SOLVED EXAMPLES

Ex.1 In the nuclear reaction,

$_{92}U^{238} \rightarrow {}_{Z}Th^{A} + {}_{2}He^{4}$, the values of A and Z are- **[MPT-96]**

(A) A = 234, Z = 94 (B) A = 234, Z = 90
(C) A = 238, Z = 94 (D) A = 238, Z = 90

Sol.(B) A = 238 – 4 = 234, Z = 92 – 2 = 90

Ex.2 The mass of helium nucleus is less than that of its constituent particles by 0.03 a.m.u. The binding energy per nucleon of $_{2}He^{4}$ nucleus will be-

(A) 7 MeV (B) 14 MeV
(C) 3.5 MeV (D) 21 MeV

Sol.(A) $\Delta m = 0.03$ a.m.u., A = 4

$$\Rightarrow \Delta E = \frac{\Delta m \times 931}{A}$$

$$\Rightarrow \Delta E = \frac{0.03 \times 931}{4} = 7 \text{ MeV}$$

Ex.3 If the binding energy of deuterium is 2.23 MeV, then the mass defect will be- (in a.m.u.)

(A) 0.0024 (B) – 0.0024
(C) – 0.0012 (D) 0.0012

Sol.(A) $\because$ $\Delta E = \Delta m \times 931$ MeV

$$\Rightarrow \Delta m = \frac{\Delta E}{931} = \frac{2.23}{931} = 0.0024 \text{ a.m.u.}$$

Ex.4 Energy of each photon obtained in the pair production process will be, if the mass of electron or positron is 1/2000 a.m.u-

(A) 0.213 MeV (B) 0.123 MeV
(C) 0.321 MeV (D) 0.465 MeV

Sol.(D) $\because$ equivalent mass of each photon = 1/2000 amu

$\because$ 1 amu = 931 MeV

$$\therefore \text{ Energy of each photon} = \frac{931}{2000} = 0.465 \text{ MeV}$$

Ex.5 The binding energies of deutron ($_{1}H^{2}$) and α-particle ($_{2}He^{4}$) are 1.125 and 7.2 MeV/nucleon respectively. In the process $_{1}H^{2} + {}_{1}H^{2} \rightarrow {}_{2}He^{4}$, Amount of energy transferred is & which nucleus is more stable ?

(A) 2.43 MeV liberated, $_{1}H^{2}$
(B) 24.3 MeV liberated, $_{2}He^{4}$
(C) 2.43 MeV supplied, $_{1}H^{2}$
(D) 24.3 MeV supplied, $_{2}He^{4}$

Sol.(B) Binding energy of deutron

= 2 × 1.125 = 2.25 MeV

$\therefore$ Total Binding energy ($_{1}H^{2} + {}_{1}H^{2}$)

= 2.25 + 2.25 = 4.5 MeV

Binding energy of $_{2}He^{4}$ is

= 4 × 7.2 = 28.8 MeV

Thus $_{2}He^{4}$, in comparison to ($_{1}H^{2} + {}_{1}H^{2}$), has (28.8 – 4.5) = 24.3 MeV more energy. So, 24.3 MeV energy will be libereated.

Also higher the binding energy per nucleon for a nucleus, more stable is the nucleus so $_{2}He^{4}$ is more stable.

Ex.6 Deuterium is an isotope of hydrogen having a mass of 2.01470 amu. Find binding energy in MeV of this isotope -

(A) 2.741 MeV (B) 2.174 MeV
(C) 1.741 MeV (D) 0.741 MeV

Sol.(C) Deuterium, the isotope of hydrogen consits of one proton and neutron. Therefore mass of nuclear constituents of deuterium = mass of proton + mass of neutron

= 1.00759 + 1.00898 = 2.01657 amu.

mass of nucleus of deuterium = 2.01470 amu.

Mass defect = 2.01657 – 2.01470 = 0.00187 amu.

Binding energy = ΔE = 0.00187 × 931 MeV

= 1.741 MeV.

Ex.7 The binding energy per nucleon for $_{3}Li^{7}$ will be, if the mass of $_{3}Li^{7}$ is 7.0163 a.m.u.

(A) 5.6 MeV (B) 39.25 MeV
(C) 1 MeV (D) zero

Sol.(A) $E = \frac{\Delta E}{A} = \frac{\Delta m \times 931}{A}$ MeV

$\Delta m = (3m_p + 4m_n)$ – mass of Li^{7}

Δm = (3 × 1.00759 + 4 × 1.00898) – 7.01653

Δm = 0.04216 a.m.u.

$$\Delta E = \frac{0.04216 \times 931}{7} = \frac{39.25}{7} = 5.6 \text{ MeV}$$

Ex.8 The energy released per fission of uranium 235 is about 200 MeV. A reactor using U-235 as fuel is producing 1000 kilowatts power. The number of U-235 nuclei undergoing fission per sec is, approximately-

(A) 10^6 (B) 2×10^8

(C) 3×10^{16} (D) 931

Sol.(C) The energy produced per second is

$$= 1000 \times 10^3 \text{ J} = \frac{10^6}{1.6\times10^{-19}} \text{ eV} = 6.25 \times 10^{24} \text{ eV}$$

The number of fissions should be, thus:

$$\text{number} = \frac{6.25\times10^{24}}{200\times10^6} = 3.125 \times 10^{16}$$

Ex.9 Power output of $_{92}U^{235}$ reactor if it takes 30 days to use up 2kg of fuel, and if each fission gives 185 MeV of usable energy is-

