
(3) Fission of a nucleus lying in the mass range of 100 < A < 200 will release energy when broken into two equal fragments
(4) Both (1) and (2)

11. A fission reaction is given by ${}^{236}_{92}U \rightarrow {}^{140}_{54}Xe + {}^{94}_{38}Sr$ + x + y, where x and y are two particles. Considering ${}^{236}_{92}U$ to be at rest, the kinetic energies of the products are denoted by K_{Xe}, K_{Sr}, K_x (2MeV) and K_y (2MeV), respectively. Let the binding energies per nucleon of ${}^{236}_{92}U$, ${}^{140}_{54}Xe$ and ${}^{94}_{38}Sr$ be 7.5 MeV, 8.5 MeV and 8.5 MeV, respectively. Considering different conservation laws, the correct option(s) is(are)
[JEE(Advanced) 2015 ; 4/88, –2]
(1) x = n, y = n, K_{Sr} = 129 MeV, K_{Xe} = 86 MeV (2) x = p, y = e^-, K_{Sr} = 129 MeV, K_{Xe} = 86 MeV
(3) x = p, y = n, K_{Sr} = 129 MeV, K_{Xe} = 86 MeV (4) x = n, y = n, K_{Sr} = 86 MeV, K_{Xe} = 129 MeV

12. In a fission reaction
${}^{236}_{92}U \longrightarrow {}^{117}X + {}^{117}Y + n + n$
the average binding energy per nucleon of X and Y is 8.5 MeV whereas that of ${}^{236}U$ is 7.6 MeV. The total energy liberated will be about :
${}^{236}_{92}U \longrightarrow {}^{117}X + {}^{117}Y + n + n$
(1) 200 keV (2) 2 MeV (3) 200 MeV (4) 2000 MeV

13. Energy is released in nuclear fission due to **[AIPMT-2001]**
(1) Few mass is converted into energy
(2) Total binding energy of fragements is more then the B. E. of parantel element
(3) Total B.E. of fragements is less than the B.E. of parantel element
(4) Total B.E. of fragements is equals to the B.E. of parantel element is

14. Boron rods in nuclear reactor are used as a : **[RPMT-2000]**
(1) moderator (2) control rods (3) coolent (4) protective shield

15. 200 Me V energy is obtained by fission of 1 nucleii of ${}_{92}U_{235}$, to obtain 1 kW energy number of fission per second will be : **[RPMT-2001]**
(1) 3.215×10^{13} (2) 3.215×10^{14} (3) 3.215×10^{15} (4) 3.215×10^{16}

16. Best moderator for neutron is - **[RPET-2000]**
(1) berillium oxide (2) pure water (3) heavy water (4) graphite

17. Which of the following are suitable for the fusion process :- **[AIPMT-2002]**
(1) Light nuclei
(2) heavy nuclei
(3) Element must be lying in the middle of the periodic table
(4) Middle elements, which are lying on binding energy curve

18. Solar energy is mainly caused due to :- **[AIPMT-2003]**
(1) burning of hydrogen in the oxygen
(2) fusion of uranium present in the Sun
(3) fusion of protons during synthesis of heavier elements
(4) gravitational contraction

19. Which one of the following acts as a neutron absorber in a nuclear reactor ? **[RPMT-2003]**
(1) Cd-rod (2) Heavy water (D_2O) (3) Graphite (4) Distilled water (H_2O)

20. The functions of mederators in nuclear reacter is : **[RPMT-2005]**
(1) decrease the speed of neutrons (2) Increase the speed of neutrons
(3) decrease the speed of electrons (4) decrease the speed of electrons

21. A chain reaction in fission of uranium is possible, because: **[RPMT-2005]**
(1) two intermediate sized nuclear fragments are formed
(2) three neutrons are given out in each fission
(3) fragments in fission are radioactive
(4) large amont of energy is released

22. Nuclear fusion is common to the pair : **[RPMT-2006]**
(1) thermonuclear rector, uranium based nuclear reactor
(2) energy production in sun, uranium based nuclear reactor
(3) energy production of heavy nuclei hydrogen bomb
(4) disintegration of heavy nuclei hydrogen bomb

