Ravi Maths Tuition

Nuclei

12th Standard

Physics

Multiple Choice Question 122 x 1 = 122

1) O_2 molecule consists of two oxygen atoms.In the molecule, nuclear force between the nuclei of the two atoms

(a) is not important because nuclear forces are short-ranged

(b) is as important as electrostatic force for binding the two atoms

(c) cancels the repulsive electrostatic force between the nuclei

(d) is not important because oxygen nucleus have equal number of neutrons and protons.

2) Suppose we consider a large number of containers each containing initially 10000 atoms of a radioactive material with a half life of 1 year. After 1 year.

(a) all the containers will have 5000 atoms of the material

(b) all the containers will contain the same number of atoms of the material but that number will only be approximately 5000

(c) the containers will in general have different numbers of the atoms of the material but their average will be close to 5000

(d) none of the containers can have more than 5000 atoms

3) Tritium is an isotope of hydrogen whose nucleus Triton contains 2 neutrons and 1 proton. Free neutrons decay into $p+\overline{e}+\overline{v}.$ If one of the neutrons in Triton decays, it would transform into He^3 nucleus. This does not happen. This is because

(a) Triton energy is less than that of a He^3 nucleus

(b) the electron created in the beta decay process can not remain in the nucleus

(c) both the neutrons in triton have to decay simultaneously resulting in a nucleus with 3 protons, which is not a He^3 nucleus

(d) because free neutrons decay due to external perturbations which is absent in a triton nucleus

4) Heavy stable nuclei have more neutrons than protons. This is because of the fact that

(a) neutrons are heavier than protons (b) electrostatic force between protons is repulsive

(c) neutrons decay into protons through beta decay

(d) nuclear forces between neutrons are weaker than that between protons

5) In a nuclear reactor, moderators slow down the neutrons which come out in a fission process. The moderators slow down the neutrons which come out in a fission process. The moderator used have light nuclei. Heavy nuclei will not serve the purpose because

(a) they will break up (b) elastic collision of neutrons with heavy nuclei will not slow them down

(c) the net weight of the reactor would be unbearably high

(d) substances with heavy nuclei do not occur in liquid or gaseous state at room temperature

6) Samples of two radioactive nuclides A and B are taken. $\lambda_A\ and\ \lambda_B$ are the disintegration constants of A and B respectively. In which of the following cases, the two samples can simultaneously have the same decay rate at any time?

(a) initial rate of decay of A is twice the initial rate of decay of B and $\lambda_A=\lambda_B$

(b) Initial rate of decay of A is twice the initial rate of decay of B and $\lambda_A>\lambda_B$

(c) Initial rate of decay of B is twice the initial rate of decay of A and $\lambda_A>\lambda_B$

(d) Initial rate of decay of B is same as the rate of decay of A at t = 2h and $\lambda_B=\lambda_A$

7) Fusion processes, like combining two deuterons to form a He nucleus are impossible at ordinary temperatures and pressure. The reasons for this can be traced to the fact:

(a) nuclear forces have short range (b) nuclei are positively charged

(c) the original nuclei must be completely ionized before fusion can take place

(d) the original nuclei must first break up before combining with each other

8) If $m_e$is mass of an electron, then mass of pion plus particle if

(a) $207m_e$ (b) $273m_e$ (c) $\frac{m_e}{207}$ (d) $\frac{m_e}{273}$

9) Two elementary particles which have almost infinite lifetime are

(a) electron and neutron (b) neutron and proton (c) electron and proton (d) none of the above

10) Relation between decay constant and half-life of a radioactive element is

(a) $T = \frac{1}{\lambda}$ (b) $\lambda = \frac{1}{T^2}$ (c) $T = \frac{0.693}{\lambda}$ (d) $\lambda = 0.693T$

11) 1 curie = k disintegrations/sec, where kis

(a) 3.7×10^{10} (b) 3.7×10^{-10} (c) 7.3×10^{-10} (d) 7.3×10^{10}

12) The radii of two nuclei with mass numbers 1 and 8 are in the ratio

(a) 1:8 (b) 8:1 (c) 1:2 (d) 2:1

13) A nucleus ${}_nX^m emits\ one\ \alpha\ particle\ and\ one\ \beta\ particle.$The mass number and atomic number of product nucleus, are

(a) (m-4),n (b) (m-4),(n-1) (c) (m-3),n+1 (d) (m-3),(n-1)

14) Out of ${}_6C^{14},_7N^{13},_7N^{14} and _8O^{16}$the pair of isotopes is

(a) ${}_6C^{14},_8O^{16}$ (b) ${}_7N^{13},_7N^{14}$ (c) ${}_7N^{14},_6C^{14}$ (d) ${}_7N^{14},_8O^{16}$

15) Consider 3rd orbit of Helium. Using non-relativistic approach, the speed of electron in this orbit will be
$\left[given\ K = 9 \times 10^9, Z = 2\ and\ h = 6.6 \times 10^{-34} Js\right]$

(a) $1.46 \times 10^6 m/s$ (b) $0.73 \times 10^6 m/s$ (c) $3 \times 10^8 m/s$ (d) $2.92 \times 10^6 m/s$

16) Hydrogen $\left({}_1H^1\right)$, Deuterium $\left({}_1H^2\right)$, singly ionized helium $\left({}_2H^4\right)^+$ and doubly ionized Lithium $\left({}_3Li^7\right)^{++}$ all have one electron around the nucleus. Consider an electron transition from n = 2 to n = 1. If wavelengths of emitted radiation are $\lambda_1, \lambda_2, \lambda_3, \lambda_4$ respectively, then approximately which one of the following is correct?

(a) $\lambda_1 = \lambda_2 = 4\lambda_3 = 9\lambda_4$ (b) $\lambda_1 = 2\lambda_2 = 3\lambda_3 = 4\lambda_4$ (c) $4\lambda_1 = 2\lambda_2 = 2\lambda_3 = \lambda_4$
(d) $\lambda_1 = 2\lambda_2 = 2\lambda_3 = \lambda_4$

17) A nucleus with mass number 220 initially at rest emits an α-particle. If the energy released in the reaction is 5.5 MeV, calculate the K.E. of α-particle.

(a) 4.4 MeV (b) 5.4 MeV (c) 5.6 MeV (d) 6.5 MeV

18) The thermal neutrons in a nuclear reactor may be regarded as a gas at a temperature $T^\circ K$, which obeys the laws of kinetic theory. Then the de-Bro-glie wavelength of such thermal neutrons in terms of temperature T, mass of neutron m is given by

(a) $\lambda = \frac{h}{\sqrt{3mKT}}$ (b) $\lambda = \frac{h}{\sqrt{6mKT}}$ (c) $\lambda = \frac{h}{\sqrt{5mKT}}$ (d) $\lambda = \frac{h}{\sqrt{2mKT}}$

19) In the nuclear fusion reaction
${}_1H^2 +_1 H^3 \rightarrow_2 H^4 + n,$
given that the repulsive potential energy between the two nuclei is $\approx 7.7 \times 10^{-14} J$, the temperature at which the gases must be heated to initiate the reaction is of the order of (given Boltzmann constant $k = 1.38 \times 10^{-23} J/K$)

(a) $10^7 K$ (b) $10^5 K$ (c) $10^3 K$ (d) $10^9 K$

20) If $M(A,Z)$, $M_p \; and \; M_n$ denote the masses of the nucleus ${}_ZX^A$, proton and neutron respectively in units of U $\left(where \; 1 \; U = 931.5 \quad MeV/c^2\right)$ and B.E. represents its B.E. in MeV, then

(a) $M(A,Z) = ZM_p + (A-Z)M_n - BE/c^2$ (b) $M(A,Z) = ZM_p + (A-Z)M_n + BE$
(c) $M(A,Z) = ZM_p + (A-Z)M_n - BE$ (d) $M(A,Z) = ZM_p + (A-Z)M_n + BE/c^2$

21) If a star can convert all the He nuclei completely into oxygen nuclei, the energy released per oxygen nucleus is [Mass of He nucleus is 4.0026 amu and mass of Oxygen nucleus is 15.9994 amu]

(a) 7.6 MeV (b) 56.12 MeV (c) 10.24 MeV (d) 23.9 MeV

22) When a slow neutron is captured by a nucleus, a fission results which releases 200 MeV energy. If the output of nuclear reactor is 1.6 MW, then the number of fissions per second of nuclei undergoing fission is

(a) 5×10^{10} (b) 5×10^{12} (c) 5×10^{4} (d) 5×10^{16}

23) A nucleus ${}_ZX^A$ has mass represented by M (A,Z). If $M_p \; and \; M_n$ denote the mass of proton and neutron respectively and B.E., the binding energy in MeV, then

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

24) In the nuclear decay given below
${}_ZX^A \longrightarrow {}_{Z+1}Y^A \longrightarrow {}_{Z-1}B*^{A-4} \longrightarrow {}_{Z-1}B^{A-4}$
The particles emitted in the sequence are :

(a) $\alpha, \; \beta, \; \gamma$ (b) $\beta, \; \alpha, \; \gamma$ (c) $\gamma, \; \beta, \; \alpha$ (d) $\beta, \; \gamma, \; \alpha$

25) The power obtained in a reactor using U^{235} disintegration is 1000 kW. The mass decay of U^{235} per hour is

(a) 10 microgram (b) 20 microgram (c) 40 microgram (d) 1 microgram

26) The binding energies per nucleon of ${}_3Li^7 \; and \; {}_2He^4$ nuclei are 5.60 MeV and 7.06 MeV respectively. In the nucleon reaction ${}_3Li^7 + {}_1H^1 \longrightarrow {}_2He^4 + {}_2He^4 + Q$ the value of energy Q released is

(a) 19.6 MeV (b) - 2.4 MeV (c) 8.4 MeV (d) 17.3 MeV

27) A nucleus of uranium decays at rest into nuclei of thorium and helium. Then :

(a) The helium nucleus has less kinetic energy than the thorium nucleus
(b) The helium nucleus has more kinetic energy that the thorium nucleus
(c) The helium nucleus has less momentum than the thorium nucleus
(d) The helium nucleus has more momentum than the thorium nucleus