(A) 5.846 KW (B) 58.46 MW

(C) .5846 KW (D) None

Sol.(B) No. of atoms in 2kg $_{92}U^{235} = \frac{2}{235} \times N_A$

$$= \frac{2}{235} \times (6.02 \times 10^{26}) = 5.12 \times 10^{24}$$

$$\text{Fission rate} = \frac{5.12\times10^{24}}{30\times24\times60\times60}$$

$= 1.975 \times 10^{18}$ per sec

Usable energy per fission = 185 MeV

∴ Power output

$= (185 \times 10^6)(1.975 \times 10^{18})(1.6 \times 10^{-19})$ watt

$= 58.4 \times 10^6$ watt = 58.46 MW

Ex.10 On disintegration of one atom of U^{235} the amount of energy obtained is 200 MeV. The power obtained in a reactor is 1000 KW. Atoms disintegrated per second in the reactor & decay in mass per hour are - **[UPB-90]**

(A) 3.125×10^{16}, 4×10^{-6} kg

(B) 3.125×10^{18}, 4×10^{-6} kg

(C) 3×10^{16}, 4×10^{-6} kg

(D) 3.125×10^{16}, 4×10^{-8} kg

Sol.(D) Power received from the reactor,

$P = 1000 \text{ KW} = 1000 \times 1000 \text{ W} = 10^6$ J/s

$$P = \frac{10^6}{1.6\times10^{-19}} \text{ eV/sec.}$$

$P = 6.25 \times 10^{18}$ MeV/sec

∴ number of atoms disintegrated per sec

$$= \frac{6.25\times10^{18}}{200} = 3.125 \times 10^{16}$$

Energy released per hour

$= 10^6 \times 60 \times 60$ Joule

Mass decay per hour $= \Delta m = \frac{\Delta E}{c^2}$

$$\Rightarrow \Delta m = \frac{10^6\times60\times60}{(3\times10^8)^2}$$

$\Rightarrow \Delta m = 4 \times 10^{-8}$ kg

Ex.11 The half life of polonium is 140 days. In what time will 15 gm of polonium be disintegrated out of its initial mass of 16 gm ?

(A) 500 days (B) 480 days

(C) 560 days (D) 280 days

Sol. Suppose the initial mass of a radio active element is N_0. The mass of the element left after n half-lives is given by $N = N_0\left(\frac{1}{2}\right)^n$

$$\therefore \frac{N}{N_0} = \left(\frac{1}{2}\right)^n$$

∵ N_0 = 16 gm. The mass of the disintegrated element is 15 gm So, the mass of the element left is N = 16 – 15 = 1 gm. Thus

$$\Rightarrow \frac{1}{16} = \left(\frac{1}{2}\right)^n \Rightarrow n = 4$$

The half life of polonium is 140 days. Hence, the time taken in the disintegration of 150 gm polonium = half-life × no. of half lives = 140 × 4 = 560 days

Ex. 12 The half life of radium is 1600 years. In how much time will its $\frac{15}{16}$ fraction disintegrate ?

(A) 6400 years (B) 3200 years

(C) 1600 years (D) 8000 years

Sol. I[st] time of Decay $t = \frac{T\log(N_0/N)}{\log 2}$

$$\Rightarrow t = \frac{1600\log\left(\frac{16}{1}\right)}{\log 2} = \frac{4\times1600\log 2}{\log 2},$$

t = 6400 years

Ex. 13 The half-life of radium is 1600 years. After how many years 25% of radium block remains undecayed ?

(A) 3200 years (B) 4800 years

(C) 7200 years (D) 9600 years

Sol. Suppose the initial quantity of radium is N_0. Then the quantity left after n half-lives will be

$$N = N_0 \left(\frac{1}{2}\right)^n$$

Here, N = 25 % of $N_0 = \frac{N_0}{4}$

$$\therefore \quad \frac{N_0}{4} = N_0 \left(\frac{1}{2}\right)^n, \ \frac{1}{4} = \left(\frac{1}{2}\right)^n$$

$$\left(\frac{1}{2}\right)^n = \left(\frac{1}{2}\right)^2 \qquad \therefore \ n = 2$$

time of disintegration = half life × number of half lives = 1600 × 2 = 32 00 years.

Ex.14 Find the half-life period of a radio-active material if its activity drops to 1/16 th of its initial value in 30 years.

(A) 15 yr. (B) 7.5 yr.

(C) 22.5 yr. (D) 120 yr.

Sol. If the initial mass of some radio-active element be N_0, then the mass of the element remaining after n half-lives is given by

$$N = N_0 \left(\frac{1}{2}\right)^n$$

$$\therefore \quad \frac{N}{N_0} = \left(\frac{1}{2}\right)^n \Rightarrow \frac{1}{16} = \left(\frac{1}{2}\right)^n$$

$$\Rightarrow \left(\frac{1}{2}\right)^n = \left(\frac{1}{2}\right)^4 \Rightarrow n = 4$$

Half life of the substance

$$= \frac{\text{time of disintegration}}{\text{number of half lives}} = \frac{30}{4} = 7.5 \text{ years.}$$

Ex.15 If a radio active material contains 0.1 mg of Th^{234}, how much of it will remain unchanged after 120 days ? Its half life is 24 days.