23. IN any fission process the ratio $\dfrac{\text{mass of fission products}}{\text{maas of parent nucleus}}$ is - **[AIPMT- 2005]**
(1) Greater than 1 (2) Depends on the mass of the parent nucleus
(3) Less than 1 (4) Less than 1

24. Fission of nuclei is possible because the binding energy in nucleon in them - **[AIPMT- 2005]**
(1) Decreases with mass number at low mass numbers
(2) Increases with mass number at low mass numbers
(3) Decreases with mass number at high mass numbers
(4) Increases with mass number at high mass numbers

25. In the nuclear fusion reaction, **[AIEEE 2003 4/300]**

$$^{2}_{1}H + ^{3}_{1}H \longrightarrow ^{4}_{2}He + n$$

given that the repulsive potential energy between the two nuclei is ~ 7.7×10^{-14} J, the temperature at which the gases must be heated to initiate the reaction is nearly (Boltzmann's constant k = 1.38×10^{-23} J/K):
(1) 10^{7} K (2) 10^{5} K (3) 10^{3} K (4) 10^{9} K

26. The operation of a nuclear reactor is said to be critical, if the multiplication factor (k) has a value **[RPMT-2007]**
(1) 1 (2) 1.5 (3) 2.1 (4) 2.5

27. This question contains Statement-1 and Statement-2. Of the four choices given after the statements, choose the one that best describes the two statements. **[AIEEE 2008 3/105, –1]**
Statement-1 : Energy is released when heavy nuclei undergo fission or light nuclei undergo fusion.
and
Statement-2 : For heavy nuclei, binding energy per nucleon increases with increasing Z while for light nuclei it decreases with increasing Z.
(1) Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1
(2) Statment-1 is true, Statement-2 is true; Statement-2 is not a correct explanation for Statement-1
(3) Statement-1 is true, Statement-2 is false
(4) Statement-1 is false, Statement-2 is true

Exercise-2

ONLY ONE OPTION CORRECT TYPE

1. The dynamic mass of electron having rest mass m_0 and moving with speed 0.8 c is **[RPMT-2003]**
(1) 0.6 m_0 (2) 0.8 m_0 (3) $\frac{5}{3}$ m_0 (4) 1.25 m_0

2. An alpha nucleus of energy $\frac{1}{2}$ mv^2 bombards a heavy of closet approach for the alpha nuclieus will be proportional to **[RPMT-2008]**
(1) v^2 (2) 1/M (3) $1/v^4$ (4) 1 / ze

3. An α-particle of energy 5 MeV is scattered through 180º by a fixed uranium nucleus. The distance of the closest approach is of the order of : **[AIEEE 2004 4/300]**
(1) 1 Å (2) 10^{-10} cm (3) 10^{-12} cm (4) 10^{-15} cm

4. Helium nuclei combine to form an oxygen nucleus. The energy released in the reaction is if m_O = 15.9994 amu and m_{He} = 4.0026 amu **[JEE 2005 (Screening) 3/84]**
(1) 10.24 MeV (2) 0 MeV (3) 5.24 MeV (4) 4 MeV

5. A nucleus ${}^{A}_{Z}X$ has mass represented by M(A, Z). If M_p and M_n denote the mass of proton and neutron respectively and BE the binding energy (in MeV), then : **[AIPMT-2007]**
(1) BE = $[M(A,Z) - ZM_p - (A - Z) M_n]c^2$
(2) BE = $[ZM_p + (A - Z) M_n - M (A, Z)]c^2$
(3) BE = $[ZM_p + AM_n - M (A,Z)]c^2$
(4) BE = $M (A,Z) - ZM_p - (A - Z) M_n$

6. If M (A, Z), M_p and M_n denote the masses of the nucleus ${}^{A}_{Z}X$, proton and neutron respectively in units of u (1 u = 931.5 MeV/c^2) and BE represents its binding energy in MeV, then **[AIPMT-2008]**
(1) $M (A, Z) = ZM_p + (A - Z) M_n - BE/c^2$
(2) $M (A, Z) = ZM_p + (A - Z) M_n - BE$
(3) $M (A, Z) = ZM_p + (A - Z) M_n - BE$
(4) $M (A, Z) = ZM_p + (A - Z) M_n + BE/c^2$