28) Two spherical nuclei have mass number 216 and 64 with their radii $R_1 \; and \; R_2$ respectively. The ratio, $\frac{R_1}{R_2}$ is equal to

(a) 3 : 2 (b) 1 : 3 (c) 1 : 2 (d) 2 : 3

29) A nuclear power plant supplying electrical power to a village uses a radioactive material of half life T years as a fuel. The amount of fuel at the beginning is such that the total power requirement of the village is 12.5% of the electrical power available from the plant at that time. If the plant is able to meet the total power needs of the village for a maximum period of nT years, then the value of n is

(a) 1 (b) 2 (c) 3 (d) 4

30) The isotopes ${}_5B^{12}$ having a mass 12.014 u undergoes β-decay to ${}_6C^{12}$.${}_6C^{12}$ has an excited state of the nucleus $\left({}_6C^{12*}\right)$ at 4.041 MeV above its ground state. If ${}_5B^{12}$ decays to ${}_6C^{12*}$, the maximum K.E. of β particle in units of MeV is (Given $1 \; u = 931.5 MeV/c^2$, where c is speed of light in vacuum)

(a) 9 (b) 6 (c) 3 (d) 1

31) For a radioactive material, its activity A and rate of change of its activity R are defined as
$A = -\frac{dN}{dt} \quad and \quad R = -\frac{dA}{dt}$,
where N (t) is the number of nuclei at time t. Two radioactive sources P (mean life τ) and Q (mean life 2τ) have the same activity at t = 0. Their rates of change of activities at t = 2τ are $R_P \; and \; R_Q$, respectively. If $\frac{R_P}{R_Q} = \frac{n}{e}$, then the value of n is

(a) 1 (b) 2 (c) 3 (d) 4

32) Two radioactive materials of half life T are produced at different instants. The activities of the material are found to be $A_1 \; and \; A_2 \; (A_2 < A_1)$. What is the age difference between them?

(a) $1.44 \; T \; \log_e \left(\frac{A_1}{A_2}\right)$ (b) $2.88 \; T \; \log_e \left(\frac{A_1}{A_2}\right)$ (c) $2.88 \; T \; \log_e \left(\frac{A_2}{A_1}\right)$ (d) $1.44 \; T \; \log_e \left(\frac{A_2}{A_1}\right)$

33) C^{14} has half life 5700 years. At the end of 11400 years, the actual amount left is

(a) 0.5 g of or original amount (b) 0.25 of original amount (c) 0.125 of original amount

(d) none of the above.

34) Two radioactive substances A and B have decay constants $5\lambda \; and \; \lambda$ respectively. At t = 0, they have the same number of nuclei. The ratio of number of nuclei of A to those of B will be $(1/e)^2$ after a time

(a) 4λ (b) 2λ (c) $\frac{1}{2\lambda}$ (d) $\frac{1}{4\lambda}$

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

(a) 2400 yrs (b) 3200 yrs (c) 4800 yrs (d) 6400 yrs

36) A radioisotope X with a half life 1.4×10^9 years decays to Y, which is stable. A sample of the rock from a cave was found to contain X and Y in the ratio 1 : 7. The age of the rock is

(a) $1.96 \times 10^9 \; years$ (b) $3.92 \times 10^9 \; years$ (c) $4.20 \times 10^9 \; years$ (d) $8.40 \times 10^9 \; years$

37) In a radioactive material, the activity at time t_1 is R_1 and later at time t_2 it is R_2. If decay constant of the material is λ, then

(a) $R_1 = R_2 \left(t_2/t_1\right)$ (b) $R_1 = R_2$ (c) $R_1 = R_2 e^{-\lambda(t_1 - t_2)}$ (d) $R_1 = R_2 e^{\lambda(t_1 - t_2)}$

38) The intensity of gamma radiation from a given source is I. On passing through 36 mm of lead, it is reduced to $\frac{I}{8}$. The thickness of lead which will reduce the intensity to $\frac{I}{2}$ will be

(a) 12 mm (b) 18 mm (c) 9 mm (d) 6 mm

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

(a) $\frac{A-Z-4}{Z-8}$ (b) $\frac{A-Z-12}{Z-4}$ (c) $\frac{A-Z-4}{Z-2}$ (d) $\frac{A-Z-8}{Z-4}$

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

(a) $\log_e 2/5$ (b) $\frac{5}{\log_e 2}$ (c) $5 \log_{10} 2$ (d) $5 \log_e 2$

41) The speed of daughter nuclei is

(a) $c\sqrt{\frac{2\Delta m}{M}}$ (b) $c\sqrt{\frac{\Delta m}{M}}$ (c) $c\sqrt{\frac{\Delta m}{M+\Delta m}}$ (d) $c\frac{\Delta m}{M+\Delta m}$

42) The decay constant of a radio isotope is λ. If $A_1 \; and \; A_2$ are its activities at times $t_1 \; and \; t_2$ respectively, the number of nuclei which have decayed during the time $(t_1 - t_2)$

(a) $A_1 t_1 - A_2 t_2$ (b) $A_1 - A_2$ (c) $(A_1 - A_2)/\lambda$ (d) $\lambda (A_1 - A_2)$

43) A radioactive nucleus of mass M emits a photon of frequency v and the nucleus recoils. The recoil energy will be

(a) $Mc^2 - hv$ (b) $h^2 v^2/2Mc^2$ (c) zero (d) hv

44) A radioactive isotope has a half life T years. How long will it take the activity to reduce to 1% of its original value?

(a) 3.2 T years (b) 4.6 T years (c) 6.6 T years (d) 9.2 T years

45) Two samples X and Y contain equal amounts of radioactive substances. If $\frac{1}{16}th$ of sample X and $\frac{1}{256}th$ of sample Y remain after 8 h, then the ratio of half periods of X and Y is

(a) 2 : 1 (b) 1 : 2 (c) 1 : 4 (d) 1 : 16 (e) 4 : 1

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

(a) 30 days (b) 50 days (c) 60 days (d) 15 days

47) The half life of a radioactive isotope 'X' is 20 years. It decays to another element 'Y' which is stable. The two elements 'X' and 'Y' were found to be in the ratio 1 : 7 in a sample of a given rock. The age of the rock is estimated to be :

(a) 100 years (b) 40 years (c) 60 years (d) 80 years

48) An accident in a nuclear laboratory resulted in deposition of a certain amount of radioactive material of half life 18 days inside the laboratory Tests revealed that radiation was 64 times more than the permissible level required for safe operation of laboratory. What is the minimum number of days, after which the laboratory can be considered safe for use?

(a) 64 (b) 90 (c) 108 (d) 120

49) The mass number of a nucleus is :

(a) always less than its atomic number (b) always more than its atomic number

(c) sometimes equal to its atomic number (d) sometimes more than and sometimes equal to its atomic number

50) As the mass number 'A' increases, which of the following quantities related to nucleus do not change?

(a) mass (b) volume (c) density (d) binding energy

51) Which of the following statement(s) is (are) correct?

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

(b) The rest mass of a stable nucleus is greater than the rest masses of its separated nucleons.

(c) In nuclear fission, energy is released by fusing two nuclei of medium mass. (approximately 100 amu)

(d) In nuclear fission, energy is released by fragmentation of a very heavy nucleus.

52) During a nuclear fusion reaction :

(a) a heavy nucleus breaks into two fragments 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 give a heavier nucleus and possibly other products

53) A freshly prepared radioactive source of half life 2 h emits radiation of intensity, which is 64 times the permissible safe level. The minimum time after which it would be possible to work safely with this source is :

(a) 6 h (b) 12 h (c) 24 h (d) 28 h

54) The nuclear forces

(a) are stronger, being roughly hundred times that of electromagnetic forces

(b) have a short range dominant over a distance of about a few fermi

(c) are central forces, independent of the spin of the nucleons (d) are independent of the nuclear charge.

55) A deutron is bombarded on ${}_8O^{16}$ nucleus and an α particle is emitted. The product nucleus is

(a) ${}_7N^{14}$ (b) ${}_7N^{13}$ (c) ${}_4Be^9$ (d) ${}_5B^{10}$

56) The heavier nuclei tend to have larger N/Z ratio, because

(a) coulomb forces have longer range compared to the nuclear forces

(b) a neutron does not exert electric repulsion (c) a neutron is an unstable particle

(d) a neutron is heavier than a proton.

57) Let m_p be the mass of a proton, m_n, the mass of neutron, M_1, the mass of ${}_{10}Ne^{20}$ nucleus and M_2, the mass of a ${}_{20}Ca^{40}$ nucleus. Then

(a) $M_2 = 2M_1$ (b) $M_2 > 2M_1$ (c) $M_2 < 2M_1$ (d) $M_1 < 10\left(m_n + m_p\right)$

58) Which of the following assertions are correct?