(A) 0.0312 gm (B) 0.0312 mg

(C) .00312 mg (D) .00312 gm

Sol. T = 24 days, t = 120 days

$$\frac{M_0}{m} = \frac{t}{2T} = 2^{120/24} = 2^5 = 32, \ N = \frac{N_0}{32},$$

$$\text{Mass left} = \frac{\text{Original mass}}{32} = \frac{0.1}{32}$$

= .003125 mg

Ex.16 The half life of a radioactive material is 12.7 hr. What fraction of the original active material would become inactive in 63.5 hr ?

(A) 1/32 (B) 1/23

(C) 31/32 (D) 23/32

Sol. t = 63.5 Hr, T = 12.7 Hr.

$$\frac{N}{N_0} = \frac{1}{2^{t/T}} = \frac{1}{2^{(63.5/12.7)}} = \frac{1}{2^5}$$

$$\Rightarrow \frac{N}{N_0} = \frac{1}{32}$$

$\therefore$ Inactive fraction

$$= 1 - \frac{N}{N_0} = 1 - \frac{1}{32} = \frac{31}{32}$$

Ex.17 The activity of a radioactive sample drops of 1/32 of its initial value in 7.5 h. Find the half life ?

(A) 7.5 Hr. (B) 5 Hr.

(C) 1.5 Hr. (D) None

Sol. Given, $\frac{R}{R_0} = \frac{1}{32}$, t = 7.5 h

$$\frac{R}{R_0} = \left(\frac{1}{2}\right)^{t/T}$$

$$\frac{1}{32} = \left(\frac{1}{2}\right)^{7.5/T} \Rightarrow \left(\frac{1}{2}\right)^5 = \left(\frac{1}{2}\right)^{7.5/T},$$

$$5 = 7.5/T \qquad \Rightarrow \quad T = \frac{7.5}{5} = 1.5 \text{ hours}$$

Ex.18 A radio active sample contains 10^6 radioactive nucleus. It's half life is 20 sec. Number of remaining nucleus after 10 seconds.

(A) 7.09 (B) 7.09×10^5

(C) 79 (D) 709

Sol. $N = 10^6 \left(\frac{1}{2}\right)^{t/T}$

$$N = 10^6 \left(\frac{1}{2}\right)^{10/20}$$

$\Rightarrow N = 10^6/\sqrt{2} = 10^6/1.41$

$\Rightarrow N = 7.9 \times 10^5$

Ex.19 The count rate of a radio active source at t = 0 was 1600 count/s and at t = 8 sec, it was 100 counts/s. The count rate (in counts) at t = 6 sec will be -

(A) 150 (B) 200

(C) 300 (D) 400

Sol. $t = \frac{T \log \frac{N_0}{N}}{\log 2} \Rightarrow 8 = \frac{T \log \frac{1600}{100}}{\log 2} = \frac{T \log 16}{\log 2}$

$$\Rightarrow 8 = \frac{T \log_2{}^4}{\log 2} \qquad \Rightarrow 8 = 4T \frac{\log 2}{\log 2}$$

$\therefore$ T = 2sec

$$N = \frac{N_0}{2^{t/T}} = \frac{1600}{2^{6/2}} \Rightarrow N = 200 \text{ counts/s}$$

Ex.20 1 milligram radium has 2.68×10^{18} atoms. Its half-life is 1620 years. How many radium atoms will disintegrate from 1 milligram of pure radium in 3240 years ?

(A) 2.01×10^{18} (B) 0.75×10^{18}
(C) cannot be predicted (D) None

Sol. If the initial quantity of a radio-active element be N_0, then the quantity left after n half-lives is given by $N = N_0 \left(\frac{1}{2}\right)^n$

The half life of radium is 1620 years. The number of half-lives in 3240 years is

$$n = \frac{3240}{1620} = 2$$

$$N = 1 \times \left(\frac{1}{2}\right)^2$$

($\therefore$ N_0 = 1mg), N = 1/4 = 0.25 m

$\therefore$ mass of disintegrated radium
= 1– 0.25 = 0.75 m

Number of atoms in it = $0.75 \times (2.86 \times 10^{18})$
$= 2.01 \times 10^{18}$

Ex.21 The mean lives of a radioactive material for α and β radiations are 1620 and 520 years respectively. The material decays simultaneously for α and β radiations. The time after which one fourth of the material remains undecayed is -

(A) 540 years (B) 324 years
(C) 720 years (D) 840 years

Sol. $$\tau = \frac{\tau_\alpha \tau_\beta}{\tau_\alpha + \tau_\beta} = \frac{1620 \times 520}{1620 + 520} = 394 \text{ years}$$

Time of decay $t = \tau\, 2.303 \log_{10} \frac{N_0}{N}$

$\Rightarrow$ $t = 394 \times 2.303 \log_{10}4$

$\Rightarrow$ $t = 394 \times 2.303 \times 0.602$

$\Rightarrow$ t = 546 years

Ex.22 When $_{90}Th^{228}$ gets converted into $_{83}Bi^{212}$, then the number of α-and β-particles emitted will respectively be -

(A) 4 α, 7 β (B) 4 α, 1 β
(C) 8 α, 7 β (D) 4 β, 4 α

Sol. $_{90}Th^{228} = {}_{83}Bi^{212} + x\,({}_2He^4) + y({}_{-1}e^0)$

According to law of conservation of charge
90 = 83 + 2x – y
2x – y = 7

According to law of conservation of mass number 228 = 212 + 4x
4x = 16, x = 4, 2 × 4 – y = 7, y = 1

Hence 4α and 1β will be emitted.

