PHYSICS

BOOKS - CP SINGH PHYSICS (HINGLISH)

NUCLEAR PHYSICS AND RADIO ACTIVITY

Example

1. Thorium $._{90}^{298}Bi$ The produces a daughter nucleus that is radioactive. The augther in turn, produces it own radioactive daugher and so on. This process continues until bismuth $._{83}^{212}Bi$ is reaches. What are the total number N_{α} of α-particle and the total number N_{β} of β^{-}-paricles that are generated in this series or radioactive decays?

2. A radioactive nucleus undergoes a series of deacy according to the scheme.

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

If the mass number and atomic number of A are 180 and 172 respectively, what are these numbers for A_4.

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3. At a given instant there are 25% undecayed ratio-activity nuclei in sample. After 10 second, the number of undecyed nuclei reduces to 12.5%. Calculate

(a) mean-life of the nuclei and

(a) the time in which the number undecayed nuclei will further reduce to 6.25% of the reduced number.

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4. If λ is the decay constant of a nucleus, find the propability that a nucleus wil decay in time t and will not decay in time t.

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5. (a) Calculate the activity of one mg sample $._{28^{Sr^{90}}}$ whose half life period is 28 years.

(b) An experiment is performed to determine the half-life of a radioactive substance which emits one beta particle for each decay process. Observation shown that an average of $8.4\beta -$ particles are emitted each second by $2.5mg$ of the substance. the atomic weight of the substance is 230. calculate the half0life of the substance.

(c) Determine the quantity of $._{84^{Po^{210}}}$ necessary to provide a source of alpha particle of $5mCi$ strength ($T_{1/2}$ for Po $= 138$ day).

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6. (a) A radioactive sample has 6.0×10^{18} active nuclei at a certain instant. How many of these nuclei will still be the same active state after two half-lives?

(b) Radioactive phosphours-32 has a half-life of 14 days. A source containing this isotope has an initial activity of $10 \mu Ci$.

(i) What is the activity of the source after 42 days?

(ii) What time elapse before the activity of the source falls at $2.5 \mu Ci$?

(c) $1g$ of a radioactive substance disintergrates at the rate of $3.7 \times 10^{10} dps$. The atomis mass of the substance is 226. Calculate its mean life.

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7. A $.^{7} Li$ target is bombarded with a proton beam current of 10^{-4} A for 1 hour to produce $.^{7} Be$ of activity 1.8×10^{8} disintegrations per second. Assuming that $.^{7} Be$ radioactive nucleus is produced by bombarding 1000 protons, determine its half-life.

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8. In the chemical analysis of a rock the mass ratio of two radioactive isotopes is found to be $100:1$. The mean lives of the two isotopes are 4×10^9 years and 2×10^9 years, respectively. If it is assumed that at the time of formation the atoms of both the isotopes were in equal propotional, calculate the age of the rock. Ratio of the atomic weights of the two isotopes is $1.02:1$.

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9. In an experiment on two radioactive isotopes of an element (which do not decay into each other), their number of atoms ratio at a given instant was found to be 3. The rapidly decaying isotope has large mass and an activity of $1.0 \mu Ci$ initially. The half-lives of the two isotopes are known to be 12 hours and 16 hours. what would be the activity of each isotope and their number of atoms ration after two days?

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10. The nuclei of two radioactive isotopes of same substance A^{236} and A^{234} are present in the ratio of $4:1$ in an ore obtained from some other planet. Their half lives are 30 min and 60 min respectively. Both isotopes are alpha emitters and the activity of the isotope with half-life 30 min is $10^6 dps$. Calculate after how much time their activites will become identical. Also calculate the time required to bring the ratio of their atoms to $1:1$.

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11. A small quantity of solution containing Na^{24} radio nuclide $(half - l \text{ if } e = 15h)$ of activity $1.0 microcurie$ is injected into the blood of a person. A sample of the blood of volume $1 cm^3$ taken after $5h$ shows an activity of 296 disintegrations per minute. Determine the total volume of the blood in the body of the person. Assume that the radioactive solution mixes uniformly in the blood of person.

(1 curie $= 3.7 \times 10^{10}$ disintegrations per second)

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12. A radioactive element decays by $\beta -$ emission. A detector racords n-beta particles in 2 sec and in next 2 sec it records $0.65n$-beta particles. Find mean life.

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13. Determine the average $.^{14}C$ activity in decays per minute per gram of natural carbon found in living organisms if the concentration of $.^{14}C$ relative to that of $.^{12}C$ is 1.4×10^{-12} and half life of $.^{14}C$ is $T_{1/2} = 5730$ years.

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14. There is a stream of neutrons with kinetic energy of 0.0327 eV. If half life of neutrons is 700s, what fraction of neutrons will decay before they travel a distance of 10m? Take mass of neutron $=1.675 \times 10^{-27} kg$.

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15. The mean lives of a radioactive substance are 1620 years and 405 years for α emission and β emission respectively. Find out the time during which three fourth of a sample will decay if it is decaying both by α-emission and β-emission simultaneously. $(\log_e 4 = 1.386)$.

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16. A charged capacitor of capacitance C is discharged through a resistance R. A radioactive sample decays with an average-life τ.Find the value of R for which the ratio of the electrostatic field energy stored in the capacitor to the activity of the radioactive sample remains constant in time.

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17. A radioactive source, in the form of a metallic sphere of radius $10^{-2}m$ emits $\beta-$ particles at the rate of 5×10^{10} particles per second. The source is electrically insulated. How long will it take for its potential to be raised by $2V$, assuming that 40% of the emitted $\beta-$ particles escape the source.

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18. U^{238} is found to be in secular equilibrium with Ra^{226} in its ore. If chemical analysis shown 1 atoms of Ra^{226} per 2.8×10^{6} atoms of U^{238}, find the half-like of U^{228}. Given the half life Ra^{226} is 1620 years.

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19. Find the half-life of uranium, given that $3.32\times10^{7}g$ radium is found per gram of uranium in old minerals. The atomic weights of uranium and radium are 238 and 226 and half-life of radium is 1600 years (Avogadro number is $6.023\times10^{23}/g-\text{atom}$).

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20. In an ore containing Uranium, the ratio of U^{238} to Pb^{206} nuceli is 3. Calculate the age of the ore, assuming that alll the lead present in the ore is the final stable, product of U^{238}. Take the half-like of U^{238} to be 4.5×10^{9} years. In $(4/3) = 0.288$.

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21. A radio nuclide X is produced at constant rate α. At time $t = 0$, number of nuclei of X are zero. Find

(a) the maximum number of nuclei of X.

(b) the number of nuclei at time t.

Decay constant of X is λ.

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22. Nuclei of radioactive element A are being produced at a constant rate. α. The element has a decay constant λ. At time $t = 0$, there are N_0 nuclei of the element.

(a) Calculate the number N of nuclei of A at time t.

(b) IF $\alpha = 2N_0\lambda$, calculate the number of nuclei of A after one half-life time of A and also the limiting value of N at $t \to \infty$.