7. The binding energy per nucleon of deuteron $\left({}^{2}_{1}H\right)$ and helium nucleus $\left({}^{4}_{2}He\right)$ is 1.1 MeV and 7 MeV respectively. If two deuteron nuclei react to form a single helium nucleus, then the energy released is : **[AIEEE 2004 4/300]**
(1) 13.9 MeV (2) 26.9 MeV (3) 23.6 MeV (4) 19.2 MeV

8. ${}_6C^{11}$ undergoes a decay by emitted β^+ then write its complete equation. Given the mass value of $m({}_5C_{11})$ = 11.011434 u, $m({}_5B_{11})$ = 11.009305 u. **[AIPMT-2008]**
m_e = 0.000548 u and 1 u = 931.5 MeV/c^2
Calculate the Q-value of reaction.
(1) 0.962 MeV (2) 09.62 MeV (3) 096.2 MeV (4) 962.0 MeV

9. Atomic weigth of boron is 10.81 and it has two isotopes ${}_5B^{10}$ and ${}_5B^{11}$ in nature would be : **[AIPMT-1998]**

(1) 19 : 81 (2) 10 : 11 (3) 15 : 16 (4) 81 : 19

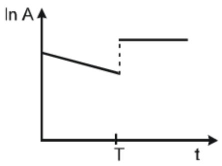
10. A nucleus of mass number 332 after many disintegrations of α and β radiations, decays into other nucleus whose mass number is 220 and atomic number is 86. The numbers of α and β radiations will be : **[RPMT-2004]**

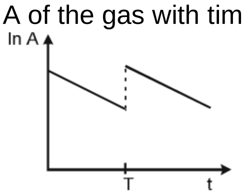
(1) 4, 0 (2) 3, 6 (3) 3, 2 (4) 2, 1

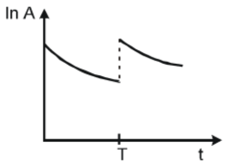
11. A radioactive sample at any instant has its disintegration rate 5000 disintegrations per minute. After 5 minutes, the rate is 1250 disintegrations per minute. Then, the decay constant (per minute) is : **[AIEEE 2003 4/300]**

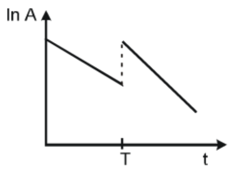
(1) 0.4 ln 2 (2) 0.2 ln 2 (3) 0.1 ln 2 (4) 0.8 ln 2

12. At time t = 0, some radioactive gas is injected into a sealed vessel. At time T, some more of the same gas is injected into the same vessel. Which one of the following graphs best represents the variation of the logarithm of the activity A of the gas with time t ?

(1) 

(2) 

(3) 

(4) 

13. N atoms of a radioactive element emit n alpha particles per second at an instant. Then the half - life of the element is

(1) $\frac{n}{N}$ sec. (2) 1.44 $\frac{n}{N}$ sec. (3) 0.69 $\frac{n}{N}$ sec. (4) 0.69 $\frac{N}{n}$ sec.

14. Two isotopes P and Q of atomic weight 10 and 20, respectively are mixed in equal amount by weight. After 20 days their weight ratio is found to be 1 : 4. Isotope P has a half-life of 10 days. The half-life of isotope Q is

(1) zero (2) 5 days (3) 20 days (4) inifinite

15. The half life of radioactive substance is 4 days. Its 100 g is kept for 16 days. After this period, the amount of substance remained is : **[RPMT-2004]**

(1) 25 g (2) 15 g (3) 10 g (4) 6.25 g

16. Two radioactive substances A and B have decay constants 5λ and λ respectively. At = 0 they have the same number of nuclei. The ratio of number of nuclei of A to those of B will be $\left(\frac{1}{e}\right)^2$ after a time interval : **[AIPMT-2007]**

(1) $\frac{1}{4\lambda}$ (2) 4λ (3) 2λ (4) $\frac{1}{2\lambda}$

17. The half-life period of a radio-active element X is same as the mean life time of another radio-active element Y. Initially they have the same number of atoms. Then : **[AIEEE 2007 3/120, –1]**