Ex.23 A radioactive Nucleus decays as follows:

$$A \xrightarrow{\alpha} A_1 \xrightarrow{\beta} A_2 \xrightarrow{\alpha} A_3 \xrightarrow{\gamma} A_4$$

If the mass number and charge number of A are 180 and 72 respectively, then for A_4 these values will respectively be -

(A) 172, 69 (B) 108, 252
(C) 108, 72 (D) None

Sol. $_{72}A^{180} = {}_2He^4 + {}_{70}A_1{}^{176}$

$_{70}A_1{}^{176} = {}_{-1}e^0 + {}_{71}A_2{}^{176}$

$_{71}A_2{}^{176} = {}_2He^4 + {}_{69}A_3{}^{172}$, $_{69}A_3^{172}$
$= \gamma + {}_{69}A_4^{172}$

Ex.24 If the activity of radioactive sample drops to 1/32 of its initial value in 7.5 Hr. Half life will be -

(A) 3 Hr (B) 4.5 Hr
(C) 7.5 Hr (D) 1.5 Hr.

Sol. $A = A_0/32$, t = 7.5 Hr, T = ?

$\because \frac{A_0}{A} = 2^{t/T}$

$\Rightarrow$ $32 = 2^{t/T}$ $\Rightarrow$ $2^5 = 2^{t/T}$ $\Rightarrow$ 5 = t/T

$\Rightarrow$ T = t/5 $\Rightarrow$ T = 7.5/5 = 1.5 Hr.

Ex.25 In 420 days, the activity of a sample of polonium, Po fell to one eighth of its initial value. Nuclear reaction is following $^a_b Po \rightarrow ^d_c \alpha + ^{206}_{82} Pb + ^e_f \gamma$ Half life of polonium & value of a, b, c, d, e, f will be-

(A) 140, 210, 84, 4, 2, 0, 0
(B) 420, 208, 83, 2, 1, 0,0
(C) 420, 210, 84, 2, 4, 0, 0
(D) 140, 210, 84, 2, 4, 0, 0

Sol. $\frac{N_0}{N} = 2^{t/T}$, $8 = 2^{t/T}$ $\Rightarrow$ $2^3 = 2^{t/T}$

$\therefore$ 3 = t/T $\Rightarrow$ T = t/3 = 420/3 = 140 days

Reaction will be,

$$^{210}_{84}Po \rightarrow {}^4_2\alpha + {}^{206}_{82}Pb + {}^0_0\gamma$$

Ex.26 A freshly prepared radioactive sample, with half-life 2 hours, emits radiations whose intensity is 64 times higher than its safe level. The minimum time after which it will be safe to work with the sample will be-

(A) 42 hr (B) 6 hr
(C) 128 hr (D) 12 hr

Sol. $$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{t/T} = \frac{1}{64} \Rightarrow \frac{1}{64} = \left(\frac{1}{2}\right)^{t/2}$$

$$\Rightarrow \left(\frac{1}{2}\right)^6 = \left(\frac{1}{2}\right)^{t/T}$$

t = 6T = 12 hr.

LEVEL # 1

Questions based on Properties of atomic nucleus

Q.1 Which of the following is not the property of atomic nucleus ?

(A) Definite charge

(B) Definite number of nucleons

(C) Characteristic atomic number

(D) Sharp boundary

Q.2 The radius of the nucleus with nucleon number 2 is 1.5×10^{-15}m, then the radius of nucleus with nucleon number 54 will be -

(A) 3×10^{-15} m (B) 4.5×10^{-15}m

(C) 6×10^{-15} m (D) 9.5×10^{-15} m

Q.3 The mass number of a nucleus is -

(A) always less than its atomic weight

(B) always greater than its atomic weight

(C) equal to its atomic weight

(D) sometimes greater than and sometimes equal to its atomic weight

Q.4 If there are N nucleons in a nucleus of radius R, then the number of nucleons in a nucleus of radius 2R will be -

(A) N (B) 2N

(C) 8N (D) $2^{1/3}$N

Q.5 The radius of $_{29}Cu^{64}$ nucleus will be -

(A) 1.2×10^{-15} m (B) -2.4×10^{-15} m

(C) 3.6×10^{-15} m (D) 4.8×10^{-15} m

Questions based on Nuclear force

Q.6 Of the three basic forces, gravitational, electrostatic and nuclear, which are able to provide an attractive force between two neutrons -

(A) electrostatic and gravitational only

(B) electrostatic and nuclear only

(C) electrostatic, nuclear and gravitational

(D) nuclear and gravitational only

Q.7 Attractive nuclear forces exist between -

(A) neutron - neutron (B) proton - proton

(C) neutron - proton (D) all of the above

Q.8 Net force that acts between proton and proton in the nucleus is -

(A) attractive (B) gravitational

(C) repulsive (D) electro-magnetic

Q.9 The correct statements about nuclear forces is

(A) these are the strongest among forces

(B) these are short range forces

(C) these are charge independent forces

(D) all of the above

Q.10 If F_{pp}, F_{pn} and F_{nn} are the magnitudes of nuclear force between proton-proton, proton-neutron and neutron-neutron respectively, then -