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23. Find the binding energy of an α-particle from the following data.

Mass of helium nulceus $= 4.001235amu$

Mass of proton $= 1.007277amu$

Mass of neutron $= 1.00866amu$

(take 1 amu=$931.4813MeV$).

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24. Calculate the energy required to remove the least tightly neutron form $.^{20}\left(Ca^{40}\right)$. Given that

Mass of $.^{20}\left(Ca^{40}\right) = 39.962589 a\mu$

Mass of $.^{20}\left(Ca^{39}\right) = 38.970691 a\mu$

Mass of neutron $= 1.008665 a\mu$

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25. A neutron breaks into a proton and electorn. Calculate the eenrgy produced in this reaction in

$m_e = 9 \times 10^{-31} kg, m_p = 1.6725 \times 10^{-27} kg, m_n = 1.6747 \times 10^{-27} kg, c =$

.

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26. The binding energy per nucleon number for deutron $H_1^2$and helium He_2^4 are $1.1 MeV$ and $7.0 MeV$ respectively . The energy released when two deuterons fase to form a belium nucleus He_2^4 is ....

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27. The nucleus $._{92}U^{238}$ is unstable angainst alpha decay with half-life of 4.5×10^9 years. Estimate the kinetic energy of the emitted α-particle.

Mass of the $._{92}U^{238}$ atom $= 238.05081u$

Mass of the $._{2}He^{4}$ atom $= 4.00260u$

Mass of the $._{90}Th^{234}$ atom $= 234.04363u$

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28. Find the amount of energy released when 1 atom of Uranium $._{92}U^{235}(235.0439\text{amu})$ undergoes fission by slow neturon (1.0087amu) and is splitted into Krypton $._{36}Kr^{92}(91.8973\text{amu})$ and Barium $._{56}Br^{141}(140.9139\text{amu})$ assuming no energy is lost. Hence find the enrgy in kWh, when $1g$ of it undergoes fission.

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29. Find the minimum kinetic energy of an α-particle to cause the reaction $.^{14}N(\alpha, p).^{17}O$. The masses of $.^{14}N, .^{4}He, .^{1}H$ and $.^{17}O$ are respectively $14.00307u, 4.00260u, 1.00783u$ and $16.99913u$.

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30. In the fusion reaction $._1^2H +_1^2 H \rightarrow_2^3 He +_0^1 n$, the masses of deuteron, helium and neutron expressed in amu are $2.015, 3.017$ and 1.009 respectively. If $1kg$ of deuterium undergoes complete fusion, find the amount of total energy released. 1 amu $= 931.5MeV/c^2$.

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31. (a) Calculate the energy released by the fission of $2g$ of $._{92}U^{235}$ in kWh. Given that the energy released per fission is $200MeV$.

(b) Assuming that $200MeV$ of enrgy is released per fission of uranium atom, find the number of fissions per second required to released 1 kilowatt power.

(c) Find the amount of energy produced in joules due to fission of $1g$ of $._{92}U^{235}$assuming that 0.1% of mass is transformed into enrgy. $._{92}U^{235} = 235a\mu$, Avogadro number $= 6.023 \times 10^{23}$

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32. When a neutron induces fisssion in a $._{92}U^{235}$ nucleus, about $185MeV$ of usable enegry is released. If a reactor continuously generates $100MW$ of power using $._{92}U^{235}$as fuel, then how long will it take for $1kg$ of the uranium to be used up?

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33. In a nuclear reactor $.^{235}U$ undergoes fission liberating $200MeV$ of energy. The reactor has a 10% efficiency and produces $1000MW$ power. If the reactor is to function for $10yr$, find the total mass of uranium required.

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34. A town has a population of 1 million. The average electric power needed per person is 300W. A reactor is to be designed to supply power to this town. The efficiency with which thermal power is converted into electric power is aimed at 25%.(a) Assuming 200 MeV of thermal energy to come form each fission event on an average, find the number of events on an place every day. (b) Assuming the fission to take place largely through U^{235}, at what rate will the amount of U^{235} decrease ? Express uour answer in kg per day. (c) Assuming that uranium enriched to 3% in U^{235} will be used, how much uranium is needed per month (30 days)?

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35. A star initially has 10^{40} deuterons. It produces energy via the process $_(1)H^2 +_1 H^2 + \rightarrow_1 H^3 + p$. and $_(1)H^2 +_1 H^3 + \rightarrow_2 He^4 + n$ .If the average power radiated by the state is $10^{16} W$, the deuteron supply of the star is exhausted in a time of the order of .

The masses of the nuclei are as follows:

$M(H^2) = 2.014 a\mu$,

$M(p) = 1.007 a\mu$, $M(n) = 1.008 a\mu$, $M(He^4) = 4.001 a\mu$.

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36. It is proposed to use the nuclear fusion reaction

$_(1)^2 H +_1^2 H \rightarrow_2^4 He$

in a nucleas of $200MW$ rating. If the energy from the above reaction is used with a 25 per cest efficiency in the reactor , how many gram of deuterium fuel will be needed per day (The masses of $_(1)^2 H$ and $_4^2 Heare 2.0141$atomic mass unit and 4.0028atomic mass unit respectively)

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37. A nuclear reactor generates power at 50% efficiency by fission of $._{92}^{235} U$ into two equal fragments of $._{46}^{116} U$ into two equal fragments of $._{46}^{116} Pd$ with the emission of two gamma rays of 5.2 MeV each and three neutrons. The average binding energies per particle of $._{92}^{235} U$ and $._{46}^{116} Pd$

are 7.2 MeV and 8.2MeV respectiveley. Calculate the energy released in one fission event. Also-estimate the amount to $.^{235}U$ consumed per hour to produce 1600 megawatt power.

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38. A nucleus at rest undergoes a decay emitting an a particle of de - Broglie wavelength $\lambda = 5.76 \times 10^{-15} m$ if the mass of the daughter nucleus is 223.610 amu and that of alpha particle is $4.002 a\mu$, determine the total kinetic energy in the final state Hence , obtain the mass of the parent nucleus in amu (1 amu = 931.470 MeV / e^2)

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39. Polonium $\left(.^{210}_{84}Po\right)$ emits $.^{4}_{2}He$ particles and is converted into lead ($.^{206}_{82}Pb$). This reaction is used for producing electric power in a space mission. Po^{210} has half-life of 138.6 days. Assuming an efficiency of 10% for the thermoelectric machine, how much $.^{210}Po$ is required to produce $1.2 \times 10^7 J$ of electric energy per day at the end of $693 days$. Also find the initial activity of the material.

