Exercise - I (OBJECTIVE PROBLEMS)

1. Let u be denote one atomic mass unit. One atom of an element of mass number A has mass exactly equal to Au.
(A) for any value of A
(B) only for A = 1
(C) only for A = 12
(D) for any value of A provided the atom is stable

2. The surface area of a nucleus varies with mass number A as
(A) $A^{2/3}$ (B) $A^{1/3}$
(C) A (D) None

3. Consider the nuclear reaction
$X^{200} \rightarrow A^{110} + B^{90}$
If the binding energy per nucleon for X, A and B is 7.4 MeV, 8.2 MeV and 8.2 MeV respectively, what is the energy released?
(A) 200 MeV (B) 160 MeV
(C) 110 MeV (D) 90 MeV

4. The binding energy per nucleon for C^{12} is 7.68 MeV and that for C^{13} is 7.5 MeV. The energy required to remove a neutron from C^{13} is
(A) 5.34 MeV (B) 5.5 MeV
(C) 9.5 MeV (D) 9.34 MeV

5. The binding energies of nuclei X and Y are E_1 and E_2 respectively. Two atoms of X fuse to give one atom of Y and an energy Q is released. Then
(A) $Q = 2E_1 - E_2$ (B) $Q = E_2 - 2E_1$
(C) $Q = 2E_1 + E_2$ (D) $Q = 2E_2 + E_1$

6. If each fission in a U^{235} nucleus releases 200 MeV, how many fissions must occurs per second to produce a power of 1 K W
(A) 1.325×10^{13} (B) 3.125×10^{13}
(C) 1.235×10^{13} (D) 2.135×10^{13}

7. A star initially has 10^{40} deutrons. It produces energy via, the processes ${}_1H^2 + {}_1H^2 \longrightarrow {}_1H^3 + p$ & ${}_1H^2 + {}_1H^3 \longrightarrow {}_2He^4 + n$. If the average power radiated by the star is 10^{16} W, the deuteron supply of the star is exhausted in a time of the order of :
(A) 10^6 sec (B) 10^8 sec
(C) 10^{12} sec (D) 10^{16} sec

8. The binding energies of the atom of elements A & B are E_a & E_b respectively. Three atom of the element B fuse to give one atom of element A. This fusion process is accompained by release of energy e. Then E_a, E_b are related to each other as
(A) $E_a + e = 3E_b$ (B) $E_a = 3E_b$
(C) $E_a - e = 3E_b$ (D) $E_a + 3E_b + e = 0$

9. The binding energies of the nuclei of ${}_2^4He$, ${}_3^7Li$, ${}_6^{12}C$ & ${}_7^{14}N$ are 28, 52, 90, 98 MeV respectively. Which of these is most stable.
(A) ${}_2^4He$, (B) ${}_3^7Li$, (C) ${}_6^{12}C$ (D) ${}_7^{14}N$

10. The following nuclear reaction is an example of ${}_6^{12}C + {}_2^4H \longrightarrow {}_8^{16}O + \text{energy}$
(A) fission (B) fusion
(C) alpha decay (D) beta decay

11. The rest mass of the deuteron, ${}_1^2H$, is equivalent to an energy of 1876 MeV, the rest mass of a proton is equivalent to 939 MeV and that of a neutron to 940 MeV. A deuteron may disintegrate to a proton and a neutron if it :
(A) emits a γ - ray photon of energy 2 MeV
(B) captures a γ - ray photon of energy 2 MeV
(C) emits a γ - ray photon of energy 3 Me V
(D) captures a γ-ray photon of energy 3 MeV

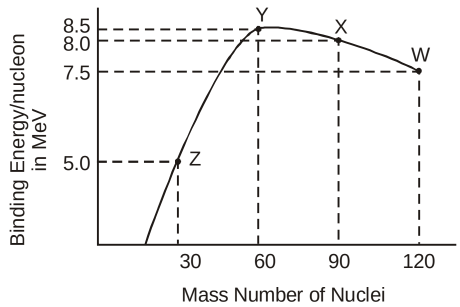
12. In an α-decay the Kinetic energy of α particle is 48 MeV and Q-value of the reaction is 50 MeV. The mass number of the mother nucleus is : (Assume that daughter nucleus is in ground state)
(A) 96 (B) 100
(C) 104 (D) none of these

13. In the uranium radioactive series the initial nucleus is ${}_{92}U^{238}$, and the final nucleus is ${}_{82}Pb^{206}$. When the uranium nucleus decays to lead, the number of α-particles emitted is.. and the number of β- particles emitted ...
(A) 6, 8 (B) 8, 6
(C) 16, 6 (D) 32, 12