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

(b) A proton can change to a neutron only inside a nucleus (c) An isolated proton can change into a neutron

(d) An isolated neutron can change into a proton

59) Two deutrons each of mass m fuse to form helium resulting in release of energy E. The mass of helium formed is

(a) $m + E/c^2$ (b) $2m + E/c^2$ (c) E/c^2 (d) $2m - E/c^2$

60) A sample of a radioactive element has a mass of 10 g at an instant t = 0. The approximate mass of this element in the sample after two mean lives is

(a) 1.35 g (b) 2.50 g (c) 3.70 g (d) 6.30 g

61) Atomic mass unit (1 u) is

(a) 1/12 of mass of ^{12}C atom (b) 1/14 of mass of ^{14}C atom (c) 1/12 of mass of ^{14}C atom

(d) 1/6 of mass of ^{12}C atom

62) Ratio of radius of an atom to the radius of its nucleus is around

(a) 10^{-2} (b) 10^4 (c) 10^{12} (d) 10^{15}

63) The number of neutrons in a ${}_{84}PO^{218}$nucleus is

(a) 84 (b) 218 (c) 222 (d) 134

64) As compared to ^{12}Catom, ^{14}Catom has

(a) two extra protons and two extra electrons (b) two extra protons but no extra electrons

(c) two extra neutrons and no extra electrons (d) two extra neutrons and two extra electrons

65) Density of a nucleus is

(a) more for lighler elements and less for heavier elements

(b) more for heavier elements and less for lighter elements (c) very less compared to ordinary matter

(d) a constant

66) Energy equivalent of 2 g of a substance is

(a) 18 x 10^{13}mJ (b) 18 x 10^{13}J (c) 9 x 10^{13}mJ (d) 9 x 10^{13}J

67) Given, $m\left(\begin{matrix}56\\26\end{matrix}\mathrm{Fe}\right) = 55.934939$ and $m\left({}^{209}_{83}\mathrm{Bi}\right)$ = 208.980388 u m_{proton} = 1.007825 u, $m_{neutron}$ = 1.008665 u.Then, BE per nucleon of Fe

(a) 8.790 MeV (b) 7.75 MeV (c) 7.5 MeV (d) Data insufficient

68) Nature of nuclear force is

(a) electrical (b) magnetic (c) gravitational (d) None of the above

69) The gravitational force between a H-atom and another particle' of mass m will be given by Newton's law $F = G\frac{Mm}{r^2}$, where r is in km

(a) Gravitational mass of H-atom (b) Effective mass of H-atom (c) Nuclear mass of H-atom

(d) Mass of electrons in H-atom

70) When a nucleus in an atom undergoes a radioactive decay, the electronic energy levels of the atom

(a) do not change for any type of radioactivity (b) change for a and β-radioactivity but not for γ-radioactivity

(c) change for a-radioactivity but not for others (d) change for β-radioactivity but not for others

71) For a radioactive sample half-life $T_{1/2}$ and disintegration constant λ are related as

(a) $T_{1/2} = \log 2 \cdot \lambda$ (b) $(\text{b})\, T_{1/2} = \frac{\log 2}{\lambda}$ (c) $T_{1/2} \times \log 2 = \lambda$ (d) None of these

72) Tritium has a half-life of 12.5 yr undergoing β-decay. Fraction of sample remaining undecayed after 25 yr will be

(a) $\frac{1}{8}$ (b) $\frac{1}{2}$ (c) $\frac{1}{4}$ (d) $\frac{1}{16}$

73) In the a-decay of $^{238}_{92}\text{U} \longrightarrow X + ^{4}_{2}\text{He}$ The nucleus X is

(a) $^{234}_{90}\text{Th}$ (b) $^{235}_{90}\text{U}$ (c) $^{237}_{91}\text{Pa}$ (d) Cannot be determined

74) In a nuclear reaction $^{298}_{02}\text{U} \rightarrow ^{A}_{Z}\text{Th} + ^{4}_{2}\text{He}$, the value of A and Z are

(a) A = 234, Z = 94 (b) A = 238, Z = 94 (c) A = 234, Z = 90 (d) A = 238, Z = 90

75) On emission of ∨-rays from a nucleus, change occurs in its

(a) proton number (b) neutron number (c) Both proton and neutron number

(d) Neither proton nor neutron number

76) A radioactive nucleus $_{81}X^{237}$ emits three a-particles and one β-particle. The resultant nucleus will be

(a) $_{76}Y^{225}$ (b) $_{78}Y^{225}$ (c) $_{80}Y^{229}$ (d) $_{83}Y^{230}$

77) For sustaining the chain reaction in a sample (of small size) of $^{235}_{92}\text{U}$ it is desirable to slow down fast neutrons by

(a) friction (b) elastic damping/scattering (c) absorption (d) None of the above

78) In a nuclear reactor, moderators slow down the neutrons which come out in a fission process. The moderator used have light nuclei. Heavy nuclei will not serve the purpose, because

(a) they will break up (b) elastic collision of neutrons with heavy nuclei will not slow them down

(c) the net weight of the reactor would be unbearably high

(d) substances with heavy nuclei do not occur in liquid or gaseous state at room temperature

79) If the nuclear radius of ^{27}Al is 3.6 Fermi, the approximate nuclear radius of ^{64}Cu in Fermi is

(a) 2.4 (b) 1.2 (c) 4.8 (d) 3.6

80) How much mass has to converted into energy to produce electric power of 200 MWfor one hour?

(a) 2×10^{-6} kg (b) 8×10^{-6} kg (c) 1×10^{-6} kg (d) 3×10^{-6} kg

81) The mass defect of helium nucleus is 0.0303 amu. The binding energy per nucleon for helium nucleus will be

(a) 28 MeV (b) 7 MeV (c) 14 MeV (d) 1 MeV

82) Binding energy of hydrogen nucleus is

(a) - 13.6 eV (b) 0 (c) 13.6 eV (d) 6.8 eV

83) Two protons are attracting each other, then separation between them is

(a) 10^{-10} m (b) 10^{-2} m (c) 10^{-8} m (d) 10^{-15} m

84) The half-life of radium is 1600 yr. The time in which 100 g of radium will disintegrate and only 25 g radium will remain undisintegrated will be

(a) 2400 yr (b) 3200 yr (c) 4800 yr (d) 6400 yr

85) In the initial mass of substance of 5 yr half-life period is N_0, then the final mass after 15 yr of that substance will be

(a) $N_0/2$ (b) $N_0/3$ (c) $N_0/4$ (d) $N_0/8$

86) The decay constant of a radioactive substance is 3.465×10^{-4} per year. The approximate half-life is

(a) 2000 yr (b) 2400 yr (c) 2600 yr (d) 6300 yr

87) In fusion reaction occurring in the sun,

(a) hydrogen is converted into carbon

(b) hydrogen and helium are converted into carbon and other heavier metals/elements

(c) helium is converted into hydrogen (d) hydrogen is converted into helium

88) The gravitational force between a H-atom and another particle of mass m will be given by Newton's law: $F = G\frac{M.m}{r^2}$,where r is in km and

(a) $M = m_{\text{proton}} + m_{\text{electron}}$ (b) $M = m_{\text{proton}} + m_{\text{electron}} - \frac{B}{c^2}(B = 13.6\text{eV})$

(c) M is not related to the mass of the hydrogen atom.

(d) $M = m_{\text{proton}} + m_{\text{electron}} - \frac{|V|}{r^2}(|V| =$ magnitude of the potential energy of electron in the H-atom).

89) M_x and M_y denote the atomic masses of the parent and the daughter nuclei respectively in a radioactive decay. The Q-value for a β^- decay is Q_1 and that for a β^+ decay is Qr If m_e denotes the mass of an electron, then which of the following statements is correct?

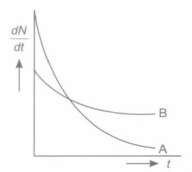
(a) $Q_1 = (M_x - M_y)\,c^2 \text{ and } Q_2 = (M_x - M_y - 2m_e)\,c^2$

(b) $Q_1 = (M_x - M_y)\,c^2 \text{ and } Q_2 = (M_x - M_y)\,c^2$

(c) $Q_1 = (M_x - M_y - 2m_e)\,c^2 \text{ and } Q_2 = (M_x - M_y + 2m_e)\,c^2$

(d) $Q_1 = (M_x - M_y + 2m_e)\,c^2 \text{ and } Q_2 = (M_x - M_y + 2m_e)\,c^2$

90) The variation of decay rate of two radioactive samples A and B with time is shown in figure.
Which of the following statements are true?



(a) Decay constant of A is greater than that of B, hence A always decays faster than B.

(b) Decay constant of B is greater than that of A but its decay rate is always smaller than that of A.

(c) Decay constant of A is equal to that of B

(d) Decay constant of B is smaller than that of A but still its decay rate becomes equal to that of A at a later instant.

91) Radioactivity is the phenomenon associated with

(a) decay of nucleus. (b) production of radio waves. (c) transmission of radio waves

(d) reception of radio waves.

92) Which of the following are not emitted by radioactive substances?

(a) Electrons (b) Protons (c) Gamma rays (d) Helium nuclei

93) In an α-decay

(a) the parent and daughter nuclei have some number of protons.

(b) the daughter nucleus has one proton more than parent nucleus.

(c) the daughter nucleus has two protons less than parent nucleus.

(d) the daughter nucleus has two nucleus more than parent nucleus

94) When a radioactive nucleus emits a β-particle, the mass number of the atom:

(a) increases by one. (b) remains the same (c) decreases by one (d) decreases by four.

95) In a β-decay

(a) the parent and daughter nuclei have the same number of protons.

(b) the daughter nucleus has one proton less than parent nucleus.

(c) the daughter nucleus has one proton. more than the parent nucleus

(d) the daughter nucleus has one neutron more than the parent nucleus.

96) When a β-particle is emitted from a nucleus then its neutron-proton ratio

(a) increases (b) decreases (c) remains unchanged.

(d) may increase or decrease depending upon the nucleus.

97) The relation between half-life $T_{1/2}$ of a radioactive sample and its mean life τ is

(a) $T_{1/2} = 0.693\tau$ (b) $\tau = 0.693T_{1/2}$ (c) $\tau = T_{1/2}$ (d) $\tau = 2.718T_{1/2}$

98) β-rays emitted by a radioactive material are

(a) electromagnetic radiations (b) electrons orbiting around the nucleus (c) neutral particles.

(d) charged particles emitted by nucleus

99) During a mean life of a radioactive element the fraction that disintegrates is

(a) e (b) $\frac{1}{e}$ (c) $\frac{e-1}{e}$ (d) $\frac{e}{e-1}$

100) γ-rays are originated from

(a) nucleus. (b) outermost shell of nucleus (c) innermost shell of nucleus. (d) outermost shell of atom.

101) Binding energy per nucleon of a stable nucleus is

(a) 8 eV (b) 8 KeV (c) 8 MeV (d) 8 Bev

102) Sun's radiant energy is due to

(a) nuclear fission. (b) nuclear fusion. (c) photoelectric effect. (d) spontaneous radioactive decay

103) Average binding energy is maximum for

(a) C^{12} (b) Fe^{26} (c) U^{235} (d) Po^{210}

104) The quantity which is not conserved in a nuclear reaction is

(a) momentum. (b) charge. (c) mass. (d) none of these

105) A nucleus undergoes γ-decay due to

(a) excess of protons. (b) excess of neutrons. (c) large mass. (d) its excited state

106) A radioactive element has half-life period 1600 years. After 6400 years what amount will remain?