Given : Masses of nuclei

$.^{210}Po = 209.98264$ amu, $.^{206}Pb = 205.97440$ amu, $._{2}^{4}He = 4.00260$ amu,

$1amu = 931MeV/c^2$ and Avogadro's number $= 6 \times 10^{23}/mol$

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40. The element curium $._{96}^{248}Cm$ has a mean life of $10^{13}s$. Its primary decay modes are spontaneous fission and α-decay, the former with a probability of 8% and the later with a probability of 92%, each fission releases $200MeV$ of energy. The masses involved in decay are as follows

$._{96}^{248}Cm = 248.072220u$,

$._{94}^{244}P_u = 244.064100u$ and $._{2}^{4}He = 4.002603u$. Calculate the power output from a sample of 10^{20} Cm atoms. ($1u = 931MeV/c^2$)

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Exercises

1. Which of the following is corect regarding nucleus?

(i) The radius of nucleus $R = R_0 A^{1/3}$ where $R_0 = 1.1 \times 10^{-15} m$, $A =$ mass number

(ii) the density of nucleus $= \rho = \frac{M}{V} = \frac{mA}{\frac{4}{3}\pi R^3}$

$m:$ mass of proton or neutron

(iii) Nucleus stability depends on neutron-proton ratio N/Z

$N/Z \cong$ .6` for heaviest stable nucleus

(iv) The total angular momentum of the nucleus is the resultant of all the spin and orbital angular momenta of the individual nucleon (nucleon means either proton or neutron). The total angular momentum of a nucleus is called the nuclear spin of that nucleus.

A. $(i), (ii), (iii)$

B. $(ii), (iii), (iv)$

C. $(i), (ii), (iv)$

D. all

Answer: D

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2. Choose the correct option

A. Atomic mass unit (u) is $1/12$ of the mass of a neutral carbon atom $._6 C^{12}$ in its lowest enegry state $1a\mu = 931MeV$

B. $Z:$ Atomic number (number of protons)

$N:$ Number of neutrons

$A:$ mass number $(A = Z + N)$

C. Isotopes: nuclei having same number of protons but differenct number of neutrons

Isobars: nuclei with same number of A

Isotones: nuclei with same number of neutrons but different are correct

D. All options are correct

Answer: D

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3. The mass number of a nucleus is equal to

A. the number of neutron in the nucleus

B. the number of protons in the nucleus

C. the number of nucleous in the nucleus

D. none of them

Answer: C

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4. The mass number of a nucleus is.

A. always less than its atomic number

B. always more than its atomic number

C. equal to its atomic number

D. sometimes more than and sometimes equal to its atomic number

Answer: D

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5. If the nuclear radius of $.^{27} A1$ is 3.6 Fermi, the approximate nuclear radius of $64Cu$ in Fermi is :

A. 2.4

B. 1.2

C. 4.8

D. 3.6

Answer: C

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6. Two nuclei have their mass numbers in the ratio of $1:3$. The ratio of their nuclear densities would be

A. $(3)^{1/3}:1$

B. $1:1$

C. $1:3$

D. $3:1$

Answer: B

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7. The graph of $1n\left(\frac{R}{R_0}\right)$ versus $1nA(R = radius$ of a nucleus and $A =$ its mass number) is

A. a straight line

B. a parabola

C. an ellipse

D. none of these

Answer: A

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8. Atomic weight of boron is 10.81 and it has two isotopes $._5\ B^{10}$ and $._5\ B^{11}$. Then ratio of $._5\ B^{10}$ in nature would be.

A. $19:81$

B. $10:11$

C. $15:16$

D. $81:19$

Answer: D

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9. An element A decays into element C by a two-step process :

$A \to B + ._2 He^4$

$B \to C + 2e^-$

Then.

A. A and C are isotopes

B. A and C are isobars

C. A and B are is isobars

D. A and B are isobars

Answer: A

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10. Which of the following is correct regarding nucleus forces?

A. Nuclear force are attractive and charge independent

$F_{\text{pp}} = F_{\text{nn}} = F_{\text{pn}}$

B. Nuclear forces are short-range forces. When separtion is about $1fm$, nuclear forces are 50 to 60 times greater than electromagnetic forces. When separation exceeds $10fm$, nuclear forces are negligible

C. Nuclear forces are not central forces (like gravitational or electro-static), but spin dependent. For parallel spin, is higher.

D. All options are correct

Answer: D

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11. Two protons are kept at a separation of $10nm$. Let F_n and F_e be the nuclear force and the electromagnetic force between them.

A. $F_e = F_n$

B. $F_e > > F_n$

C. $F_e < < F_n$

D. F_e and F_n duffer slightly

Answer: B

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12. Two nucleons are at a separation of $1 \times 10^{-15} m$. The net force between them is F_1, if both are neutrons, F_2 if both are protons and F_3 if one is a proton and other is a neutron. In such a case.

A. $F_2 > F_1 > F_3$

B. $F_1 = F_2 = F_3$

C. $F_1 = F_2 > F_3$

D. $F_1 = F_3 > F_2$

Answer: D

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13. Size of nucleus is of the order of

A. $10^{-10}m$

B. $10^{-15}m$

C. $10^{-12}m$

D. $10^{-19}m$

Answer: B

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14. Which of the following is correct regarding binding enegry of nucleus?

A. The nucleons are bound together in a nucleus and energy must be supplied to the nucleus to separate the consituent nucleons to large distance. The amount of energy needed to do this is called the binding enegry o fthe nucleus. If the nucleons are initially well separated and are brought to from the nucleus, this much energy is released

$B.E. = \Delta mc^2, \Delta m:$ mass defect

$B.E. = (Zm_p + Nm_n - M)c^2$

B. $B.E.$ /nucleon is maximum for $\cdot_{26} Fe^{56}$, hence iron is most stable element

C. For a nuclear reaction, α-value of the reaction is the difference between the rest mass enegry of the initial consituents and that of the final products

$Q = U_i - U_f$

$A + B \rightarrow C + D$

$Q -$ value $= \{(m_A + m_B) - (m_C + m_D)\}c^2$

D. All options are correct

Answer: D

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15. Mass defect of an atom refers to

A. inaccurate measurement of mass of nucleons

B. mass annihiliated to produce enegry to bind the nucleus

C. packing fraction

D. difference in the number of neutrons and protons in the nucleus

Answer: B

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16. 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 by.

A. $M(N, Z) = NM_n + ZM_p - Bc^2$

B. $M(N, Z) = NM_n + ZM_p + Bc^2$

C. $M(N, Z) = NM_n + ZM_p - B/c^2$

D. $M(N, Z) = NM_n + ZM_p + B/c^2$

Answer: C

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17. A nucleus $._Z^A X$ has mass represented by $M(A, Z)$. If M_p and M_p denote the mass of proton and neutron respectively and BE the binding energy (in MeV), then :

A. $B.E. = [M(A, Z) - ZM_p - (A - Z)M_n]c^2$

B. $B.E. = [ZM_p + (A - Z)M_n - M(A, Z)]c^2$

C. $B.E. = [ZM_p + AM_n - M(A, Z)]c^2$

D. $B.E. = M(A, Z) - ZM_p - (A - Z)M_n$

Answer: B

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18. The masses of neutron and proton are 1.0087 a.m.u. and 1.0073 a.m.u. respectively. If the neutrons and protons combine to form a helium nucleus (alpha particle) of mass 4.0015a.m.u. The binding energy of the helium nucleus will be $(1a.\ m.\ u. \ = 931MeV)$.