(1) X will decay faster than Y (2) Y will decay faster than X
(3) X and Y have same decay rate initially (4) X and Y decay at same rate always

18. How much uranium is required per day in a nuclear reactor of power capacity of 1 MW

(1) 15 mg (2) 1.05 gm (3) 105 gm (4) 10.5 kg

19. Complete the equation for the following fission process : **[AIPMT-1998]**

$_{92}U_{235} + {_0}n_1 \longrightarrow {_{38}}Sr_{90} + ...$

(1) $_{54}Xe_{143} + 3\ {_0}n_1$ (2) $_{54}Xe_{145}$ (3) $_{57}Xe_{142}$ (4) $_{54}Xe_{142} + {_0}n_1$

Exercise-3

PART - I : NEET / AIPMT QUESTION (PREVIOUS YEARS)

1. In the nuclear decay given below **[AIPMT-2009]**

$^{A}_{Z}X \longrightarrow {}^{A}_{Z+1}Y \longrightarrow {}^{A-4}_{Z-1}B^{\circ} \longrightarrow {}^{A-4}_{Z-1}B$,

the particles emitted in the sequence are

(1) β, α ,γ (2) γ, β ,α (3) β, γ ,α (4) α, β ,γ

2. The number of beta particles emitted by a radioactive substance is twice the number of alpha particle emitted by it. The resulting daughter is an **[AIPMT-2009]**

(1) isobar of parent (2) isomar of parent (3) isotone of parent (4) isotope of parent

3. A radioactive nucleus X converts in to stable nucleus Y. Half-life of X is 50 yr. Calculate the age of radioactive sample when the radio of X and Y is 1:15. **[AIPMT-2009]**

(1) 200 yr (2) 350 yr (3) 150 yr (4) 250 yr

4. The mass of a $^{7}_{3}Li$ nucleus is 0.042 u less than the sum of the masses of all its nucleons. The binding energy per nucleon of $^{7}_{3}Li$ nucleus is nearly **[AIPMT-2010]**

(1) 46 MeV (2) 5.6 MeV (3) 3.9 MeV (4) 23 MeV

5. The activity of a radioactive sample is measured as N_0 counts per minute at t = 0 and N_0/e counts per minute at t = 5 minutes. The time (in minutes) at which the activity reduces to half its value is **[AIPMT-2010]**

(1) $\log_e \frac{2}{5}$ (2) $\frac{5}{\log_e 2}$ (3) $5 \log_{10}2$ (4) $5 \log_e 2$

6. An alpha nucleus of energy $\frac{1}{2}mu^2$ bombards a heavy nuclear target of charge Ze. Then the distance of closest approach for the alpha nucleus will be proportional to **[AIPMT-2010]**

(1) $\frac{1}{Ze}$ (2) u_2 (3) $\frac{1}{m}$ (4) $\frac{1}{u^4}$

7. The decay constant of a radio isotope is λ. If A_1 and A_2 are its activities at times t_1 and t_2 respectively, the number of nuclei which have decayed during the time $(t_2 - t_1)$ **[AIPMT-2010]**

(1) $A_1t_1 - A_2t_2$ (2) $A_1 - A_2$ (3) $(A_1 - A_2)/\lambda$ (4) $\lambda(A_1 - A_2)$

8. The binding energy per nucleon in deuterium and helium nuclei are 1.1 MeV and 7.0 MeV, respectively. When two deuterium nuclei fuse to form a helium nucleus the energy released in the fusion is **[AIPMT-2010]**

(1) 23.6 MeV (2) 2.2 MeV (3) 28.0 MeV (4) 30.2 MeV

9. Two radioactive nuclei P and Q, in a given sample decay into a stable nucleolus R. At time t = 0, number of P species are 4 N_0 and that of Q are N_0. Half-life of P (for conversion to R) is 1 minute where as that of Q is 2 minutes. Initially there are no nuclei of R present in the sample. When number of nuclei of P and Q are equal, the number of nuclei of R present in the sample would be - **[AIPMT 2011]**