(a) $\frac{1}{2}$ (b) $\frac{1}{16}$ (c) $\frac{1}{8}$ (d) $\frac{1}{4}$

107) Ratio of the radii of the nuclei with mass numbers f 8 and 27 would be

(a) $\frac{27}{8}$ (b) $\frac{8}{27}$ (c) $\frac{2}{3}$ (d) $\frac{3}{2}$

108) The decay constant of a radioactive substance is λ. Its half-life and mean life, respectively are

(a) $\frac{1}{\lambda}$ and $\log_e 2$ (b) $\frac{\log_e 2}{\lambda}$ and $\frac{1}{\lambda}$ (c) $2\log_e 2$ and $\frac{1}{\lambda}$ (d) $\frac{1}{\lambda}$ and $\frac{1}{\lambda}$

109) A radioactive nucleus emits a beta particle. The parent and daughter nuclei are

(a) isotopes (b) isotones (c) isomers (d) isobars

110) In the disintegration series ${}^{238}_{92}\mathrm{U} \longrightarrow \mathbf{X} \xrightarrow{-\alpha} {}^{\mathrm{A}}_{\mathrm{Z}}\mathbf{Y}$ the values of Z and A respectively will be

(a) 92, 236 (b) 88,230 (c) 90, 234 (d) 91, 234

111) A nucleus ${}^{A}_{Z}X$ emits an α-particle. The resultant nucleus emits a β-particle. The respective atomic and mass numbers of the daughter nucleus will be

(a) Z - 3, A - 4 (b) Z - 1, A - 4 (c) Z - 2, A - 4 (d) Z, A - 2

112) In the nuclear reaction ${}^{11}_{6}C \longrightarrow {}^{11}_{5}B + \beta^{+} + \mathbf{X}$ What does X stand for?

(a) Electron (b) Proton (c) Neutron (d) Neutrino

113) If the number of nucleons increase, then binding energy per nucleon of the nucleus

(a) continuously increases with mass number. (b) continuously decreases with mass number.

(c) first increases and then decreases with mass number (d) remains constant with mass number.

114) Penetrating power is minimum for

(a) α-rays (b) γ-rays (c) β-rays (d) X-rays

115) Isotopes have

(a) same number of protons (b) same number of nucleons (c) same number of neutrons

(d) same number of positrons

116) Which of the following statements is true for nuclear forces?

(a) They obey the inverse square law of distance. (b) They obey the inverse third power law of distance.

(c) They are short range forces (d) They are equal in strength to electromagnetic forces

117) The mass density of a nucleus varies with mass number A as

(a) A^2 (b) A (c) constant (d) A/2

118) The radius (r_n) of n^{th} orbit in Bohr model of hydrogen atom varies with n as

(a) $r_n \propto n$ (b) $r_n \propto \frac{1}{n}$ (c) $r_n \propto n^2$ (d) $r_n \propto \frac{1}{n^2}$

119) The ratio of the nuclear densities of two nuclei having mass numbers 64 and 125 is

(a) $\frac{64}{125}$ (b) $\frac{4}{5}$ (c) $\frac{5}{4}$ (d) 1

120) The curve of binding energy per nucleon as a function of atomic mass number has a sharp peak for helium nucleus. This implies that helium nucleus is

(a) radioactive (b) unstable (c) easily fissionable (d) more stable nucleus than its neighbours

121) The formation of depletion region in a p-n junction diode is due to

(a) movement of dopant atoms (b) diffusion of the electrons and holes (c) drift of electrons only

(d) drift of holes only

122) Which of the following statements about nuclear forces is not true?

(a) The nuclear force between two nucleons falls rapidly to zero as their distance is more than a few femtometres.

(b) The nuclear force is much weaker than the Coulomb force.

(c) The force is attractive for distances larger than 0.8 fm and repulsive if they are separated by distances less than 0.8 fm

(d) The nuclear force between neutron-neutron,proton-neutron and proton-proton is approximately the same.

Fill up / 1 Marks 12 x 1 = 12

123) Total energy of electron in outer orbit is ___________ that in ___________.

124) The energy equivalent of 1 amu is _________

125) One electron volt is the __________ when accelerated through a ____________

126) Density of nuclear matter is the ___________ mass of __________ and its ___________.

127) Isotones are the nuclides which contain _____________.

128) Packing fraction of a nucleus is defined as _________ per _________.

129) Nuclear forces are the ________ which hold together __________ in the tiny___________.

130) Radioactivity is the property by virtue of which __________ without being forced by __________.

131) Neutrino is a particle, which is chargeless and has spin.

132) Isotones have the same number of ________.

133) Packing fraction of a nucleus is its _________ its per nucleon.

134) In β^+ decay atomic number of daughter nucleus is one __________ than parent nucleus.

Assertion and reason 14 x 1 = 14

135) **Assertion (A)** : Rydberg's constant varies with the mass number of a given element.
Reason (R) : The reduced mass of the electron depends on the mass of the nucleus only.
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

136) **Assertion (A)** : Isotopes of an element can be separated by using a mass spectrometer.
Reason (R) : Separation of isotopes is possible because of the difference in electron numbers of isotopes
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

137) **Assertion (R)** : $^{14}_{7}\mathrm{N}$ is stable.
Reason (R) : Nuclei having an odd number of protons and an odd number of neutrons are generally less stable than the one having even number of protons and even number of neutrons.
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

138) **Assertion (A)** : Nuclear density is extremely higher than atomic density.
Reason (R) : Most of the mass of the atom is concentrated in the nucleus
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

139) **Assertion (A)** : The nuclear force becomes weak if the nucleus contains too many protons compared to neutrons.
Reason (R) : The electrostatic forces weaken the nuclear force.
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

140) **Assertion (A)** : Two protons can attract each other.
Reason (R) : The distance between the protons within the nucleus is about 10^{-15} m.
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

141) **Assertion (A)** : For the fission of heavy nuclei, neutrons are more effective than protons.
Reason (R) : Neutrons are heavier than protons.
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

142) **Assertion (A)** : Energy is released in a nuclear reaction.
Reason (R) : In any nuclear reaction the reactants and resultant products obey the law of conservation of charge and mass only.
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

143) **Assertion (A)** : Density of all the nuclei is same.
Reason (R) : Radius of nucleus is directly proportional to the cube root of mass number.
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

144) **Assertion (A)** : There is a chain reaction when uranium is bombarded with slow neutrons.
Reason (R) : When uranium is bombarded with slow neutrons more neutrons are produced.
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

145) **Assertion (A)** : Cadmium rods used in a nuclear reactor, control the rate of fission.
Reason (R) : Cadmium rods speed up the slow neutrons.
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

146) **Assertion (A)** : A fission reaction can be more easily controlled than a fission reaction.
Reason (R) : The percentage of mass converted to energy in a fission reaction is 0.1% whereas in a fission reaction it is 0.4%.
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

147) **Assertion (A)** : The ratio for time taken for light emission from an atom to that for release of nuclear energy in fission is 1 : 100.
Reason (R) : Time taken for the light emission from an atom is of the order of 10-8 s.
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

148) **Assertion (A)** : Thermonuclear fusion reactions may become the source of unlimited power for the mankind.
Reason (R) : A single fusion event involving isotopes of hydrogen produces more energy than energy from nuclear fission of a single uranium
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

2 Marks 181 x 2 = 362

149) Given the mass of iron nucleus as 55.85u and A = 56, find the nuclear density?

150) Calculate the energy equivalent of 1 g of substance.

151) Obtain approximately the ratio of the nuclear radii of the gold isotope $^{197}_{79}\mathrm{Au}$ and the silver isotope $^{107}_{47}\mathrm{Ag}$.

152) How is impact parameter related to the scattering angle?

153) Write the relation for (i) the distance of closest approach and (ii) impact parameter.

154) Why is that mass of nucleus does not enter the formula for impact parameter but its charge does?

155) Show that Bohr's second postulate "The electron revolves around the nucleus only in certain fixed orbits without radiating energy" can be explained on the basis of de-Broglie hypothesis of wave nature of electron.

156) What is the order of nuclear density?

157) Why is nuclear density same for all nuclei?

158) Why are heavy nuclei usually unstable?

159) A nucleus pf mass number A has mass defect (Δm). What is BE per nucleon of this nucleus?

160) State two characteristic properties of nuclear forces.

161) Name two elementary particles which have almost infinite life time.

162) Compare the radii of two nuclei with mass numbers 1 and 27 respectively.

163) How many coulombs of charge is carried by 1kg of electrons?

164) Name three nuclei which lie on maxima in Binding energy curve.

165) Proton and neutron exist together in an extremely small space within the nucleus.How is this possible when protons repel each other?

166) Write down the names and formulate of the three isotopes of hydrogen.

167) Select the pairs of isobars and isotones from the following nuclei: ${}_6C^{14},{}_7N^{13},{}_7N^{14},{}_8O^{16}$: :

168) Select the pairs of isotopes and isotones from the following nuclei: ${}_6C^{13},{}_7N^{14},{}_{15}P^{30},{}_{15}P^{31}$.

169) Two nuclei have mass numbers on the radio 1:8.What is the ratio of their nuclear radii?

170) What do you understand by the fact that the binding energy of helium nucleus is 28.17 MeV.

171) The binding energies of deutron $({}_1H^2)$ and α- particle $({}_2He^4)$ are 1.25 and 7.2 MeV/nucleon respectively. Which nucleus is more stable?

172) Nuclear forces are short range forces. Comment.

173) Two nuclei have mass numbers in the ratio 1:2. What is the ratio of their nuclear densities?