(A) $F_{pp} = F_{pn} = F_{nn}$ (B) $F_{pp} < F_{pn} = F_{nn}$

(C) $F_{pp} > F_{pn} > F_{nn}$ (D) $F_{pp} < F_{pn} < F_{nn}$

Q.11 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 -

(A) $F_n >> F_e$ (B) $F_n = F_e$

(C) $F_n << F_e$ (D) $F_n \approx F_e$

Questions based on Mass defect and Binding energy

Q.12 In stable nuclei neutron number N and proton number Z has the relation -

(A) N < Z (B) N = Z

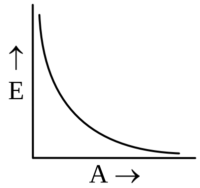
(C) N > Z (D) N ≥ Z

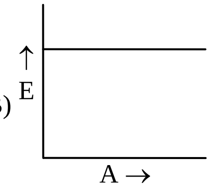
Q.13 The correct relation between the packing fraction f and mass number A is -

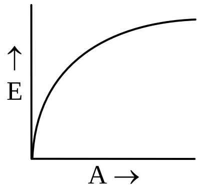
(A) $f = \frac{M - A}{A}$ (B) $f = \frac{M + A}{A}$

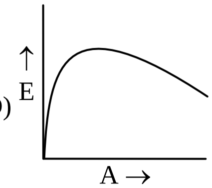
(C) $f = \frac{A}{M - A}$ (D) $f = \frac{A}{M + A}$

Q.14 The graph between the binding energy per nucleon (E) and atomic mass number (A) is as -

(A) 

(B) 

(C) 

(D) 

Q.15 The value of binding energy per nucleon is -
(A) more for light nuclei
(B) more for heavy nuclei
(C) more for medium nuclei
(D) equal for all nuclei

Q.16 The binding energy per nucleon for a radioactive element in comparison to that for a stable element is -
(A) less
(B) more
(C) having no definite relation
(D) none of the above

Q.17 Binding energies of nuclei $_1H^2$, $_2He^4$, $_{25}Fe^{56}$ and $_{92}U^{235}$ are 2.22, 28.3, 492 and 1786 respectively. Most stable nucleus is -
(A) $_{26}Fe^{56}$ (B) $_1H^2$
(C) $_{92}H^{235}$ (D) $_2He^4$

Q.18 The value of binding energy per nucleon is maximum for the elements having the mass number -
(A) more then 10 (B) between 50 to 100
(C) more than 100 (D) between 100 to 200

Q.19 Masses of nucleus, neutron an protons are M, m_n and m_p respectively. If nucleus has been divided in to neutrons and protons, then -
(A) $M = (A - Z)\ m_n + Zm_p$
(B) $M = Zm_n + (A - Z)m_p$
(C) $M < (A - Z)m_n + Zm_p$
(D) $M > (A - Z)\ + Zm_p$

Q.20 The wrong statement about binding energy is -
(A) It is the sum of the rest mass energies of nucleons minus the rest mass energy of the nucleus
(B) It is the energy released when the nucleons combine to from a nucleus
(C) It is the energy required to break a given nucleus into its constituent nucleons
(D) It is the sum of the kinetic energies of all the nucleons in the nucleus

Q.21 As the mass number A increases, which of the following quantities related to a nucleus do not change -
(A) mass (B) volume
(C) density (D) binding energy

Q.22 Mass defect of an atom refers to -
(A) packing fraction of the atom
(B) increase in mass over total mass of its constituents to bind the atoms
(C) mass annihilated to produce energy to bind the nucleons
(D) error in the measurement of atomic masses

Q.23 Most of the stable nuclides have -
(A) even number of protons and even number of neutrons
(B) odd number of proton and odd number of neutrons
(C) even number of protons and odd number of neutrons
(D) odd number of protons and even number of neutrons

Q.24 Calculate the mass defect for helium-4 nucleus, given M(He) = 4.0015084, Mp = 1.007276 u, mn = 1.008665u -
(A) 0.03074 (B) 0.030384
(C) 0.030374 (D) 0.30374

Q.25 The binding energy of a deuterium nucleus is about 1.115 MeV per nucleon. Then the mass defect of the nucleus is about -
(A) 2.23 u (B) 0.0024 u
(C) 2077 u (D) None of the above

Q.26 The energy equivalent to 1 kilogram of matter is approximately -
(A) 10^{11} joule (B) 10^{14} joule
(C) 10^{17} joule (D) 10^{20} joule

Questions based on Nuclear reaction and Atomic reactor

Q.27 In nuclear reactions -
(A) mass and momentum both are conserved
(B) only energy and momentum both are conserved
(C) charge and momentum both are conserved
(D) only energy and charge both are conserved

Q.28 When do two protons attract each other ?
(A) the distance between them is 1 Å
(B) the distance between them is 1 mm
(C) the distance between them is 10^{-15} m
(D) this will never happen

Q.29 If two nuclei of mass number A_1 and A_2 fuse together to form a nucleus of mass number A, then -
(A) $A = A_1 + A_2$ (B) $A > A_1 + A_2$
(C) $A < A_1 + A_2$ (D) $A \leq A_1 + A_2$

Q.30 If there is a mass defect of 0.1% in nuclear fission, then the energy released in the fission of 1 kg mass would be -
(A) 2.5×10^5 kWH (B) 2.5×10^7 kWH
(C) 2.5×10^9 kWH (D) 2.4×10^{-7} kWH

Q.31 Thermal neutron means :
(A) neutron being heated
(B) the energy of these neutrons is equal to the energy of neutrons in a heated atom.
(C) these neutrons have energy of neutron in a neutron gas at normal temperature
(D) such neutrons gather energy released in the fission process