A. $28.4MeV$

B. $20.8MeV$

C. $27.1MeV$

D. $14.2MeV$

Answer: A

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19. If M is the mass of a nucleus and A is its mass number, then $\frac{M-A}{M}$ is called its

A. binding energy

B. Fermi energy

C. mass defect

D. packing fraction

Answer: D

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20. As the mass number A increases, the binding energy per nucleon in a nucleus.

A. increases

B. decreases

C. remains the same

D. varies in a way that depends on the actual value of A

Answer: D

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21. For atomic nuclei, the binding energy per nucleon

A. increases continously with increases in mass number

B. decreases continously with increases in mass number

C. remains constant with increases in mass number

D. first increases and then with decreases in mass number

Answer: D

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22. Which of the following is a wrong description of binding energy of a nucleus?

A. It is the enegry required to break a nucleus into its constituent nucleous

B. It is the enegry made available when free nucleons combine to from a nucleus

C. It is the sun of the rest mass energies of its nucleons minus the rest mass energy of the nucleus

D. It is the sun of kinetic energy of all the nucleons in the nucleus

Answer: D

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23. If the total binding energies of $._1 H^2, ._2 He^4, ._{26} Fe^{56}$ and $._{92} U^{235}$ nuclei are $2.22, 28.3, 492$ and $1786 MeV$ respectively, identify the most stable nucleus out of the following

A. $._{26} Fe^{56}$

B. $._1 H^2$

C. $._{92} U^{235}$

D. $._2 He^4$

Answer: A

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24. If the binding energy per nucleon in Li^7 and He^4 nuclei are respectively $5.60MeV$ and $7.06MeV$. Then energy of reaction $Li^7 + p \rightarrow 2_2He^4$ is.

A. $19.6MeV$

B. $2.4MeV$

C. $8.4MeV$

D. $17.3MeV$

Answer: D

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25. Average binding energy per nucleon over a wide range is

A. $8eV$

B. $8MeV$

C. $8J$

D. $8ergs$

Answer: B

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26. A neutron is thermal equilibrium at room temperature. Its enegry would be

A. $0.025eV$

B. $0.1eV$

C. $1.0eV$

D. $4.0eV$

Answer: A

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27. The binding energy per nucleon number for deutron $H_1^2$and helium He_2^4 are $1.1MeV$ and $7.0MeV$ respectively . The energy released when two deuterons fase to form a belium nucleus He_2^4 is ....

A. $2.2MeV$

B. $23.6MeV$

C. $28.0MeV$

D. $30.2MeV$

Answer: B

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28. For nuclei with $A > 100$,

(i) the binding energy of the nucleus decreases on an averages as A increases

(ii) the binding enegry per nucleon decreases on an averages as A increases

(iii) if the nucleus breaks into two roughly equal parts, enegry is released

(iv) if two nuclei fuse to from a bigger nucleus, energy is released

A. $(i), (ii)$

B. $(ii), (iv)$

C. $(ii), (iii)$

D. $(iii), (iv)$

Answer: A

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29. 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

Answer: C

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30. The heavier nuclei tend to have larger N/Z ratio because

A. $(i), (ii)$

B. $(ii), (iv)$

C. $(ii), (iii)$

D. $(iii), (iv)$

Answer: D

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31. A free neutron decays to a proton but a free proton does not decay to a neutron. This is because

A. neutron is a composite particel made of a proton and an electron whereas proton is a fundamental particle

B. neutron is an uncharged particle whereas proton is a charged particle

C. neutron has large rest mass than the proton

D. weak forces can operate in a neutron but not in a proton

Answer: C

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32. The binding energies per nucleon for a deuteron and an $\alpha -$ particle are x_1 and x_2 respectively. What will be the energy Q released in the following reaction ?

$._1 H^2 + ._1 H^2 \rightarrow ._2 He^4 + Q.$

A. $4(x_1 + x_2)$

B. $4(x_2 - x_1)$

C. $2(x_1 + x_2)$

D. $2(x_2 - x_1)$

Answer: B

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33. The binding energy of deuteron $._1^2 H$ is $1.112 MeV$ per nucleon and an $\alpha -$ particle $._2^4 He$ has a binding energy of $7.047 MeV$ per nucleon. Then in the fusion reaction $._1^2 H + ._1^2 h \rightarrow ._2^4 He + Q$, the energy Q released is.

A. $1 MeV$

B. $11.9 MeV$

C. $23.8 MeV$

D. $931 MeV$

Answer: C

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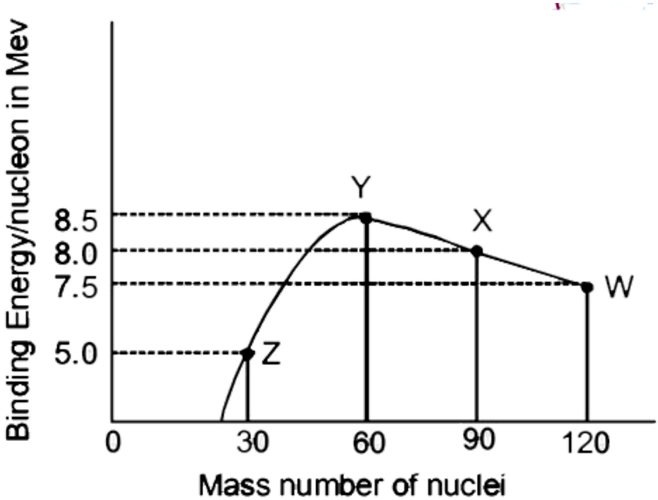
34. Binding energy per nucleons vs mass curve for nucleus is shown in the figure W, X, Y and Z are four nuclei indicated on the curve . The process that would release energy is



A. $Y \rightarrow 2Z$

B. $W \rightarrow X + Z$

C. $W \rightarrow 2Y$

D. $X \rightarrow Y + Z$

Answer: C

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35. In the nuclear reaction : $X(n, \alpha)_3 Li^7$ the term X will be 3

A. $._5\ B_{10}$

B. $._5\ B^9$

C. $._5\ B^{11}$

D. $._2\ He^4$

Answer: A

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36. In nuclear reactions, we have the conservation of

A. mass only

B. momentum only

C. energy only

D. mass,energy and momentum

Answer: D

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37. In the α-decay process occuring in different types of nuclei at rest

(i) the $K.E.$ of the daughter nucleus is always greater than the $K.E.$ of the α-particle

(ii) the $K.E.$ of the daughter nucleus is always less than the $K.E.$ of the α-particle

(iii) the magnitudes of the linear momenta of the α-particle and the daughter nucleus are always equal

(iv) the daughter nucleus is always in a stable state

A. (i), (ii)

B. (ii), (iv)

C. (ii), (iii)

D. (iii), (iv)

Answer: C

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38. The phenomenon of pair production is the

A. formation of an electron and a position from γ-rays

B. ejection of an electron from a metal surface when exposed to ultra-violet light

C. ejection of an electron form a nucleus

D. ionization of a neutral atom

Answer: A

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39. Following process is known as $hv \rightarrow e^{+} + e^{-}$

A. Pair production

B. Photoelectric effect

C. Compton effect

D. Zeeman effect

Answer: A

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40. To produce an electron-position pair, the minimum energy of γ-ray photon must be

A. $1.02keV$

B. $1.02MeV$

C. $1.02BeV$

D. $1.02eV$

Answer: B

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41. A gamma ray photon creates an electron-positron pair. If the rest mass energy of an electron is $0.5MeV$ and the total $K.E.$ of the electron-position pair is $0.78MeV$, then the energy of the gamma ray photon must be.