174) Identify the nuclides X and Y in the nuclear reactions ${}_5\beta^{11} +_1 H^1 \rightarrow_4 Be^8 + X;$
${}_6C^{14} \rightarrow Y +_{-1} e^0.$

175) Out of alpha, beta and gamma radiations, which are affected by electric field and magnetic field?

176) The decay constant of a radioactive element is λ. Give the formula for half life and mean life.

177) The mean life of a radioactive sample is T_m. What is the time in which 50% of the sample would get decayed?

178) Write the SI unit of activity of a radioactive nuclide.

179) Can radioactivity be controlled?

180) What is the difference between a beta particle and electron?

181) A radioactive material has a half-life of 1 minute. If one of the nuclei decays now, when will the next one decay?

182) A nucleus ${}_{92}U^{235}$ undergoes alpha decay and transforms into thorium. What is mass number and charge number of nucleus produced?

183) Name the process responsible for energy production in the sun.

184) Name the absorbing material used to control the reaction rate of neutrons in a nuclear reactor.

185) What do you mean by Q value of a nuclear reaction?

186) What is meant by critical size?

187) What is pair production?

188) What is the mass of pion plus (π^+)?

189) What is the mass muon plus (π^+)?

190) Is it possible that a nucleus has negative mass defect?

191) In a particular fission reaction, a ${}_{92}U^{235}$ nucleus captures a slow neutron. The fission products are three neutrons, a ${}_{57}La^{142}$nucleus and a fission product ${}_ZX^A$. What is the value of Z?

192) Neutrons produced in fission can be slowed down even by using ordinary water.Then, why is heavy water used for this purpose?

193) Two nuclei have mass numbers in the ratio 2:5. What is the ratio of their nuclear densities?

194) Assuming the nuclei to be spherical in shape, how does the surface area of a nucleus of mass number A_1 compare with that of a nucleus of mass number A_2?

195) What is the effect on neutron to proton ratio in a nucleus when (i) an electron, (ii) a positron is emitted?

196) Why must heavy stable nucleus contain more neutrons than protons?

197) Which property of nuclear forces is responsible for the constancy of binding energy per nucleon?

198) Calculate the energy equivalent of 1 a.m.u. in MeV.

199) You are given two nuclei ${}_3X^7$ and ${}_3Y^4$. Explain giving reasons, as to which one of the two nuclei is likely to be more stable?

200) If the nucleons bound in a nucleus are separated apart from each other, the sum of their masses is greater than the mass of the nucleus. Where does this mass difference come from? Explain briefly.

201) Binding energies of ${}_8O^{16}$ and ${}_{17}Cl^{35}$ are 127.35 MeV and 289.3 MeV respectively. Which of the two nuclei is more stable?

202) Show that the decay rate R of a sample of radionuclide is related to the number of radioactive nuclei N at the same instant by the expression $R = \lambda N$.

203) What % will age of a given mass of a radioactive substance be left undecayed after five half life periods?

204) Why is the energy distribution of β- rays continuous?

205) Why is ${}_{92}U^{238}$ not suitable for chain reaction?

206) Why is neutron so effective as a bombarding particle?

207) Nuclear fusion is not possible in laboratory.Why?

208) A fusion reaction is much more energetic than a fission reaction.Comment.

209) Write symbolically the nuclear β^{+} decay process of ${}_{6}C^{11}$. Is the decayed product X an isotope or isobar of ${}_{6}C^{11}$? Given the mass values of $\left({}_{6}C^{11}\right)$
11.011434 u and m(X) = 11.009305 u. Estimate the Q value in the process.

210) What is meant by critical mass in a nuclear chain reaction?

211) A chain reaction dies out sometimes, why?

212) Explain one similarity and one dissimilarity between nuclear fission and fusion.

213) What are thermal neutrons? Why are neutrons considered as ideal particles for nuclear fission?

214) Imagine removing one electron from $He^{4}\ and\ He^{3}$. Their energy levels, as worked out on the basis of Bohr model will be very close. Explain why.

215) In pair annihilation, an electron and a positron destroy each other to produce gamma radiation. How is the momentum conserved?

216) Why do stable nuclei never have more protons than neutrons?

217) A piece of wood from the ruins of an ancient building was found to have a ${}^{14}C$ activity of 12 disintegrations per minute per gram of its carbon content. The ${}^{14}C$ activity of the living wood is 16 disintegrations per minute per gram. How long ago did the tree, from which the wooden sample came, die? Given half-life of ${}^{14}C$ is 5760 years.

218) A nuclide 1 is said to be the mirror isobar of nuclide 2 if $Z_1 = N_2\ and\ Z_2 = N_1$. (a) What nuclide is a mirror isobar of $\begin{matrix}23\\11\end{matrix}Na?$ (b) Which nuclide out of the two mirror isobars has greater binding energy and why?

219) Obtain approximately the ratio of the nuclear radii of the gold isotope $79^{Au^{197}}$ and the silver isotope $79^{Au^{197}}$

220) Draw a graph showing the variation of decay rate with number of active nuclei.

221) ${}_{2}^{3}He$ and ${}_{1}^{3}He$ nuclei have the same mass number. Do they have same binding energy?

222) If the both the numbers of protons and neutrons are conserved in a nuclear reaction like
${}_{6}^{12}C +{}_{6}^{12} C \longrightarrow {}_{10}^{20}Ne +{}_{2}^{4} He$
In what way is the mass converted into energy? Explain.

223) Draw a plot of potential energy between a pair of nucleons as a function of their separation. Mark the regions where potential energy is (i) positive and (ii) negative.

224) In accordance with the Bohr's model, find the quantum number that characterises in the earth's revolution around the sun in an orbit of radius 1.5 $\times 10^{11}$m with orbital speed 3$\times 10^{4}$m/s. (Mass of the earth = 6 $\times 10^{24}$ Kg)

225) The number of particles scattered at 90^{0} is 50 per minute. What will be the number of -particles, when it is scattered at an angle of 120^{0} ?

226) Two nuclei have mass numbers in the ratio of 27:512. What is the ratio of their nuclear radii?

227) In a given sample, two radio isotopes, A and B, are initially present in the ratio of 1:8. The half-lives of A and B are 200 yr and 100 yr, respectively. Find the time after which the amounts of A and B become equal.

228) An ionised H-molecule consists of an e^{-} and two protons. The protons are separated by a small distance. What will happen to the path of electron?

229) Show that the density of nucleus over a wide range of nuclei is constant independent of mass number.

230) Calculate the half-life period of a radioactive substances,if its activity drops to $\frac{1}{16}$ th of its initial value in 30 years

231) In a typical nuclear reaction e.g
$^2_1H +^2_1 H \longrightarrow^3_2 He + n + 3.27MeV$
although number of nucleons is conserved,yet energy is released.How?Explain.

232) What characteristic property of nuclear force explain the constancy of binding energy per nucleon (BE/A) in the range of mass number 'A' lying 30

233) Draw a plot of BE/A versus mass number A for Use this graph to explain the release of enegry in the process of nuclear fusion of two light nuclei.

234) Using the curve for the binding energy per nucleon as a function of mass number A,state clearly how the release in energy in the processes of nuclear fission and nuclear fusion can be explained

235) Define the activity of a given radioactive substance. Write its SI unit.

236) How is the radius of a nucleus related to its mass number?

237) Two nuclei have mass numbers in the ratio 8: 125. What is the ratio of their nuclear radii?

238) Complete the following nuclear reactions.
$^{10}_5B +^1_0 n \rightarrow^4_2 He + \ldots\ldots$
$^{94}_{42}Mo +^2_1 H \rightarrow^{95}_{43} Te + \ldots\ldots$

239) Derive the expression for the law of radioactive decay of a given sample having initially No decaying to the number N present at any subsequent time t.
Plot a graph showing the variation of the number of nuclei versus the time lapsed. Mark a point on the plot in terms of $T_{1/2}$ value the number present N = No / 16.

240) How the size of a nucleus is experimentally determined? Write the relation between the radius and mass number of the nucleus. Show that the density of nucleus is independent of its mass number.

241) Calculate the energy in fusion reaction
$^2_1H +^2_1 H \longrightarrow^3_2 He + n$, where BE of $^2_1H = 2.23$ MeV and of ^3_2He = 7.73 MeV.

242) A nucleus with mass number A = 240 and BE I A = 7.6 MeV breaks into two fragments each of A = 120 with BE/A = 8.5 MeV. Calculate the released energy.

243) Draw a graph showing the variation of potential energy of a pair of nucleons as a function of their separation. Indicate the region in which the nuclear force is (i) attractive and (ii) repulsive.

244) Draw a plot of the binding energy per nucleon as a function of mass number for a large number of nuclei 20 > A > 240. How do you explain the constancy of binding energy per nucleon in the range of 30 < A < 170 using the property that nuclear force is short-ranged?

245) The mass of a nucleus in its ground state is always less than the total mass of its constituents neutrons and protons. Explain.
Plot a graph showing the variation of potential energy of a pair of nucleons as a function of their separation.

246) (i) Write three characteristic properties of nuclear force.
(ii) Draw a plot of potential energy of a pair of nucleons as a function of their separation. Write two important conclusions that can be drawn from the graph.

247) Name and define, the SI units for the'activity', of a given sample of radioactive nuclei.

248) The following table shows some measurements of the decay rate of a radio nuclei sample. Find the disintegration constant.

TIME(MIN)	INR (BQ)
36	5.08
100	3.29
164	1.52
218	1.00

249) The activity R of an unknow nuclide is measured at hourly intervals. The results found are tabulated as follows:

T(H)	0	1	2	3	4
R(MBQ)	100	35.36	12.51	1.56	1.56

250) Two nuclei have mass numbers in the ratio 1:8.What is the ratio of their nuclear radii?

251) which have greater ionizing power:α-particles or β-particles?

252) Why neutrons are considered as ideal particle for nuclear reactions?

253) Does the ratio of neutrons and protons in the nucleus increase, decreases or remain the same after the emission of α – particles?

254) A radio isotope of silver has a half life of 20 minutes. What fraction of the original mass would remain after one hour?

255) What changes takes place in the nucleus when a γ – rays is emitted?