Q.32 10^{14} fissions per second are taking place in a nuclear reactor having efficiency 40%. The energy released per fission is 250 MeV. The power output of the reactor is -
(A) 2000 W (B) 4000 W
(C) 1600 W (D) 3200 W

Q.33 Two lighter nuclei are fused together to form another nucleus an energy is released in the process because -
(A) binding energy of lighter nucleus is more
(B) binding energy per nucleon of lighter nucleus is more
(C) binding energy per nucleon is more for medium nucleus
(D) energy is always released when two nuclei are combined

Q.34 Atomic reactor is based on -
(A) controlled chain reaction
(B) uncontrolled chain reaction
(C) nuclear fission
(D) nuclear fusion

Q.35 If the energy required to eject an electron from an atom is E_e and the energy required to eject a nucleon from a nucleus is E_n, then -
(A) $E_n < E_e$
(B) $E_e < E_n$
(C) $E_e = E_n$
(D) nothing can be stated

Q.36 The critical mass of fissionable material is -
(A) 75 kg (B) 1 kg
(C) 20 kg (D) 10 kg

Q.37 In fission the percentage of mass converted into energy is about -
(A) 0.01% (B) 0.1%
(C) 1% (D) 10%

Q.38 The ratio of the volume of atom to volume of nucleus is -
(A) 10^5 (B) 10 (C) 10^{15} (D) 10^{10}

Q.39 Which of the following materials is used for controlling the fission -
(A) heavy water (B) graphite
(C) cadmium (D) Berilium oxide

Q.40 Which of the following is a fusion reaction ?

(A) ${}_1^2H + {}_1^2H \rightarrow {}_2^4He$

(B) ${}_0^1n + {}_7^{14}N \rightarrow {}_6^{14}C + {}_1^1H$

(C) ${}_0^1n + {}_{92}^{238}U \rightarrow {}_{93}^{239}Np + \beta^- + \gamma$

(D) ${}_1^3H \rightarrow {}_2^3He + \beta^- + \gamma$

Q.41 Which element is used for making atom bomb -

(A) Ra^{226} (B) U^{234}

(C) U^{238} (D) Pu^{239}

Q.42 For a chain nuclear fission of U^{235} the moderation of neutron is a must because very high energy neutron -

(A) will collide inelastically with the nucleus and so there is no fission

(B) will collide elastically with the nucleus and so there is no fission

(C) will be trapped in the nucleus and hence no fission

(D) replied by nucleus

Q.43 In an atomic reactor fast moving neutrons are slowed down to thermal energies by colliding them with -

(A) oxygen atoms of heavy water

(B) lead atoms

(C) paraffin-Hydrogen

(D) cadmium-atoms

Q.44 Neutron ratio (available/used) r per fission in atomic reactor an atom bomb are -

(A) r > 1 in atomic reactor and r < 1 in bomb

(B) r = 1 in atomic reactor and r > 1 in bomb

(C) r > 1 in both atomic reactor and bomb

(D) r < 1 in both atomic reactor and bomb

Questions based on **Introduction of Radioactivity**

Q.45 Radioactivity is a -

(A) nuclear process (B) atomic process

(C) chemical process (D) physical process

Q.46 The value of decay constant of last element of radioactive series is -

(A) infinite

(B) much less

(C) zero

(D) equal to the decay constant of first element

Q.47 If the pressure on a radioactive material is increased three times, then the mean life of the element -

(A) does not change

(B) will become three times

(C) will becomes $\frac{1}{3}$rd

(D) will depend on the initial pressure

Q.48 A radioactive material emits 20 β-particles per sec at 10ºC. If the temperature is increased to 20ºC then the emission rate of β-particles per sec is -

(A) 20 (B) 40

(C) 30 (D) 1

Q.49 What will be the effect of dissolving a radioactive material in HNO_3?

(A) Its radioactive properties will remain unchanged

(B) Its radioactive properties will change

(C) The state of material cannot be predicted

(D) None of these

Q.50 The particles emitted by a radioactive substance are deflected in a magnetic field. The particle may be -

(A) neutrons (B) electrons

(C) protons (D) hydrogen atoms

Q.51 What will happen when a radioactive substance with mean life 2×10^5 years is dissolved in H_2SO_4 ?

(A) it will dissociate into H^+ and SO_4 ions

(B) it will be converted into SO_4 gas

(C) it will be converted into H_2 gas

(D) it will remain unchanged

Q.52 The half life of a radioactive material is 20 days. If it is heated to 10000 K, then its half life will become -

(A) 20 × 10000 days (B) 20/10000 days

(C) 9800 days (D) 20 days

Q.53 The following is not an application of radioactive material -
(A) to locate cracks in welding or castings
(B) to find the thickness of material
(C) in cigarette factory
(D) in photography

Q.54 SI unit of radioactivity is -
(A) curie (B) rutherfored
(B) rontgen (D) bacqueral

Questions based on Ratherford equation of Radioactivity

Q.55 The graph between remaining radioactive atoms and time for a radioactive decay is -
(A) straight line (B) parabola
(C) exponential (D) ellipse

Q.56 Number of active atoms in m gram material is : (M → atomic weight)
(A) Mm × 6.02 × 10^{23}
(B) (M/m) × 6.02 × 10^{23}
(C) 6.02 × 10^{23}/Mm
(D) (m/M) × 6.02 × 10^{23}