(1) $3N_0$ (2) $\frac{9N_0}{2}$ (3) $\frac{5N_0}{2}$ (4) $2N_0$

10. The half life of a radioactive isotope 'X' is 50 years. It decay to another element 'Y' which is stable. The two elements 'X' and 'Y' were found to be in the ratio of 1 : 15 in a sample of a given rock. The age of the rock was estimated to be : **[AIPMT-2011]**

(1) 150 years (2) 200 years (3) 250 years (4) 100 years

11. The power obtained in a reactor using U_{235} disintegration is 1000 kW. The mass decay of U_{235} per hour is : **[AIPMT-2011]**

(1) 10 microgram (2) 20 microgram (3) 40 microgram (4) 1 microgram

12. A radioactive nucleus of mass M emits a photon of frequency υ and the nucleus recoils. The recoil energy will be : **[AIPMT-2011]**

(1) $Mc^2 - h\upsilon$ (2) $h^2v^2 / 2Mc^2$ (3) zero (4) $h\upsilon$

13. A nucleus ${}^{m}_{n}X$ emits one α–particle and two β^- particles. The resulting nucleus is : **[AIPMT-2011]**

(1) ${}^{m-6}_{n-4}Z$ (2) ${}^{m-6}_{n}Z$ (3) ${}^{m-4}_{n}X$ (4) ${}^{m-4}_{n-2}Y$

14. Fusion reaction takes place at high temperature because : **[AIPMT-2011]**

(1) nuclei break up at high temperature
(2) atoms get ionised at high temperature
(3) kinetic energy is high enough to overcome the coulomb repulsion between nuclei
(4) molecules break up at high temperature

15. If the nuclear radius of ${}_{27}Al$ is 3.6 Fermi, the approximate nuclear radius of ${}_{64}Cu$ in Fermi is : **[AIPMT-Pre-2012]**

(1) 2.4 (2) 1.2 (3) 4.8 (4) 3.6

16. A mixture consists of two radioactive materials A_1 and A_2 with half lives of 20s and 10 s respectively. Initially the mixture has 40 g of A_1 and 160 g of A_2. The amount of the two in the mixture will become equal after : **[AIPMT-Pre-2012]**

(1) 60 s (2) 80 s (3) 20 s (4) 40 s

17. The half life of a radioactive nucleus is 50 days. The time interval $(t_2 - t_1)$ between the time t_2 when $\frac{2}{3}$ of it has decayed and the time t_1 when $\frac{1}{3}$ of it had decayed is : **[AIPMT 2012 (Mains)]**

(1) 30 days (2) 50 days (3) 60 days (4) 15 days

18. A certain mass of Hydrogen is changed to Helium by the process of fusion. The Mass defect in fusion reaction is 0.02866 u. The energy liberated per u is : (given 1u = 931 MeV) **[NEET_2013]**

(1) 26.7 MeV (2) 6.675 MeV (3) 13.35MeV (4) 2.67 MeV

19. The half life of a radioactive isotope ‘X’ is 20 years. It decays to another element ‘Y’ which is stable. The two elements ‘X’ and ‘Y’ were found to be in the ratio 1 : 7 in a sample of a given rock. The age of the rock is estimated to be : **[NEET_2013]**

(1) 60 years (2) 80 years (3) 100 years (4) 40 years

20. The Binding energy per nucleon of ${}^{7}_{3}Li$ and ${}^{4}_{2}He$ nucleon are 5.60 MeV and 7.06 MeV, respectively. In the nuclear reaction ${}^{7}_{3}Li + {}^{1}_{1}H \rightarrow {}^{4}_{2}He + {}^{4}_{2}He + Q$, the value of energy Q released is :**[AIPMT-2014]**

(1) 19.6 MeV (2) –2.4 MeV (3) 8.4 MeV (4) 17.3 MeV

21. A radio isotope 'X' with a half life 1.4×10^9 years decays to 'Y' which is stable. A sample of the rock from a cave was found to contain 'X' and 'Y' in the ratio 1 : 7. The age of the rock is :**[AIPMT -2014]**