A. $0.28MeV$

B. $0.78 MeV$

C. $1.28 MeV$

D. $1.78 MeV$

Answer: D

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42. Which of the following is correct regarding nuclear fission?

(i) The process in which a heavy nucleus is broken into two nearly equal fragments, is called 'Nuclear Fission'

(ii) Nautral uranium has two istopes,$._{92}U^{238}$and $._{92}U^{235}$ in the ratio $1:0.07$. the fission of U^{235} takes place only by fats neutrons, whereast that of U^{235} is possible by slow neutrons

(iii) One of the reaction for fission of U^{235}

$._{92}^{236}U + ._{0}^{1}n \rightarrow ._{92}^{236}U \rightarrow ._{52}^{144}Ba + ._{36}^{89}Kr + 3_{0}^{1}n +$ energy

(iv) In the fission of one U^{235} nucleus, about $200 MeV$ of enegry of obtained. Most of this enegry is obtained from of $K.E.$ of fragments obtained by fission, the rest of obained as $K.E.$ of emitted neutrons, γ-rays, heat and light radiation

A. (i), (ii), (iii)

B. (ii), (iii), (iv)

C. (i), (ii), (iv)

D. all

Answer: D

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43. During a nuclear fission reaction,

A. a heavy nucleus breaks into two gragments by itself

B. a light nucleus bombarded by thermal neutrons breaks up

C. a heavy nucleus bombarded by thermal neutrons breaks up

D. two light nuclei combine to given a heavier nuclear reactor possibly other products

Answer: C

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44. Enriched uranium is better as a fuel for a nuclear reactor because it has greater proportion of

A. $.^{233}U$

B. $.^{235}U$

C. $.^{238}U$

D. $.^{239}U$

Answer: B

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45. A slow neutron(n) is captured by a $._{92}U^{235}$ nucleus forming a highly unstable nucleus $._{92}U^{236*}$ (where $*$ ddenotes that the nucleus is in an excited state). The fission of the nucleus occurs by

A. $._{92}^{236}U^* \rightarrow ._{50}^{140}Sn + ._{42}^{89}Mo + 6n + Q$

B. $._{236}^{92}U^* \rightarrow ._{54}^{140}Sn + ._{38}^{94}Sr + 4n + Q$

C. $._{92}^{236}U^* \rightarrow ._{52}^{144}Sn + ._{42}^{89}Mo + 3n + Q$

D. $._{92}^{236}U^* \rightarrow ._{56}^{144}Ba + ._{36}^{89}Kr + 3n + Q$

Answer: D

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46. Complete the equation for the following fission process

$._{92}U^{235}._{0}n^{1} \rightarrow ._{38}Sr^{90} + \dots .$

A. $._{54}Xe^{143} + 3_0n^1$

B. $._{54}Xe^{145}$

C. $._{57}Xe^{142}$

D. $._{54}Xe^{142} + ._{0}n^{1}$

Answer: A

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47. Let m_p be the mass of a poton , M_1 the mass of a $\_(10)^{20}Ne$ nucleus and M_2 the mass of a $\_(20)^{40}Ca$ nucleus . Then

A. $(i), (iv)$

B. $(ii), (iv)$

C. $(ii), (iii)$

D. $(iii), (iv)$

Answer: D

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48. Choose the correct option

(a) Atom bomb is based on nucleus fission (uncontrolled chain reaction)used as fissionable substance. In the exposion, a temperature of the order of $10^6 . ^\circ C$ and a pressure of lacs of atomspheres is obtained

(ii) In nuclear reactor, by controlled chain reaction a huge enegry is obtained for useful purpose

(iii) In a reactor fuel is U^{234} or Pu^{238}

(iv) Moderators (Light water, heavy water, graphite, Cadmium rods are used as safety rods

A. $(i), (ii), (iii)$

B. $(i), (ii), (iv)$

C. $(ii), (iii), (iv)$

D. all

Answer: D

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49. The power obtained in a reactor using U^{235} disintergration is $1000kW$. The mass decay of U^{235} per hour is

A. 1 microgram

B. 10 microgram

C. 20microgram

D. 40microgram

Answer: D

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50. (a) What are thermal neutrons in the context of nuclear fission ?

(b) What role does a moderator play in a nuclear reactor ?

A. to control the energy released in the reactor

B. to absorb neutrons and stop the chain reaction

C. to cool the reactor

D. to slow down the neutron to thermal energies

Answer: D

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51. Fast neutrons can easily be slowed down by

A. the use of lead shielding

B. passing them through water

C. elastic collision with heavy nuclei

D. applying a strong electric field

Answer: B

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52. Cadmium and Broron rods are used in a nuclear reactor to

A. speed up neutrons

B. slow down neutrons

C. absorb neutrons

D. produce neutrons

Answer: C

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53. When $._{92}U^{235}$ undergoes fission, 0.1% of its original mass is changed into energy. How much energy is released if $1kg$ of $._{92}U^{235}$ undergoes fission ?

A. $9 \times 10^{10} J$

B. $9 \times 10^{11} J$

C. $9 \times 10^{12} J$

D. $9 \times 10^{13} J$

Answer: D

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54. In a fission process, nucleus A divides into two nuclei B and C, their binding energies being E_a, E_b and E_c respectively. Then.

A. $E_b + E_c = E_a$

B. $E_b + E_c > E_a$

C. $E_b + E_c < E_a$

D. $E_b . E_c = E_a$

Answer: B

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55. Energy released in the fission of a single $._{92} U^{235}$ nucleus is $200 MeV$. The fission rate of a $._{92} U^{235}$ fuelled reactor operating at a power level of

$5W$ is.

A. $1.56 \times 10^{10} s^{-1}$

B. $1.56 \times 10^{11} s^{-1}$

C. $1.56 \times 10^{16} s^{-1}$

D. $1.56 \times 10^{17} s^{-1}$

Answer: B

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56. The enegry released per fission of $.^{235} u$ is nearly

A. $200eV$

B. $20eV$

C. $2000eV$

D. $200MeV$

Answer: D

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57. A slow neutron can cause fission in

A. $.^{235} U$

B. $.^{238} U$

C. $.^{235} Pu$

D. $.^{232} Th$

Answer: A

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58. $200 MeV$ of energy may be obtained per fission of U^{235}. A reactor is generating $1000 kW$ of power. The rate of nuclear fission in the reactor is.