Q.57 The activity of a radioactive element (decay constant λ) becomes $\frac{1}{3}$ of initial activity A_0 in 9 years then the decay constant after 9 years will -
(A) λ (B) λ/3 (C) λ/9 (D) 2λ/3

Q.58 A radioactive sample contains two elements P and Q. The mass of each is 10^{-3}kg. The ratio of their atomic weights is 1 : 3. Their half lives are 4s and 8s respectively. The mass of P and Q after 16s will respectively be -
(A) 1.25 × 10^{-5} kg and 2.5 × 10^{-4} kg
(B) 6.25 × 10^{-5} kg and 2.5 × 10^{-4} kg
(C) 6.25 × 10^{-5} kg and 1.25 × 10^{-4} kg
(D) 2.25 × 10^{-5} kg and 6.25 × 10^{-4} kg

Q.59 A fraction of $\frac{5}{9}$ of a radioactive substance decays in time t. What fraction of the substance would had been active after time $\frac{t}{2}$ -
(A) 1/2 (B) 2/3 (C) 3/4 (D) 4/5

Q.60 What percentage of the atoms in a sample will remain undecayed in a time equal to mean life ?
(A) 100% (B) 63%
(C) 50 % (D) 37%

Q.61 If the quantity of radioactive material reduces by 10% in 5 days, then the quantity that remains after 20 days will be -
(A) 70% (B) 75 %
(C) 65 % (D) 60%

Q.62 The half life of a radioactive substance is 23.10 minute. If 10^{23} atoms of the substance are active at any instant of time, then the activity of the substance will be - (in dps)
(A) 1 × 10^{19} (B) 3 × 10^{19}
(C) 5 × 10^{19} (D) 7 × 10^{19}

Q.63 We get N_1 and N_2 β-particles per second from two specimens of a radioactive specimen, then the ratio of number of atoms present in the samples is -
(A) N_2/N_1 (B) N_1/N_2
(C) N_1^2/N_2^2 (D) None of these

Q.64 A radio active substance has $t_{1/2}$ = 60 min. After 3 hrs, what percentage of radioactivity will remain -
(A) 50% (B) 17.5%
(C) 12.5% (D) 25%

Q.65 When 64 gms of a radioactive element are carried from Jaipur to Jodhpur in 2 hours, then 1 gm of active element remains. The half life of the element is -
(A) 2 hours (B) 30 minute
(C) 20 minute (D) 1 hour

Q.66 The number of active atoms of a radio active element decreases from 1024 to 128 in 6 hours. The half life of the element is -
(A) 6 hours (B) 4 hours
(C) 3 hours (D) 2 hours

Q.67 The weight based ratio of U^{238} and Pb^{226} in a sample of rock is 4 : 3. If the half life of U^{238} is 4.5 × 10^9 years, then the age of rock is [given : ln7/4 = 0.559, ln2 = 0.693]-
(A) 9.0 × 10^9 years (B) 6.3 × 10^9 years
(C) 4.5 × 10^9 years (D) 3.68 × 10^9 years

Q.68 The rate of decay of radioactive element at a given instant of time is 10^3 disintegration per second. If the half life of this element is 1 second, then the rate of decay after 3 second will be -
(A) 12 per sec (B) 50 per sec
(C) 500 per sec (D) 125 per sec

Q.69 A radioactive isotope X with a half-life of 1.37×10^9 years decays to Y which is stable. A sample of rock from the moon was found to contain both the elements X and Y which were in the ratio 1 : 7. The age of the rocks is -
(A) 1.96×10^8 years (B) 3.85×10^9 years
(C) 4.11×10^9 years (D) 9.59×10^9 years

Q.70 Two radioactive substance X and Y initially contain equal number of nuclei. X has a half life of 1 hours and Y has half of 2 hours. After two hours t he ratio of the activity of X to the activity of Y is -
(A) 1 : 4 (B) 1 : 2 (C) 1 : 1 (D) 2 : 1

Q.71 The radioactivity of a sample is R_1 at a time T_1 and R_2 at a time T_2 If the half-life of the specimen is T, the number of atoms that have disintegrated in the time $(T_2 - T_1)$ is proportional to -
(A) $(R_1 T_1 - R_2 T_2)$ (B) $(R_1 - R_2)$
(C) $(R_1 - R_2)$ T (D) $(R_2 - R_1) / T$

Q.72 The counting rate observed from radioactivity source at t = 0 second was 1600 counts per second and at t = 8 seconds it was 100 counts per second. The counting rate observed, as counts per second at t = 6 seconds will be -
(A) 400 (B) 300 (C) 200 (D) 150

Q.73 If N_0 is the original mass of the substance of half life period 5 years, then the amount of substance left after 15 years is -
(A) $\frac{N_0}{2}$ (B) $\frac{N_0}{3}$
(C) $\frac{N_0}{4}$ (D) $\frac{N_0}{8}$

Q.74 The fraction of a radioactive material which remains active after time t is 9/16. The fraction which remains active after time t/2 will be -
(A) 4/5 (B) 7/8 (C) 3/5 (D) 3/4

Q.75 One curie is the activity of one gram of -
(A) Uranium (B) Radium
(C) Polonium (D) Radon

Q.76 In one average - life -
(A) Half the active nuclei decay
(B) Less than half the active nuclei decay
(C) More than half the active nuclei decay
(D) All the nuclei decay