(1) 1.96×10^9 years (2) 3.92×10^9 years (3) 4.20×10^9 years (4) 8.40×10^9 years

22. If radius of the ${}^{27}_{12}Al$ nucles is taken to be R_{Al}, then the radius of ${}^{125}_{53}Te$ nucleus is nearly:**[AIPMT-2015]**

(1) $\frac{5}{3}R_{Al}$ (2) $\frac{3}{5}R_{Al}$ (3) $\left(\frac{13}{53}\right)^{1/3} R_{Al}$ (4) $\left(\frac{53}{13}\right)^{1/3} R_{Al}$

23. The half-life of a radioactive substance is 30 minutes. The time (in minutes) taken between 40% decay and 85% decay of the same radioactive substance is : **[NEET 2016]**

(1) 60 (2) 15 (3) 30 (4) 45

24. Radioactive material 'A' has decay constant '8 λ' and material 'B' has decay constant 'λ'. Initially they have same number of nuclei. After what time, the ratio of number of nuclei of material 'B' to that 'A' will be $\frac{1}{e}$? **[NEET 2017]**

(1) $\frac{1}{\lambda}$ (2) $\frac{1}{7\lambda}$ (3) $\frac{1}{8\lambda}$ (4) $\frac{1}{9\lambda}$

25. For a radioactive material, half-life is 10 minutes. If initially there are 600 number of nuclei, the time taken (in minutes) for the disintegration of 450 nuclei is : **[NEET 2018]**

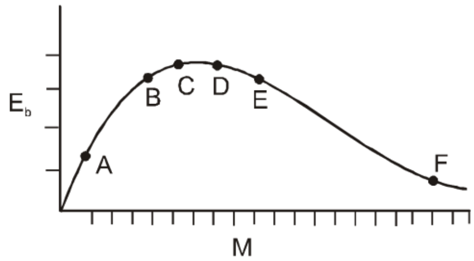
(1) 20 (2) 15 (3) 30 (4) 10

26. The rate of radioactive disintegration at an instant for a radioactive sample of half life 2.2×10^9 s is 10^{10} s^{-1}. The number of radioactive atoms in that sample at that instant is: **[NEET_2019-II]**

(1) 3.17×10^{20} (2) 3.17×10^{17} (3) 3.17×10^{18} (4) 3.17×10^{19}

PART - II : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

1. The above is a plot of binding energy per nucleon E_b, against the nuclear mass M; A, B, C, D, E, correspond to different nuclei. Consider four reactions : **[AIEEE 2009; 4/144]**



(i) A + B → C + ε (ii) C → A + B + ε (iii) D + E → F + ε and (iv) F → D + E + ε,
where ε is the energy released. In which reactions ε positive?

(1) (i) and (iii) (2) (ii) and (iv) (3) (ii) and (iii) (4) (i) and (iv)

2. The half life of a radioactive substance is 20 minutes. The approximate time interval ($t_2 - t_1$) between the time t_2 when $\frac{2}{3}$ of it has decayed and time t_1 when $\frac{1}{3}$ of it had decayed is:**[AIEEE- 2011, 4/120, –1]**

(1) 7 min (2) 14 min (3) 20 min (4) 28 min

3. **Statement - 1 :** A nucleus having energy E_1 decays by β_- emission to daughter nucleus having energy E_2, but the β_- rays are emitted with a continuous energy spectrum having end point energy $E_1 - E_2$.
Statement - 2: To conserve energy and momentum in β-decay at least three particles must take part in the transformation. **[AIEEE 2011, 11 May; 4, –1]**

(1) Statement-1 is correct but statement-2 is not correct.
(2) Statement-1 and statement-2 both are correct and stateemnt-2 is the correct explanation of statement-1.
(3) Statement-1 is correct, statement-2 is correct and statement-2 is not the correct explanation of statement-1
(4) Statement-1 is incorrect, statement-2 is correct.