256) Can a single nucleus emit α – particle, β – particle and a γ – rays together?

257) Two nuclei have mass no. in the ratio 1:2. What is the ratio their nuclear densities?

258) Establish the relationship between half life of a radio- active substance and decay constant

259) Explain how ά particle scattering experiment led to Rutherford to estimate the size of the nucleus

260) Find the time required to decay $3/4^{th}$ of a radioactive sample whose half life is 60 days.

261) The disintegration rate of a certain radioactive sample at any instant is 4750 disintegrations per minute. Five minutes later the rate becomes 2700 per minute. Calculate a) Decay constant b) Half-life of the sample

262) Explain with an example, whether neutron-proton ratio increases or decreases during beta decay

263) Obtain the binding energy of a nitrogen nucleus from the following data
m_h=1.007834; m_n=1.00867; m_N=14.03074
Give your answer in MeV

264) Write nuclear equations for
a) The α-decay of $^{226}Ra_{88}$
b) The β^- -decay of $^{32}P_{15}$
c) The β^+ decay of $^{32}P_{15}$

265) A neutron is absorbed by a ^{6}Li3 nucleus with the subsequent emission of an alpha particle.
i) Write the corresponding nuclear reactions.
ii) Calculate the energy released in MeV, in this reaction.
Given mass ^{6}Li3 = 6.0151264; mass (neutron) = 1.00966544
Mass (alpha particle) = 4.00260444 and mass(triton) = 3.01000004

266) Tritium has a half-life of 12.5 y undergoing beta decay.What fraction of a sample of pure tritium will remain undecayed after 25 y.

267) Two nuclei have different number of protons and different number of neutrons. Can they have the same radii and same nuclear density?

268) The isotope $^{16}_{8}\mathrm{O}$ has 8 protons, 8 neutrons and 8 electrons, while$^{8}_{4}\mathrm{Be}$ has 4 protons, 4 neutrons and 4 electrons. Yet the ratio of their atomic masses is not exactly 2. Why?

269) $^{3}_{2}\mathrm{He}$ and $^{3}_{1}\mathrm{He}$ nuclei have the same mass number. Do they have same binding energy?

270) Which property of nuclear forces is responsible for constancy of E_b per nucleon? Comment.

271) Calculate the energy equivalent of 2 g of substance.

272) Check whether the given statement is correct or incorrect, if incorrect then correct it with proper explaination. The order of magnitude of density of nuclear matter is $10^4 kg/m^3$.

273) The mass of a nucleus is less than the sum of the masses of constituent neutrons and protons. Comment.

274) If both the numbers of protons and neutrons are conserved in a nuclear reaction like
$_6C^{12} + {_6C^{12}} \longrightarrow {_{10}Ne^{20}} + {_2He^4}$
In what way is the mass converted into energy? Explain.

275) Explain the processes of nuclear fission and nuclear fusion by using the plot of binding energy per nucleon (BE/ A) versus the mass number A.

276) A heavy nucleus X of mass number 240 and binding energy per nucleon 7.6MeV is splitted, into two fragments Y and Z of mass numbers 110 and 130 .The binding energy of nucleons in Y and Z is 8.5MeV per nucleon. Calculate the energy released per fission in MeV.

277) Anuclide 1is said to be the mirror isobar of nuclide 2, if $Z_1 = N_2$ and $Z_2 = N_1$
(i) What nuclide is a mirror isobar of $^{23}_{11}Na$?
(ii) Which nuclide out of the two mirror isobars have greater binding energy and why?

278) Which one of the following cannot emit radiation and why? Excited nucleus, excited electron.

279) Why a-particles have high ionising power?

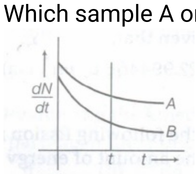
280) An element emits in succession 2 a-particles and 1β-particle. What is the change in mass number?

281) If anti-neutrino has a mass of 3 eV/c^2 (where, c is the speed of light) instead of zero mass, then what should be the range of the kinetic energy of the electron?

282) What is nuclear holocaust?

283) Four nuclei of an element undergo fusion to form a heavier nucleus, with release of energy. Which of the two-the parent or the daughter nucleus-would have higher binding energy per nucleon?

284) Which sample A or B shown in the figure, has shorter mean-life?



285) Two samples contain different radioactive isotopes. Explain, whether it is possible for these samples to have the same activity.

286) Aradioactive isotope has a half-life of 10 yr. How long will it take for the activity to reduce to 3.125%?

287) Consider a radioactive nucleus A which decays to a stable nucleus Cthrough the following sequence
$A \longrightarrow B \longrightarrow C$ where, B is an intermediate nuclei, which is also radioactive. Considering that there are N_0 atoms of A initially, plot the graph showing the variation of number of atoms of A and B versus time.

288) A piece of wood from the ruins of an ancient building was found to have a ^{14}C activity of 12 disintegrations per minute per gram of its carbon content. The ^{14}C activity of the living wood is 16 disintegrations per minute per gram. How long ago did the tree, froin which the wooden sample came, die? Given, half-life ^{14}C is 5760 yr.

289) An atomic power nuclear reactor can deliver 300 MW. The energy released due to fission of each nucleus of uranium atoms U^{238} is 170MeV. What will be the number of uranium atoms fissioned per hour?

290) The half-life period of a radioactive substance is 30 days. What is the time taken for $\frac{3}{4}$ th of its original mass to disintegrate?

291) The Nucleus $^{23}_{10}Ne$ decays by β^--emission.write down the β- decay equation and determine the maximum kinetic energy of the electrons emitted, given that,
$m\left(^{23}_{10}Ne\right) = 22.994466u, m^{23}_{11}Na) = 22.989770u$

292) Complete the following fission reaction and calculate the amount of energy it releases.
$^1_0n + {^{235}_{92}U} \longrightarrow {^{88}_{38}Sr} + {^{136}_{54}Xe} + (?)$

293) Determine the energy released in the following fusion reaction.
$^1_1H + {^2_1H} \longrightarrow {^3_2He} + \gamma$

294) Suppose we think of fission of a $^{56}_{26}\mathrm{Fe}$ nucleus into two equal fragments, $^{28}_{13}\mathrm{Al}$ Is the fission energetically possible? Argue by working out Q of the process. Given,m ($^{56}_{26}\mathrm{Fe}$) = 55.93494 u and $m\left(\begin{matrix}28\\13\end{matrix}\mathrm{Al}\right)=27.98191\mathrm{u}$

295) The fission properties of $^{239}_{94}\mathrm{Pu}$ are very similar to those of $^{235}_{92}\mathrm{U}$ the average energy released per fission is 180 MeV. How much energy in MeV is released, if all the atoms in 1kg of pure $^{239}_{94}\mathrm{Pu}$ undergo fission?

296) Distinguish between nuclear fission and fusion. Show how in both these processes energy is released? Calculate the energy release in MeV in the deuterium-tritium fusion reaction.
$^{2}_{1}\mathrm{H}+^{3}_{1}\mathrm{H}\longrightarrow ^{4}_{2}\mathrm{He}+n$
Using the data,
$m\left(\begin{matrix}2\\1\end{matrix}\mathrm{H}\right)=2.014102\mathrm{u}, m\left(^{3}_{1}\mathrm{H}\right)=3.016049\mathrm{u}$
$m\left(\begin{matrix}4\\2\end{matrix}\mathrm{He}\right)=4.002603\mathrm{u}, \quad m_n=1.008665\mathrm{u}$
$1\mathrm{u}=931.5\frac{\mathrm{MeV}}{c^2}$

297) Define the term "activity" of a radio nuclide. Write its SI unit.

298) Anucleus undergoes a-decay, How does its
(i) mass number and,
(ii) atomic number change?

299) Why is it necessary to slow down the neutrons, produced through the fission of $^{235}_{92}\mathrm{U}$ nuclei (by neutrons) to sustain a chain reaction? What type of nuclei are (preferably) needed for slowing down fast neutrons?

300) Name the materials used as moderators in nuclear reactors and write the reasons for their use as moderator.

301) If both the numbers of protons and neutrons are conserved in a nuclear reaction like
${}_6\mathrm{C}^{12}+{}_6\mathrm{C}^{12}\longrightarrow {}_{10}\mathrm{N}^{20}+{}_2\mathrm{He}^4$
In what way is the mass converted into the energy? Explain.

302) Write the nuclear decay process for β-decay of ${}_{15}P^{32}$

303) What is the relation between the binding energy per nucleon and stability of a nucleus?

304) Write any two characteristic properties of nuclear force.

305) How is the mean life of a radioactive sample related to its half-life?

306) The radioactive isotope D decays according to the sequence $D\xrightarrow{\beta^-}D_1\xrightarrow{\alpha\text{-particle}}D_2$
If the mass number and atomic number of D_2 are 176 and 71 respectively, what is (i) the mass number (ii) atomic number of D?

307) A nucleus ${}_nX^m$ emits one a-particle and one β-particle. What is the mass number and atomic number of the product nucleus?

308) Which nucleus has greater mean life, A or B?

309) Why is a free neutron unstable but a free proton is a stable particle?

310) A neutron strikes a nucleus of $^{10}_{5}B$ and emits an alpha particle. Write down the nuclear reaction for it.

311) Write the necessary condition required for fusion reaction.

312) Out of $^{30}_{14}X; ^{6}_{3}Y$ and ${}_{40}Z^{130}$ which is more likely to undergo the nuclear fusion?

313) What is the effect of temperature on radioactivity?

314) What is the difference between an electron and a β-particle?

315) What is the source of stellar energy?

316) If both the number of protons and the number of neutrons are conserved in a nuclear reaction like
$^{12}_{6}\mathrm{C}+^{12}_{6}\mathrm{C}\longrightarrow ^{20}_{10}\mathrm{Ne}+^{4}_{2}He$, in what way is mass converted into energy? Explain.

317) Draw a plot representing the law of radioactive decay. Define the activity of a sample of a radioactive nucleus. Write its SI unit.