A. 1000

B. 2×10^{8}

C. 3.125×10^{16}

D. 931

Answer: C

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59. If $5g$ of $.^{235}U$ is completely destroyed in a reactor, the energy released would be

A. $45 \times 10^{13} J$

B. $45 \times 10^{17} erg$

C. $15 \times 10^{10} J$

D. $60 \times 10^{15} J$

Answer: A

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60. Which of the following is correct regarding Nuclear fusion?

(i) When two lighter nuclei moving at very high speeds fuse together to from a single heavier nucleus, then this phenomenon is called 'Nuclear Fusion'

(ii) Solar energy is due to fusion. at sun, major process of fusion is carbon-carbon cycle and proton-proton cycle. Hydeogen bomb is based on fusion

(iii) For fusion take place, a very high temperature of the order of $10^8 K$ is needed

(iv) Some example of fusion are

$\cdot_1 H^2 + \cdot_1 n^2 \rightarrow \cdot_2 He^3 + \cdot_0 n^1 + \text{energy}$

$\cdot_2 He^3 + \cdot_1 H^2 \rightarrow \cdot_2 He^4 + \cdot_1 H^1 + \text{energy}$

A. $(i), (ii), (iii)$

B. $(i), (ii), (iv)$

C. $(ii), (iii), (iv)$

D. all

Answer: D

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61. Fusion reaction takes place at high temperature because

A. atoms are iinized at high temperature

B. molecules break up at high temperature

C. nuclei break up at high temperature

D. kinetic enegry is high enough to vercome repulsion at high temperature

Answer: D

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62. Solar energy is mainly caused due to

A. nuclear fission

B. nuclear fusion

C. gravitational contraction

D. combustion

Answer: B

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63. If in a nuclear fusion process the masses of the fusing nuclei be m_1 and m_2 and the mass of the resuktant nucleus be m_3, then

A. $m_3 = m_1 + m_2$

B. $m_3 = |m_1 + m_2|$

C. $m_3 < (m_1 + m_2)$

D. $m_3 > (m_1 + m_2)$

Answer: C

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64. From the following equations pick out the pssible nuclear fusion reactions

(i) $._5 C^{13} + ._1 H^1 \rightarrow ._6 C^{14} + 4.3MeV$

(ii) $._6 C^{12} + ._1 H^1 \rightarrow ._7 C^{13} + 2MeV$

(iii) $._7 C^{14} + ._1 H^1 \rightarrow ._8 C^{15} + 7.3MeV$

(iv) $._{92}^{235} U + ._0^1 n \rightarrow ._{54}^{140} Xe + ._{38}^{94} Sr + 2._0^1 n + \gamma + \text{energy}$

A. $(i), (ii)$

B. $(ii), (iv)$

C. $(ii), (iii)$

D. $(iii), (iv)$

Answer: C

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65. A nuclear fusion reaction is given by

$._1 H^2 + ._1 H^2 \rightarrow ._1 He^3 + ._0^1 n + Q(\text{energy}).$

If 2 moles of deuterium are fused, then total released energy is

A. $2Q$

B. $4Q$

C. $Q \times 6.02 \times 10^{23}$

D. $Q \times 2 \times 6 \times 10^{23}$

Answer: C

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66. The sun radiates energy in all directions. The average radiations received on the earth surface from the sun is $1.4 \text{kilowatt} / m^2$. The average earth-sun distance is 1.5×10^{11} meters. The mass lost by the sun per day is.

A. $4.4 \times 10^9 kg$

B. $7.6 \times 10^{14} kg$

C. $3.8 \times 10^{12} kg$

D. $3.8 \times 10^{14} kg$

Answer: D

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67. Which of the following statement (s) is/are correct

(i) The rest mass of a stable nucleus is less than the sum of the rest masses of its separated nucleous

(ii) The rest mass of a stable nucleus is greater than the sum of the rest masses of its separated nucleous

(iii) In culear fusion, energy is released by fusion two nuclei of medium amss (approximaltely 100amu)

(iv) In nuclear fussion, energy is released by freagmentation of a very heavy nucleus

A. $(i), (iii)$

B. $(ii), (iii)$

C. $(i), (iv)$

D. $(ii), (iv)$

Answer: C

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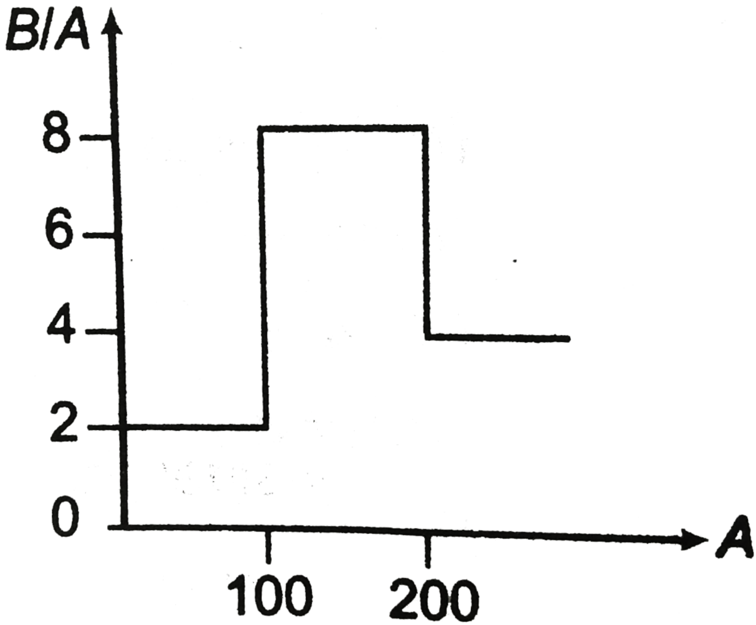
68. Assume that the nuclear binding energy per nucleon (B/A) versus mass number (A) is as shown in figure. Use this plot to choose the correct choice(s) given below.

(a) Fusion of two nuclei with mass numbers, lying in the range of $1 < A < 50$ will release energy.

(b) Fusion of two nuclei with mass numbers lying in the range of $51 < A < 100$ will release energy.

(c) Fission of a nucleus lying in the mass range of $100 < A < 200$ will release energy when broken into two equal fragements.

(d) Fission of a nucleus lying in the mass range of $200 < A < 260$ will release energy when broken into two equal fragments.



A. $(i), (ii)$

B. $(ii), (iii)$

C. $(iii), (iv)$

D. $(ii), (iv)$

Answer: D

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69. Which of the following is correct regarding radioactive process ?