4. Assume that a neutron breaks into a proton and an electron. The energy released during this process is: (mass of neutron = 1.6725×10^{-27} kg, Mass of proton = 1.6725×10^{-27} kg, mass of electron = 9×10^{-31} kg) **[AIEEE 2012 ; 4/120, –1]**

(1) 0.73 MeV (2) 7.10 MeV (3) 6.30 MeV (4) 5.4 MeV

5. Ina hydrogen like atom electron make transition from an energy level with quantum number n to another with quantum number (n–1). If n>>1, the frequency of radiation emitted is proportional to : **[JEE-Main 2013, 4/120]**

(1) $\frac{1}{n}$ (2) $\frac{1}{n^2}$ (3) $\frac{1}{n^{3/2}}$ (4) $\frac{1}{n^3}$

6. Half-lives of two radioactive elements A and B are 20 minutes and 40 minutes, respectively, initially the samples have equal number of nuclei. After 80 minutes, the ratio of decayed numbers of A and B nuclei will be : **[JEE Main 2016 ; 4/120, –1]**

(1) 4 : 1 (2) 1 : 4 (3) 5 : 4 (4) 1 : 16

7. A radioactive nucleus A with a half life T, decays into a nucleus B. At t = 0, there is no nucleus B. At sometime t, the ratio of the number of B to that of A is 0.3. Then, t is given by : **[JEE Main 2017]**

(1) $t = \frac{T}{\log(1.3)}$ (2) $t = \frac{T}{2}\frac{\log 2}{\log 1.3}$ (3) $t = T\frac{\log 1.3}{\log 2}$ (4) t = T log (1.3)

8. A sample of radioactive material A, that has an activity of 10 mCi(1 Ci = 3.7×10^{10} decays/s), has twice the number of nuclei as another sample of a different radioactive material B which has an activity of 20 mCi. The correct choices for half-lives of A and B would then be respectively : **[JEE Main 2019]**

(1) 10 days and 40 days (2) 20 days and 5 days
(3) 5 days and 10 days (4) 20 days and 10 days

9. At a given instant, say t = 0, two radioactive substances A and B have equal activities. The ratio $\frac{R_B}{R_A}$ of their activities after time t itself decays with time t as e^{-3t}. If the half-life of A is $\ell n2$, the half-life of B is : **[JEE Main 2019]**

(1) $\frac{\ell n2}{4}$ (2) $2\ell n2$ (3) $4\ell n2$ (4) $\frac{\ell n2}{2}$

10. Using a nuclear counter the count rate of emitted particles from a radioactive source is measured. At t = 0 it was 1600 counts per second and t = 8 seconds it was 100 counts per second. The count rate observed, as counts per second, at t = 6 seconds is close to : **[JEE Main 2019]**

(1) 150 (2) 400 (3) 360 (4) 2000

11. Consider the nuclear fission

$Ne^{20} \rightarrow 2He^4 + C^{12}$

Given that the bindig energy/nucleon of Ne^{20}, He^4 and C^{12} are, respectively, 8.03 MeV, 7.07 MeV and 7.86 MeV, identify the correc statement : **[JEE Main 2019]**

(1) energy of 11.9 MeV has to be supplid (2) 8.3 MeV energy will be released
(3) energy of 12.4 MeV will be supplied (4) energy of 3.6 MeV will be releaed

12. In a radioactive decay chain, the initial nucleus is $^{232}_{90}Th$. At the end there are 6 α-particles and 4 β-particles which are emitted. If the end nucleus is $^{A}_{Z}X$, A and Z are given by : **[JEE Main 2019]**

(1) A = 202 ; Z = 80 (2) A = 208 ; Z = 80 (3) A = 200 ; Z = 81 (4) A = 208 ; Z = 82

Answers

EXERCISE - 1

SECTION (A) :

1.	(4)	**2.**	(1)	**3.**	(1)	**4.**	(1)	**5.**	(1)	**6.**	(1)	**7.**	(3)
8.	(2)	**9.**	(3)	**10.**	(2)	**11.**	(1)	**12.**	(4)	**13.**	(4)	**14.**	(1)
15.	(1)	**16.**	(4)	**17.**	(2)	**18.**	(1)	**19.**	(1)				

SECTION (B) :