318) (a) Write the β-decay of tritium in symbolic form.
(b) Why is it experimentally found difficult to detect neutrinos in this process?

319) State two characteristics of nuclear force. Why does the binding energy per nucleon decrease with increase in mass number for heavy nuclei like ^{235}U?

320) Are the equations of nuclear reactions 'balanced' in the sense a chemical equation $(\mathrm{e.g.}\ 2\mathrm{H}_2 + \mathrm{O}_2 \rightarrow$ 2 H_2O) is? If not, in what sense are they balanced on both sides?

321) The half life period of a radioactive element A is the same as the mean life of another radioactive element B. Initially both of them have same number of atoms. Show that the radioactive element B decay faster than A.

322) Define the binding energy of the nucleus.

323) A nucleus $^{238}_{92}\mathrm{U}$ undergoes alpha-decay and transforms to thorium. What is
(i) the mass number, and
(ii) atomic number of the nucleus produced?

324) Complete the following nuclear reaction:
$^{4}_{2}\mathrm{He} + ^{9}_{4}\mathrm{Be} \longrightarrow ^{1}_{0}n + \ldots$

325) A nucleus undergoes β^--decay. How does its (i) mass number, (ii) atomic number change

326) What is the nuclear radius of ^{125}Fe, if that of ^{27}Al is 3.6 fm ?

327) Is free proton stable or unstable?

328) Can atomic number be equal to mass number ?

329) In isotones, which particles are different?

3 Marks 113 x 3 = 339

330) Find the energy equivalent of one atomic mass unit, first in Joules and then in MeV. Using this, express the mass defect of $^{16}_{8}\mathrm{O\ in\ MeV/c^2}$

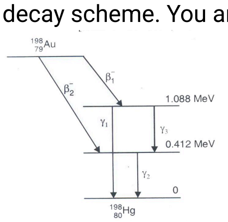
331) Suppose, we think of fission of a $^{56}_{26}\mathrm{Fe}$ nucleus into two equal fragments, $^{28}_{13}\mathrm{Al}$. Is the fission energetically possible? Argue by working out Q of the process. Given m ($^{56}_{26}\mathrm{Fe}$) = 55.93494 u and m ($^{28}_{13}\mathrm{Al}$) = 27.98191 u.

332) The fission properties of $^{239}_{94}\mathrm{Pu}$ are very similar to those of $^{235}_{92}\mathrm{U}$. The average energy released per fission is 180 MeV. How much energy,in MeV, is released if all the atoms in 1 kg of pure $^{239}_{94}\mathrm{Pu}$ undergo fission?

333) From the relation $R = R_0A^{1/3}$, where R_0 is a constant and A is the mass number of a nucleus, show that the nuclear matter density is nearly constant (i.e. independent of A).

334) (a) Define the term decay constant and half life of a radioactive sample. Derive the relation connecting the two.
(b) How many disintegrations per second will occur in one gram of $_{92}U^{238}$, if its half-life against alpha decay is $1.42 \times 10^{17} s$?

335) Obtain the maximum kinetic energy of $\beta-$particles, and the radiation frequencies to $\gamma-$decays in the following decay scheme. You are given that : m(^{198}Au) = 197.968233 u,m(^{198}Hg) = 197.966760 u.



336) For the β^+ (positron) emission from a nucleus, there is another competing process known as electron capture (electron from an inner orbit say the K-shell)is captured by the nucleus and a neutrino is emitted:
$e^+ {}_ZX^A \rightarrow {}_{Z-1}\,Y^A + \nu$
Show that if β^+ emission is energetically allowed, electron capture is necessarily allowed but not vice versa,

337) When impact parameter of α-particle is zero, the -particle travelling directly towards the centre of the nucleus retraces its path.Explain why.

338) How do you justify the assumption that nucleus is at rest while treating the motion of an electron around it?

339) A 12.5 MeV $\alpha -$particle approaching a gold nucleus is deflected back by 180^0. How close does it approach the nucleus?

340) An α- particle of K.E.10^{-12}J exhibits backscattering from a gold nucleus Z = 79. What can be the maximum possible radius of the gold nucleus?

341) A beam of α -particles of velocity $2.1 \times 10^7 \ m/s$ is scattered by a gold foil (Z = 79). Find the distance of closest approach of α -particle to the gold nucleus. For α -particle, $\frac{2e}{m} = 4.8 \times 10^7 Ckg^{-1}$.

342) An alpha particle is scattered through an angle of 10° on passing through a thin foil of copper (Z = 29). If energy of the particle is 5MeV, what is the impact parameter?

343) The number of alpha particles scattered at 60° is 100 per minute in an alpha particle scattering experiment. Calculate the number of alpha particles scattered per minute at 90°.

344) Calculate the impact parameter of a 5 MeV particle scattered by 90°, when it approaches a gold nucleus (Z = 79).

345) Calculate the density of hydrogen nucleus in SI units, given $R_0 = 1.2 \ fermi$, mass of a proton = 1.007825 a.m.u.

346) Assuming that protons and neutrons have equal masses; calculate how many times nuclear matter is denser than water. Take mass of a nucleon $1.67 \times 10^{-27} kg$ and $R_0 = 1.2 \times 10^{-15} m$.

347) What is the nuclear radius of Fe^{125}, if that of Al^{27} is 3.6 fermi.

348) The nuclear radius of ${}_8O^{16}$ is $3 \times 10^{-15} m$. What is its nuclear mass density?

349) The binding energies of deuteron $\left({}_1H^2\right)$ and alpha particle $\left({}_2He^4\right)$ are 1.25 and 7.2 MeV/nucleon respectively. Which nucleus is more stable? Calculate binding energy per nucleon of ${}_{26}Fe^{56}. m\left({}_{26}Fe^{56}\right) = 55.934939$ amu, m (proton) = 1.007825 amu, m (neutron) = 1.008665 a.m.u

350) What energy is needed to split an alpha particle to pieces? Given mass of α-particle is 4.0039a.m.u., mass of proton = 1.007825 u and mass of neutron = 1.008665 u. Use 1 a.m.u = 931.5 MeV.

351) The binding energy per nucleon for ${}_6C^{12}$ is 7.68 MeV/N and that for ${}_6C^{13}$ is 7.47 MeV/N. Calculate the energy required to remove a neutron ${}_6C^{13}$.

352) The sun is believed to be getting its energy from the fusion of four protons to form a helium nucleus and a pair of positrons. Calculate the release of energy perfusion in MeV. Mass of proton = 1.007825a.m.u.,mass of positron = 0.000549 a.m.u., mass of helium nucleus = 4.002603 a.m.u. Take 1 a.m.u.= 931.5MeV.

353) Calculate the binding energy per nucleon in the nuclei of ${}_{15}P^{31}$ Given $m({}_{15}P^{31})$= 30.97376 u
$m({}_0n^1) = 1.00865 \ u; m({}_1H^1) = 1.00782u$

354) The decay constant for a radionuclide has a value of $1.386 \ day^{-1}$. After how much time will a given sample of this nuclide get reduced to only 6.25% of its present number?

355) The half-life of a radioactive substance is $5 \times 10^3 \ years$In how many years will its activity decay to 0.2 times its initial activity? Take $log_{10}5 = 0.6990.$

356) The count rate of a radioactive sample falls from $4 \times 10^6 s^{-1} to \ 1.0 \times 10^6 s^{-1}$in 20 hours. What will be the count rate 100 hours after the beginning?

357) A sample of radioactive material has an activity of 9×10^{12} Becquerel. The material has a half-life of 80 s. How long will it take for the activity to fall to 2×10^{12} Becquerel?

358) For a given sample, the counting rate is 4.75 $\alpha - particles$ per minute. After 5 minutes, the count is reduced to 27 $\alpha - particles$per minute. Find the decay constant and half-life of the sample.

359) The selling rate of a radioactive isotope is decided by its activity. What will be the second-hand rate of a one-month-old ${}^{32}P$sample with half life = 14.3 days if it was originally purchased for 800 rupees?

360) Thorium ${}_{90}Th^{232}$ is converted into ${}_{82}Pb^{208}$ by radioactive transformations. How much $\alpha\ and \beta\ particles$ are emitted?

361) How many alpha and beta particles are emitted when ${}_{92}U^{238}$ decays to ${}_{82}Pb^{206}$

362) When a deuteron of mass 2.0141 a.m.u. and negligible K.E. is absorbed by a Lithium nucleus of mass 6.0155 a.m.u. the compound nucleus disintegrates spontaneously into two alpha particles, each of mass 4.0026 a.m.u. Calculate the energy carried by each $\alpha - particles$

363) An isotope of ${}_{92}U^{238}$ decays successively to form ${}_{90}Th^{234}, {}_{91}Pa^{234}, {}_{92}U^{234}, {}_{90}Th^{230} and {}_{88}Ra^{226}$ What are the radiations emitted in these five steps?

364) How much Uranium ${}_{92}U^{235}$ should be consumed per day in a nuclear reactor, for giving the power of 1 MW? Given energy released per fission is 200 MeV.

365) (a) If α-decay of ${}_{92}U^{238}$ is energetically allowed (i.e. the decay products have a total mass less than the mass of ${}_{92}U^{238}$), what prevents ${}_{92}U^{238}$ from decaying all at once? Why is its half life so large?
(b) The α-particle faces a Coulomb barrier. A neutron being uncharged faces no such barrier. Why does the nucleus ${}_{92}U^{238}$ not decay spontaneously, by emitting a neutron?

366) The half-lives of radioactive nuclides that emit α-rays vary from microsecond to billion years. What is the reason for this large variation in the half life of alpha emitters?

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

368) The radioactive decay rate of a radio active element is found to be 10^3 disintegrations/sec. at a certain time. If half life of the element is one second, what would be the decay rate after 1 sec. and after 3 sec.?

369) The isotopes of $U^{238}\ and\ U^{235}$ occur in nature in the ratio 140 : 1. Assuming that at the time of earth's formation, they were present in equal ratio, make an estimate of the age of the earth. The half lives of $U^{238}\ and\ U^{235}$ are 4.5×10^9 years and 7.13×10^8 years respectively.
Given : $\log_{10} 140 = 2.1461, \log_{10} 2 = 0.3010$

370) Suppose you are given a chance to repeat the alpha particle scattering experiment using a thin sheet of solid hydrogen in place of gold foil. What results do you expect?