14. A certain radioactive nuclide of mass number m_x disintegrates, with the emission of an electron and γ radiation only, to give second nuclied of mass number m_y. Which one of the following equation correctly relates m_x and m_y ?
(A) $m_y = m_x + 1$ (B) $m_y = m_x - 2$
(C) $m_y = m_x - 1$ (D) $m_y = m_x$

15. The number of α and β^-– emitted during the radioactive decay chain starting from ${}_{88}^{226}Ra$ and ending at ${}_{82}^{206}Pb$ us
(A) 3α & $6\beta^-$ (B) 4α & $5\beta^-$
(C) 5α & $4\beta^-$ (D) 6α & $6\beta^-$

16. 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



(A) Y $\longrightarrow$ 2Z (B) W $\longrightarrow$ X + Z
(C) W $\longrightarrow$ 2Y (D) X $\longrightarrow$ Y + Z

17. Two radioactive material A_1 and A_2 have decay constants of 10 λ_0 and λ_0. If initially they have same number of nuclei, the ratio of number of their undecayed nuclei will be (1/e) after a time

(A) $\frac{1}{\lambda_0}$ (B) $\frac{1}{9\lambda_0}$ (C) $\frac{1}{10\lambda_0}$ (D) 1

18. The radioactive sources A and B of half lives of 2 hr and 4 hr respectively, initially contain the same number of radioactive atoms. At the end of 2 hours, their rates of disintegration are in the ratio :

(A) 4 : 1 (B) 2 : 1 (C) $\sqrt{2}:1$ (D) 1 : 1

19. In a RA element the fraction of initiated amount remaining after its mean life time is :

(A) $1 - \frac{1}{e}$ (B) $\frac{1}{e^2}$ (C) $\frac{1}{e}$ (D) $1 - \frac{1}{e^2}$

20. 90% of a radioactive sample is left undecayed after time t has elapsed. What percentage of the initialsample will decay in a total time 2t :
(A) 20% (B) 19% (C) 40% (D) 38 %

21. A radioactive meterial of half-life T was produced in a nuclear reactor at different instants, the quantity produced second time was twice of that produced first time. If now their present activities are A_1 and A_2 respectively then their age difference equals :

(A) $\frac{T}{\ln 2}\left|\ln\frac{A_1}{A_2}\right|$ (B) $T\left|\ln\frac{A_1}{A_2}\right|$

(C) $\frac{T}{\ln 2}\left|\ln\frac{A_2}{2A_1}\right|$ (D) $T\left|\ln\frac{A_2}{2A_1}\right|$

22. Activity of a radioactive substance is R_1 at time t_1 and R_2 at time $t_2 (t_2 > t_1)$. Then the ratio $\frac{R_2}{R_1}$ is :

(A) $\frac{t_2}{t_1}$ (B) $e^{-\lambda(t_1+t_2)}$

(C) $e\left(\frac{t_1-t_2}{\lambda}\right)$ (D) $e^{\lambda(t_1-t_2)}$

23. There are two radionuclei A and B. A is an alpha emitter and B is a beta emitter. Their distintegration constants are in the ratio of 1 : 2. What should be the ratio of number of atoms of two at time t = 0 so that probabilities of getting α and β particles are same at time t = 0
(A) 2 : 1 (B) 1 : 2 (C) e (D) e^{-1}

24. The activity of a sample reduces from A_0 to $A_0 / \sqrt{3}$ in one hour. The activity after 3 hours more will be

(A) $\frac{A_0}{3\sqrt{3}}$ (B) $\frac{A_0}{9}$ (C) $\frac{A_0}{9\sqrt{3}}$ (D) $\frac{A_0}{27}$

25. Half life of radium is 1620 years. How many radium nuclei decay in 5 hours in 5 gm radium ? (Atomic weight of radium = 223)
(A) 9.1×10^{12} (B) 3.23×10^{15}
(C) 1.72×10^{20} (D) 3.3×10^{17}

26. The activity of a sample of radioactive material is A_1 at time t_1 and A_2 at time t_2 $(t_2 > t_1)$. Its mean life is T.