1.	(3)	**2.**	(3)	**3.**	(4)	**4.**	(4)	**5.**	(1)	**6.**	(2)	**7.**	(3)
8.	(3)	**9.**	(3)	**10.**	(3)	**11.**	(3)	**12.**	(1)	**13.**	(2)	**14.**	(2)
15.	(2)	**16.**	(3)	**17.**	(2)	**18.**	(3)	**19.**	(2)	**20.**	(3)	**21.**	(3)
22.	(2)	**23.**	(3)	**24.**	(1)	**25.**	(4)	**26.**	(3)				

SECTION (C) :

1.	(2)	**2.**	(2)	**3.**	(2)	**4.**	(1)	**5.**	(4)	**6.**	(1)	**7.**	(4)
8.	(1)	**9.**	(4)	**10.**	(2)	**11.**	(4)	**12.**	(1)	**13.**	(3)	**14.**	(2)
15.	(1)	**16.**	(2)	**17.**	(1)	**18.**	(1)	**19.**	(2)	**20.**	(2)	**21.**	(4)
22.	(4)	**23.**	(2)	**24.**	(3)	**25.**	(2)	**26.**	(4)	**27.**	(1)	**28.**	(1)
29.	(2)	**30.**	(4)	**31.**	(2)	**32.**	(3)	**33.**	(2)	**34.**	(1)	**35.**	(3)
36.	(2)												

SECTION (D) :

1.	(3)	**2.**	(2)	**3.**	(1)	**4.**	(1)	**5.**	(4)	**6.**	(2)	**7.**	(1)
8.	(2)	**9.**	(3)	**10.**	(2)	**11.**	(4)	**12.**	(3)	**13.**	(1)	**14.**	(2)
15.	(2)	**16.**	(2)	**17.**	(1)	**18.**	(3)	**19.**	(1)	**20.**	(2)	**21.**	(1)
22.	(1)	**23.**	(1)	**24.**	(3)	**25.**	(3)	**26.**	(3)	**27.**	(3)	**28.**	(2)
29.	(2)	**30.**	(2)	**31.**	(1)	**32.**	(3)	**33.**	(1)	**34.**	(1)	**35.**	(3)
36.	(3)	**37.**	(1)	**38.**	(3)	**39.**	(4)	**40.**	(3)	**41.**	(4)	**42.**	(3)
43.	(3)	**44.**	(2)	**45.**	(1)	**46.**	(4)	**47.**	(1)	**48.**	(4)		

SECTION (E) :

1.	(2)	**2.**	(3)	**3.**	(1)	**4.**	(3)	**5.**	(4)	**6.**	(4)	**7.**	(3)
8.	(4)	**9.**	(4)	**10.**	(3)	**11.**	(1)	**12.**	(3)	**13.**	(2)	**14.**	(2)
15.	(1)	**16.**	(3)	**17.**	(1)	**18.**	(3)	**19.**	(1)	**20.**	(1)	**21.**	(2)
22.	(3)	**23.**	(3)	**24.**	(3)	**25.**	(4)	**26.**	(1)	**27.**	(3)		

EXERCISE - 2

1.	(3)	**2.**	(2)	**3.**	(3)	**4.**	(1)	**5.**	(2)	**6.**	(1)	**7.**	(3)
8.	(1)	**9.**	(1)	**10.**	(3)	**11.**	(1)	**12.**	(2)	**13.**	(4)	**14.**	(4)
15.	(4)	**16.**	(4)	**17.**	(2)	**18.**	(2)	**19.**	(1)				

EXERCISE - 3

PART-I

1.	(1)	**2.**	(4)	**3.**	(1)	**4.**	(2)	**5.**	(4)	**6.**	(3)	**7.**	(3)
8.	(1)	**9.**	(2)	**10.**	(2)	**11.**	(3)	**12.**	(2)	**13.**	(3)	**14.**	(3)
15.	(3)	**16.**	(4)	**17.**	(2)	**18.**	(2)	**19.**	(1)	**20.**	(4)	**21.**	(3)
22.	(1)	**23.**	(1)	**24.**	(2)	**25.**	(1)	**26.**	(4)				

PART-II

1.	(4)	**2.**	(3)	**3.**	(2)	**4.**	(1)	**5.**	(4)	**6.**	(3)	**7.**	(3)
8.	(2)	**9.**	(1)	**10.**	(4)	**11.**	(1 or 3)	**12.**	(4)				