(i) Despite the strength of the forces that hold them togther, many nucleides are unstable and spontaneously alter temselves through radioactive decay sometime through radioactive decay somtimes through a series of such decays, untiall thry reach stable comfigurations

(ii) When a nucleus undergoes α or β decay, its atomic number Z chnges and it becomes the nucleus of a different element

The energy liberated during radioactive decay comes form within individual nuclei without external exciatation, unlike the case of atomic radiation

(iv) Radioactive decay is a statistical process that obeys the laws of chance. no cause effect relationship is involved in the decay of a particular nucleus, only a certain probaility per unit time

A. $(i), (ii), (iii)$

B. $(ii), (iii), (iv)$

C. $(i), (ii), (iv)$

D. all

Answer: D

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70. α, β and γ radiations come out of a radioactive substance

A. spontaneously

B. when it is put in a reactor

C. when it is heated

D. under pressure

Answer: A

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71. In a radioactive decay, neither the atomic number nor the mass number changes. Which of the following particles is emitted in the decay?

A. proton

B. neutron

C. electorn

D. photon

Answer: D

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72. In which of the following decays the element does not change?

A. α-decay

B. β^{+}-decay

C. β^{-}-decay

D. $\gamma-$ decay

Answer: D

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73. Which of the following process represents a $\gamma - decay$?

A. $._{Z}X^{A} + \gamma \rightarrow ._{Z-1}X^{A} + a + b$

B. $._{Z}X^{A} +_{0} n^{1} \rightarrow ._{Z-1}X^{A-3} + c$

C. $._{Z}X^{A} \rightarrow ._{Z}X^{A} + f$

D. $._{Z}X^{A} +_{-1} e^{0} \rightarrow ._{Z-1}X^{A} + g$

Answer: C

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74. During a negative beta decay,

A. an atomic electorn is ejected

B. an electron which is already present within the nucleus is ejected

C. a neutron in the nucleus decays emitting an electron

D. a proton in the nucleus in beta decays emitting an electorn

Answer: C

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75. The electron emitted in beta radiation originates from

A. inner orbits of atoms

B. free electorns exiting in nuclei

C. decay of a neutron in a nuclei

D. photon escaping form the nucleus

Answer: C

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76. Consider a sample of a pure beta-active material

A. All the beta particles emitted have the sae energy

B. The beta particles originally exist inside the nucleus and are ejected at the time of beta decay

C. The antineutrion emitted in a beta decay has zero mass and hence zero momentum

D. The active nucleus changes to one of its isobars after the beta decay

Answer: D

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77. In a radioactive decay, a nucleus is transformed into another with the emission of a positron. In this process the neutron-proton ratio

A. decreases

B. remains same

C. increases

D. becomes one

Answer: C

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78. In which of the following decays the atomic number decreases?

(i) α-decay (ii) β^{+}-decay

(iii) β^{-}-decay (iv) electron capture

A. $(i), (ii), (iii)$

B. $(ii), (iii), (iv)$

C. $(i), (ii), (iv)$

D. all

Answer: C

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79. A and B are isotopes. B and C are isobars. All three are radioactive.

Which one of the following is true.

A. A, B and C must belong to the same element

B. A, B and C may belong to the same element

C. It is possible that A will change to B through a radioactive decay process

D. It is possible that B will change to C through a radioactive decay process

Answer: D

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80. Which of the following assertions are correct?

(i) A neutron can decay to a proton only inside a nucleus

(ii) A proton can change to a neutron only inside a nucleus

(iii) An isolated neutron can change into a proton

(iv) An isolated proton can change into a neutron

A. $(i), (ii)$

B. $(ii), (iii)$

C. $(i), (iv)$

D. $(ii), (iv)$

Answer: B

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81. When a nucleus with atomic number Z and mass number A undergoes a radioactive decay process,

(i) Both Z and A will decrease, if the process is α decay

(ii) Z will decrease but A will not change, if the process is $\beta^+ -$ decay

(iii) Z will increase but A will not change, if the process is $\beta -$ decay

(iv) Z and a will remain uncharged, if the prices is γ decay

A. $(i), (ii), (iii)$

B. $(ii), (iii), (iv)$

C. $(i), (ii), (iv)$

D. all

Answer: D

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82. The number of beta particles emitter by radioactive sustance is twice the number of alpha particles emitter by it. The resulting daughter is an

A. isobar of parent

B. isome of parent

C. isotone of parent

D. isotope of parent

Answer: D

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83. The decay constant λ of the radioactive sample is probaility of decay of an atom in unit time, then

A. λ decrease as atoms become older

B. λ increases as the age of atoms increases

C. λ is independent of the age

D. behaviour of λ with time depends on the nature of the activity

Answer: C

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84. Some radioactive nucleus may emit

A. only one $(\alpha, \gamma)(\beta, \gamma)$ at a time

B. all the three α, β and γ one after another

C. all the three α, β and γ sinultaneously

D. only α and β simultaneously

Answer: A

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85. The correct order of ionising capcity of α, β and γ-rays is

A. $\alpha > \gamma > \beta$

B. $\alpha > \beta > \gamma$

C. $\alpha < \beta < \gamma$

D. $\gamma > \alpha > \beta$

Answer: B

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86. Which of the following is in the increasing order for penetrating power

A. α, β, γ

B. β, α, γ

C. γ, α, β

D. γ, β, α

Answer: D

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87. A radiaoactive nucleus (initial mass number A and atomic number Z emits 3α- particles and 2 positrons The ratio of number of neutrons to that of proton in the final nucleus will be

A. $\dfrac{A-Z-4}{Z-2}$

B. $\dfrac{A-Z-8}{Z-4}$

C. $\frac{A-Z-4}{Z-8}$

D. $\frac{A-Z-12}{Z-4}$

Answer: C

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88. Consider a radioactive material of half-life 1.0 minute. If one of the nuclei decays now, the next one will decay

A. after 1 minute

B. after $\frac{1}{\log_e 2}$ minute

C. after $1/N$ minute, where N is the number of nuclei present at that moment

D. after any time

Answer: D

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89. In a radioactive series, $._{92}U^{238}$ charges to $._{82}Pb^{206}$ through $n_1(\alpha$- decay processes) and $n_2(\beta -$ deacy processes)

A. $n_1 = 8, n_2 = 8$

B. $n_1 = 6, n_2 = 2$

C. $n_1 = 8, n_2 = 6$

D. $n_1 = 6, n_2 = 8$

Answer: C

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90. The decay constant of a radiaoactive sample is λ . The half life and mean life of the sample are respectively given by

A. $\frac{1}{\lambda}, \frac{\ln 2}{\lambda}$

B. $\frac{\ln 2}{\lambda}, \frac{1}{\lambda}$

C. $\lambda \ln 2, \frac{1}{\lambda}$

D. $\frac{\ln 2}{\lambda}, \frac{2}{\lambda}$

Answer: B

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91. The decay constant λ of the radioactive sample is probaility of decay of an atom in unit time, then

A. λ-decrease as the age of atoms increases

B. λ-increase as the age of atoms increases

C. λ is independent of the age of atom

D. behaviour of λ with time depends on the material

Answer: C

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92. An accident occurs in a laboratory in which a large amount of a radioactive material, having a half life of 20 days, becomes embeded in the foor and walls so that the level of adiation is 32 times the permissible level. The laboratory can be safely occupied after

A. 20 days

B. 32 days

C. 64 days

D. 100days

Answer: D

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93. The percentage of quantity of a radioactive material that remains after 5 half-lives will be .