Q.77 A radioactive element, with mass 8 gm and half life 100 second, after 5 minutes will reduce to -
(A) 1.5 gram (B) 4 gram
(C) 1 gram (D) 2 gram

Q.78 A specimen of radioactive material contains 10^6 radioactive nuclei. Its half life is 20 second. How many nuclei will remain undecayed after 10 second ?
(A) 7.07 (B) 7.07×10^5
(C) 79 (D) 709

Q.79 The rate of decay of a radioactive element at any instant is 10^3 disintegrations per second. If the half life of the element is 1 second then the rate of decay after one second will be -
(A) 500 per sec (B) 1000 per sec
(C) 250 per sec (D) 2000 per sec

Questions based on
Characteristics of α, β and γ-decay

Q.80 The particles not emitted by a radioactive substance are -
(A) γ-rays (B) electrons
(C) protons (D) helium nuclei

Q.81 The α-particles will get deflected in electric and magnetic fields -
(A) towards negative plate and outside the magnetic pole
(B) towards negative plate and towards north pole
(C) towards positive plate and towards north pole
(D) towards positive plate and towards south pole

Q.82 γ-rays are produced ...... α or β-decay -
(A) after (B) before
(C) without (D) none of the above

Q.83 The β^--particle obtained by radioactive decay and the electrons obtained by thermionic emission have -
(A) different charges
(B) same velocity
(C) same penetrating power
(D) velocity much less than that of β^--particles

Q.84 The particle emitted in the nuclear reaction $_{Z}X^{A} = {}_{Z+1}Y^{A}$ + ... will be -

(A) α particle (B) β^{-} particle

(C) β^{+} particle (D) Photon

Q.85 By neutrino hypothesis which conservation law for β-decay can be explained -

(A) energy conservation

(B) angular momentum conservation

(C) both of the above

(D) momentum conservation

Q.86 Which of the following particle is emitted along with β-emission after considering the conservation laws ?

(A) electron (B) proton

(C) positron (D) neutrino

Q.87 The following conservation law/laws could be obeyed in β-decay with the help of neutrino hypothesis -

(A) energy conservation

(B) angular momentum conservation

(C) energy and linear momentum conservation

(D) energy and angular momentum conservation

Q.88 In negative β-decay -

(A) electrons are emitted by an atom

(B) electrons are emitted by a nucleus which are initially present in the nucleus

(C) electrons are emitted by a nucleus which are formed by neutron decay

(D) some part of the binding energy of the nucleus changes into electron.

Q.89 In which of the following we don't use a radioactive isotope -

(A) growth process of plants

(B) in cure of dysentery

(C) to divide chromosomes

(D) treatment by X-rays

Q.90 The half-life of radium is about 1600 years. Of 100g of radium existing now, 25 g will remain unchanged after -

(A) 6400 years (B) 2400 years

(C) 3200 years (D) 4800 years

Q.91 At sun, energy is released by -

(A) nuclear reaction

(B) thermionic emission

(C) thermo-nuclear fusion

(D) radioactive decay

Q.92 In a given magnetic field for the particles of same velocities the curvature of the paths of -

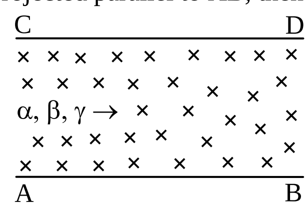
(A) β and α- particles will be same

(B) β-particles will be less than that of α- particles.

(C) β-particles will be greater than that of α-particles.

(D) β and α particles does not depend upon the magnetic field

Q.93 A magnetic field is applied normal to the plane of paper downwards in the region ABCD as shown in the figure. If now the α, β and γ rays are projected parallel to AB, then –



(A) β-particles will get deflected towards AB

(B) α-particles will get deflected towards AB

(C) γ-particles will get deflected towards AB

(D) all of the above

Q.94 A nucleus, with mass number m and atomic number n, emits one α-particle and one β-particle. The mass number and atomic number of the resulting nucleus will respectively be-

(A) (m – 2), n (B) (m – 4), (n – 1)

(C) (m – 4), (n–2) (D) (m + 4) (n –1)

Q.95 A neutron decays to -

(A) one proton, one neutron and one γ

(B) one β^{+} and one ν

(C) one p, one β^{-} and one $\bar{\nu}$

(D) one p, one β^{+} and one ν

Q.96 The nucleus $_{92}X^{234}$ decays by emitting 3α and 1β^{-} particle. Final product is -

(A) $_{87}Y^{228}$ (B) $_{84}Z^{228}$

(C) $_{87}Y^{222}$ (D) $_{84}Z^{222}$

Q.97 Which quantity is different for a neutrino and a photon -

(A) mass

(B) charge

(C) spin

(D) effect of magnetic field

Q.98 After radioactive γ-decay of an element, the change occurs -

(A) only in atomic number

(B) only in mass number

(C) in atomic number and mass number both

(D) neither in atomic number nor in mass number

Q.99 In the radioactive decay process of uranium the initial nuclide is $_{92}U^{238}$ and the final nuclide is $_{82}Pb^{206}$. When uranium nucleus decays to lead, then the number of α and β-particles emitted will respectively be -

(A) 8, 6 (B) 8, 4

(C) 6, 8 (D) 4, 8

Q.100 A radioactive material of mass 16 gm with half-life period of two years is kept in store for six years. Material that remains unchanged after six years is -

(A) 1 gm (B) 1.5 gm

(C) 2 gm (D) 2.5 gm