(A) $A_1t_1 = A_2t_2$ (B) $\frac{A_1 - A_2}{t_2 - t_1}$ = constant

(C) $A_2 = A_1e^{(t_1-t_2)/T}$ (D) $A_2 = A_1e^{(t_1/Tt_2)}$

27. A fraction f_1 of a radioactive sample decays in one mean life, and a fraction f_2 decays in one half-life.
(A) $f_1 > f_2$ (B) $f_1 < f_2$ (C) $f_1 = f_2$
(D) May be (A), (B) or (C) depending on the values of the mean life and half life.

28. A radioactive substance is being produced at a constant rate of 10 nucle is. The decay constant of the substance is 1/2 sec^{-1}. After what time the number of radioactive nuclei will become 10? Initially there are no nuclei present. Assume decay law holds for the sample.
(A) 2.45 sec (B) log (2) sec

(C) 1.386 sec (D) $\frac{l}{ln(2)}$ sec

29. The radioactivity of a sample is R_1 at time T_1 and R_2 at time T_2. If the half life of the specimen is T. Number of atoms that have disintegrated in time $(T_2 - T_1)$ is proportional to
(A) $(R_1T_1 - R_2T_2)$ (B) $(R_1 - R_2)$ T
(C) $(R_1 - R_2)$/T (D) $(R_1 - R_2)(T_1 - T_2)$

30. The decay constant of the end product of a radioactive series is
(A) zero (B) infinite
(C) finite (non zero)

(D) depends on the end product.

31. At time t = 0, N_1 nuclei of decay constant λ_1 & N_2 nuclei of decay constant λ_2 are mixed. The decay rate of the mixture is :

(A) $N_1N_2e^{-(\lambda_1+\lambda_2)t}$ (B) $+\left(\frac{N_1}{N_2}\right)e^{-(\lambda_1-\lambda_2)t}$

(C) $+(N_1\lambda_1e^{-\lambda_1 t}+N_2\lambda_2e^{-\lambda_2 t})$ (D) $+N_1\lambda_1N_2\lambda_2e^{-(\lambda_1+\lambda_2)t}$

32. The half-life of ^{131}I is 8 days. Given a sample of ^{131}I at time t = 0, we can assert that :
(A) no nucleus will decays before t = 4 days
(B) no nucleus will decays before t = 8 days
(C) all nuclei will decays before t = 16 days
(D) a given nucleus may decay at any time after t = 0.

33. There are two radionuclie A and B. A is an alpha emitter and B is a beta emitter. Their distintegration constants are in the ratio of 1 : 2. What should be the ratio of number of atoms of two at time t = 0 so that probabilities of getting α and β particles are same at time t = 0.
(A) 2 : 1 (B) 1 : 2 (C) e (D) e^{-1}

34. A particular nucleus in a large population of identical radioactive nuclei did survive 5 half lives of that isotope. Then the probability that this surviving nucleus will survive the next half life :

(A) $\frac{1}{32}$ (B) $\frac{1}{5}$ (C) $\frac{1}{2}$

(D) $\frac{1}{10}$ (E) $\frac{5}{2}$

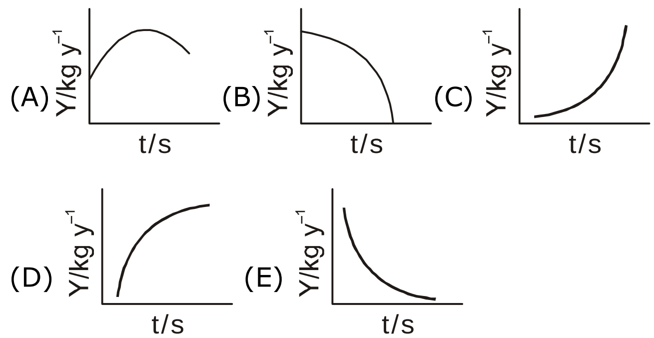
35. A certain radio active substance has a half life of 5 years. Thus for a particular necleus in a sample of the element, the probability of decay in ten years is
(A) 50% (B) 75% (C) 100% (D) 60%

36. The half-life of substance X is 45 years, and it decomposes to substance Y. A sample from a meteorite was taken which contained 2% of X and 14% Y by quantity of substance. If substance Y is not normally found on a meteorite, what is the approximate age of the meteorite?
(A) 270 years (B) 135 years
(C) 90 years (D) 45 years

37. A radioactive nuclide can decay simultaneously by two different processes which have decay constants λ_1 and λ_2. The effective decay constant of the nuclide is λ, then :
(A) $\lambda = \lambda_1 + \lambda_2$ (B) $\lambda = 1/2(\lambda_1 + \lambda_1)$