A. 1 %

B. 3%

C. 5%

D. 20%

Answer: B

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94. Three fourth of the active decays in a radioactive sample in $3/4$ sec. The half-life of the sample is

A. 1 sec

B. $1/2$ sec

C. $\frac{3}{4}$ sec

D. $\frac{3}{8}$ sec

Answer: D

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95. Let T be the mean life of a radioactive sample. 75% of the active nuclei present in th sample initially will deacy in time

A. $2T$

B. $1/2(\ln 2)T$

C. $4T$

D. $2(\ln 2)T$

Answer: D

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96. A fraction f_1 of a radioactive sample decays in one mean lie 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 (1), (2) or (3), depending on the values of the mean life and half-life

Answer: A

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97. A radioactive nuclide can decay simultaneously by two different processes which have decay constant λ_1 and λ_2. The effective decay constant of the nucleide is λ

A. $\lambda = \lambda_1 + \lambda_2$

B. $\lambda = (\lambda_1 + \lambda_2)/2$

C. $\frac{1}{\lambda} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$

D. $\lambda = \sqrt{\lambda_1 \lambda_2}$

Answer: A

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98. In a sample of radioactive material, what fraction of initial number of active nuclei will remain undistintegrated after half of a half0life of the sample?

A. $\frac{1}{4}$

B. $\frac{1}{2\sqrt{2}}$

C. $\frac{1}{\sqrt{2}}$

D. $\sqrt{2}-1$

Answer: C

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99. In a sample of radioactive material, what percentage of the initial number of active nuclei will decay during one mean life ?

A. $37\ \%$

B. $50\ \%$

C. $63\ \%$

D. $69.3\ \%$

Answer: C

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100. The half life of Radon is 3.8 days. Calculate how much of 15 milligram of Radon will remain after 38 days.

A. $0.45mg$

B. $0.30mg$

C. $0.15mg$

D. $0.60mg$

Answer: C

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101. The half - life of $\hat{}(215)At$ is $100\mu, s$. The time taken for the radioactivity of a sample of $\hat{}(215)At$ to decay to $1/16^{th}$ of its initially value is

A. $400\mu\sec$

B. $6.3\mu\sec$

C. $40\mu\sec$

D. $300\mu\sec$

Answer: A

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102. 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

Answer: C

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

A. $A_1 t_1 = A_2 t_2$

B. $\frac{A_1 - A_2}{t_2 - t_1} =$ constant

C. $A_2 = A_1 e^{\left(\frac{t_1 - t_2}{T}\right)}$

D. $A_2 = A_1 e^{\left(\frac{t_1}{t_2 T}\right)}$

Answer: C

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104. 90% of the active nuclei present in a radioactive sample are found to remain undecyayed after 1 day. The precentage of undecayed nuclei left after two days will be

A. 85%

B. 81%

C. 80%

D. 79%

Answer: B

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105. Two radioactive substances A and B have half lives of T and $2T$ respectively. Samples of a and b contain equal number of nuclei initially. After a time $4T$, the ratio of the number of undecayed nuclei of A to the number if undecayed nuclei of A to the number of undeacyed nuclei of B is

A. $1:4$

B. $1:2$

C. $2:1$

D. $4:1$

Answer: A

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106. Two radioactive substances A and B have half lives of T and $2T$ respectively. Samples of a and b contain equal number of nuclei initially. After a time $4T$, the ratio of the number of undecayed nuclei of A to the number of undeacyed nuclei of B is

A. $\frac{1}{10\lambda}$

B. $\frac{1}{11\lambda}$

C. $\frac{11}{10\lambda}$

D. $\frac{1}{9\lambda}$

Answer: D

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107. Two radioactive substance X and Y initially contain equal number of nuclei. X has a half life of 1 hour and Y has a half-life of 2 hours. After 2 hours the ratio of activity of X to that of y is

A. $1:4$

B. $1:2$

C. $1:1$

D. $2:1$

Answer: B

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108. A radioactive isotope X with a half-life of 1.37×109 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 of $1:7$. The age of the rock is.

A. $1.96 \times 10^8 years$

B. $3.85 \times 10^9 years$

C. $4.11 \times 10^9 years$

D. $9.59 \times 10^9 years$

Answer: C

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109. The count rate from $100cm^3$ of a radioactive liquid is c. Some of this liquid is now discarded. The count rate of the remaining liquid is found to be $c/10$ after three half-lives. The volume of the remaining liquid, in cm^3, is

A. 20

B. 40

C. 60

D. 80

Answer: D

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110. Half-lives of two radioactive substances A and B are respectively 20 minutes and 40 minutes. Initially, he sample of A and B have equal number of nuclei. After 80 minutes the ratio of the remaining number of A and B nuclei is :

A. $1:16$

B. $4:1$

C. $1:4$

D. $1:1$

Answer: C

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111. The decay constant of 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 $(t_1 - t_2)$

A. $A_1 t_1 - A_2 t_2$

B. $A_1 - A_2$

C. $(A_1 - A_2)/\lambda$

D. $\lambda(A_1 - A_2)$

Answer: C

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112. A radioactive sample has half-life of 5 years. Probability of decay in 10 years will be.

A. $100\ \%$

B. $75\ \%$

C. $50\ \%$

D. $25\ \%$

Answer: B

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113. 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,

(a) x and y have the same decay rate initially

(b) x and y decay at the same rate always

(c) y will decay at a faster rate than x

(d) x will decay at a faster rate than y

A. $X$and Y have the same decay rate initially

B. X and Y decay at the same rate always

C. Y will decay at a faster rate than X

D. X will decay at a faster rate than Y

Answer: C

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114. Two radioactive nuclei P and Q, in a given sample decay into a stable nucleus R. At time $t=0$, number of P species are $4N_0$ and that of Q are N_0. Half-life of P (for conversation to R) is $1mm$ whereas that of Q is 2 min . 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 :

A. $\frac{5N_0}{2}$

B. $2N_0$

C. $3N_0$

D. $\frac{9N_0}{2}$

Answer: D

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115. Two radioactive materials have decay constant $5\lambda \& \lambda$. If initially they have same no. of nuclei. Find time when ratio of nuclei become $\left(\frac{1}{e}\right)^2$:

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116. 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 had decayed and time t_1 when $\frac{1}{3}$ of it had decay is

A. 7 min

B. 14 min

C. 20 min

D. 28 min

Answer: C

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117. A radio isotope X with a half-life 1.4×10^9 years decays of 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.

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118. If the binding energy per nucleon in Li^7 and He^4 nuclei are respectively $5.60 MeV$ and $7.06 MeV$. Then energy of reaction $Li^7 + p \rightarrow 2_2 He^4$ is.

A. $-2.4 MeV$

B. $8.4 MeV$

C. $17.3 MeV$

D. $19.6 MeV$

Answer: C

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