(C) $\frac{1}{\lambda}=\frac{1}{\lambda_1}+\frac{1}{\lambda_2}$ (D) $\lambda=\sqrt{\lambda_1\lambda_2}$

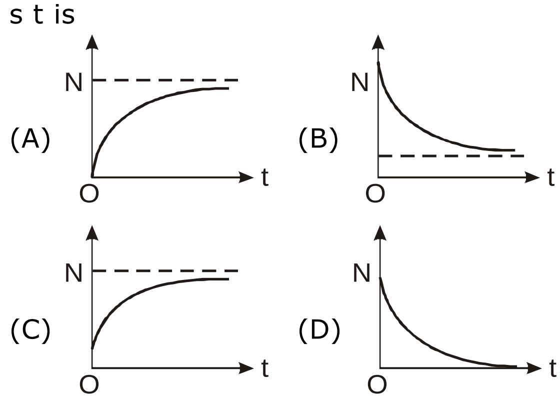
38. The radioactive nucleus of an element X decays to a stable nucleus of element Y. a graph of the rate of formation of Y against time would look like



39. A radioactive substance is dissolved in a liquid and the solution is heated. The activity of the solution
(A) is smaller than that of element
(B) is greater than that of element
(C) is equal to that of element
(D) will be smaller or greater depending upon whether the solution is weak or concentrated

40. In a certain nuclear reactor, a radioactive nucleus is being produced at a constant rate = 1000/s. The mean life of the radionuclide is 40 minutes. A steady state, the number of radionuclide will be
(A) 4×10^4 (B) 24×10^4
(C) 24×10^5 (D) 24×10^6

41. In the above question, if there were 20×10^5 radionuclide at t = 0, then the graph of N v/s t is



42. The half life of a neutron is 800 sec. 10^8 neutrons at a certain instant are projected from one space station towards another space station, situated 3200 km away, with a velocity 2000 m/s. Their velocity remains constant during the journey. How many neutrons reach the other station?
(A) 50×10^6 (B) 25×10^6
(C) 80×10^5 (D) 25×10^5

43. A radioactive source in the form of a metal sphere of diameter 3.2×10^{-3} m emits β-particle at a constant rate of 6.25×10^{10} particle/sec. The source is electrically insulated and all the β-

particle are emitted from the surface. The potential of the sphere will riese to 1 V in time

(A) 180 μ sec (B) 90 μ sec
(C) 18 μ sec (D) 9 μ sec

44. An energy of 24.6 eV is required to remove one of the electrons from a neutral helium atom. The energy (In eV) required to remove both the electrons from a neutral helium atom is :

(A) 38.2 (B) 49.2
(C) 51.8 (D) 79.0

REASONING TYPE

45. Statement-1: It is easy to remove a proton from $^{40}_{20}Ca$ nucleus as compared to a neutron.

Statement-2: Inside nucleus neutrons are acted on only attractive forces but protons are also acted on by repulsive forces.

(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.
(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.
(C) Statement-1 is true, statement-2 is false.
(D) Statement-1 is false, statement-2 is true.

46. Statement-1: It is possible for a thermal neutron to be absorbed by a nucleus whereas a proton or an α-particle would need a much larger amount of energy for being absorbed by the same nucleus.

Statement-2: Neutron is electrically neutral but proton and α-particle are positively charged.

(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.
(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.
(C) Statement-1 is true, statement-2 is false.
(D) Statement-1 is false, statement-2 is true.

47. Statement-1: Consider the following nuclear reaction of an unstable $^{14}_{6}C$ nucleus initially at rest. The decay $^{14}_{6}C \longrightarrow ^{14}_{7}N + ^{0}_{-1}e + \bar{\nu}$. In a nuclear reaction total energy and momentum is conserved experiments show that the electrons are emitted with a continuous range of kinetic energies upto some maximum value.

Statement-2: Remaining energy is released as thermal energy.

(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.
(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.
(C) Statement-1 is true, statement-2 is false.
(D) Statement-1 is false, statement-2 is true.

48. Half life for certain radioactive element is 5 min. Four nuclei of that element are observed at a certain instant of time. After five minutes

Assertion (A) : It can be definitely said that two nuclei will be left undecayed.

Reasoning (R) : After half life i.e. 5 minutes, half of total nuclei will disintegrate. So only two nuclei will be left undecayed. Then

(A) A is correct & R is correct explanation of A.
(B) Both are correct. But R is not correct explanation of A.
(C) A is incorrect & R is correct.
(D) Both are incorrect.