371) What is the shortest wavelength present in the Paschen series of spectral lines?

372) In accordance with the Bohr's model, find the quantum number that characterises the earth's revolution around the sun in an orbit of radius $1.5 \times 10^{11} m\ with\ orbital\ speed\ 3 \times 10^4 m/s$

373) If Bohr's quantization postulate is a basic law of nature, it should be equally valid for the case of planetary motion also. Why then do we never speak of quantization of orbits of planets around the sun?

374) Obtain the binding energy of a nitrogen nucleus ${}_{7}N^{14}$. Given, m(${}_{7}N^{14}$) = 14.00307u

375) Obtain approximately the ratio of the nuclear radii of the gold isotope ${}_{79}Au^{97}$ and silver isotope ${}_{47}Ag^{107}$

376) The nucleus ${}_{10}Ne^{23}$ decays by emission β^-. Write down the β^- decay equation and determine the maximum kinetic energy of the electrons emitted from the following data:
$m({}_{10}Ne^{23}) = 22.994466amu \quad m({}_{11}Na^{23}) = 22.989770amu$

377) Calculate the height of potential barrier for a head-on collision of two deuterons. The effective radius of deuteron can be taken to be 2fm. Note that height of the potential barrier is given by the coulomb repulsion between two deuterons when they just touch each other.

378) The neutron separation energy is defined to be the energy required to remove a neutron from a nucleus. Obtain the neutron separation energy of the nuclei ${}_{20}Ca^{41} and\ {}_{13}Al^{27}$ from the following data:
$m({}_{20}Ca^{40}) = 39.962591u\ and\ m({}_{20}Ca^{41}) = 40.962278$
$m({}_{13}Al^{26}) = 25.986895u\ and\ m({}_{13}Al^{27}) = 26.981541u$

379) In a nucleus of ${}_{92}U^{238}$, find the number of protons and the number of neutrons.

380) Obtian the approximate velue of the radius of a nucleus ${}_{92}U^{238}$, R_0 is 1.2 x 10^{-15} m.

381) Find the binding energy per nucleon of $_{20}Ca^{40}$ nucleus. Given, m_N ($_{20}Ca^{40}$) =39.962589 u, m_n = 1.008665 u and m_p = 1.007825 u.
(Take, 1 amu $= \frac{931}{c^2}\mathrm{MeV}$)

382) The number of α-particles scattered at an angle of 90^0 is 100 per minute. What will be the number of α-particles, when it is scattered at an angle of 60^0?

383) Two radioactive nuclei A and B, in a given sample disintegrates into a stable nucleus C. At time t = 0, number of A species are $4N_0$ and that of B are N_0. Half-life of A (for conversion to C) is 1 min whereas, that of B is 2 min. Initially, there are no nuclei of C present in the sample. When number of nuclei of A and B are equal, then what would be the number of nuclei of C present in the sample?

384) $_{86}R^{222}$ is converted into $_{84}Po^{218}$. Name the particle emitted in this case and write down the corresponding equation.

385) find the quantum number n corresponding to the excited state of He^+ ion, if on transition to the ground state that ion emits two photons in succession with wavelength 1026.7 $\mathring{A}$ and 304$\mathring{A}$ (Take, R = 1.097 $\times$ 10^7per m)

386) If the average lifetime of an excited state of hydrogen is of the order of 10^{-8}s is, estimate how many orbits an electron makes when it is in the state n= 2 and before it suffers a transition to state n = 1 (Bohr's radius, a_0 = 5.3 $\times$ 10^{11} m)?

387) (a) Deduce the expression ,N = $N_0 e^{-\lambda t}$, for the law of radioactive decay
(b) (i) Write symbolically the process expressing the β^+ decay of $^{22}_{11}Na$. Also write the basic nuclear process underlying this decay.
(ii) Is the nucleus formed in the decay of the nucleus $^{22}_{11}Na$, an isotope or an isobar?

388) Write symbolically the process expressing the β^+ decay of $^{22}_{11}Na$. Also write the basic nuclear process underlying this decay.

389) Is the nucleus formed in the decay of the nucleus $^{22}_{11}Na$, an isotope or an isobar?

390) Identify the nature of the 'radioactive radiations', emitted in each step
of the 'decay chain' given below:
$^{A}_{Z}X \rightarrow ^{A-4}_{Z-2}Y \rightarrow ^{A-4}_{Z-2}Y \rightarrow ^{A-4}_{Z-1}W$

391) State the law of radioactive decay.
Plot a graph showing the number (N) of undercayed nuclei as a function of time (t) for a given radioactive sample having half life $T_{1/2}$
Depict the plot,the number of undecayed nuclei at
(i) t = 3 $T_{1/2}$ and
(ii) t = 5 $T_{1/2}$

392) (a) Write symbolically the β^- decay process of phosphorus.
(b) Derive an expression for the average life of a radio-nuclide. Give its relationship with the half life.

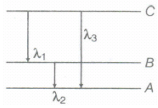
393) In a Geiger-Marsden experiment, calculate the distance of the closest approach to the nucleus of Z = 80, when an α-particle of 8 MeV energy impinges on it comes momentarily to rest and reverses its direction.
How will the distance of the closest approach be affected when the kinetic energy of the α- particle is doubled?

394) Define the term
(i) mass defect
(ii) binding energy for a nuceus and state the relation between the two.
For a given nuclear reaction,the B.E/nucleon of the product nuclear/nuclei is more than that for the original nucleus/nuclei.Is this nuclear reaction exothermic or endothermic in nature?Justify your choice.

395) Define the term binding energy for a nuceus and state the relation between the two. For a given nuclear reaction, the B.E/nucleon of the product nuclear/nuclei is more than that for the original nucleus/nuclei. Is this nuclear reaction exothermic or endothermic in nature? Justify your choice.

396) (i) Write the basic nuclear process involved in the emission of β^+ in a symbolic form by a radioactive nucleus.
(ii) In the reactions given below:
(a) ${}^{11}_{6}C \rightarrow {}^{z}_{y} B + x + v$
(b) ${}^{12}_{6}C \rightarrow {}^{12}_{6} C + {}^{20}_{6} Ne + {}^{c}_{b} He$
Find the values of x,y and z and a,b and c.

397) (i) State Bohr's quantisation condition for defining stationary orbits. How does de-Broglie's hypothesis explain the stationary orbits?
(ii) Find the relation between the three wavelengths $\lambda 1$, $\lambda 2$ and $\lambda 3$ from the energy level diagram shown below.



398) Complete the following nuclear reactions:
(a) ${}^{208}_{84}Po \rightarrow {}^{204}_{82} Pb + \ldots\ldots$
(b) ${}^{32}_{15}P {}^{32}_{16}S + \ldots\ldots\ldots$
(ii) Write the basic process involved in nuclei responsible for (a) β^- and (b) β^+ - decay.
(iii) Why is it found experimentally difficult to detect neutrinos?

399) An electron is revolving around the nucleus with a constant speed of 2.2 x 10^8 m/s. Find the de Broglie' wavelength associated with it.

400) An observer in a laboratory starts with N_0 nuclei of a radioactive sample and keep on observing the number (N) of left over nuclei at regular intervals of 10 min each. She prepares the following table on the basis of her observation.

Time t (in min)	$log_e\left(\frac{N_0}{N}\right)$
0	0
10	3.465
20	6.930
30	10.395
40	13.860

Use this data to plot a graph. of $\log_e(N_0/N)$ versus time (t) and calculate the decay constant and half-life of the given sample.

401) In a typical nuclear reaction, e.g.
${}^{2}_{1}H + {}^{2}_{1} H \longrightarrow {}^{3}_{2} He + n + 3.27$
although number of nucleons is conserved yet energy is released. How? Explain.
Show that nuclear density in a given nucleus is independent of mass number A.

402) Explain giving necessary reactions, how energy is released during
(i) fission
(ii) fusion

403) A proton and an alpha particle enter at right angles into a uniform magnetic field of intensity B. Calculate the radii of their paths when they enter the field with the same.
(i) momentum and
(ii) kinetic energy

404) Obtain the relation N = $N_0e^{-\lambda t}$ for a sample of radioactive material having decay constant λ, where N is the number of nuclei present at instant t. Hence obtain the relation between decay constant λ and half life $T_{1/2}$ of the sample.

405) Define the terms
(i) mass defect
(ii) binding energy for a nucleus and state the relation between the two.
For a given nuclear reaction, the B.E. / nucleon of the product nucleus/nuclei is more than that for the original nucleus/nuclei. Is this nuclear reaction exothermic or endothermic in nature? Justify your choice.

406) The half-life of ${}^{238}_{92}\mathrm{U}$ undergoing α -decay is 4.5 x 10^9 years. What is the activity of 1g sample of ${}^{238}_{92}\mathrm{U}$?

407) The three stable isotopes of neon: $\frac{20}{10}\mathrm{Ne}$, $\frac{21}{10}\mathrm{Ne}$ and $\frac{22}{10}\mathrm{Ne}$ have respective abundances of 90.51%, 0.27% and 9.22%. The atomic masses of the three isotopes are 19.99 u, 20.99 u and 21.99 u,respectively. Obtain the average atomic mass of neon.

408) The normal activity of living carbon-containing matter is found to be about 15 decays per minute for every gram of carbon. This activity arises from the small proportion of radioactive ${}_{6}^{14}\mathrm{C}$ present with the stable carbon isotope ${}_{6}^{12}\mathrm{C}$. When the organism is dead, its interaction with the atmosphere (which maintains the above equilibrium activity) ceases and its activity begins to drop. From the known half-life (5730 years) of ${}_{6}^{14}\mathrm{C}$, and the measured activity, the age of the specimen can be approximately estimated. This is the principle of ${}_{6}^{14}\mathrm{C}$ dating used in archaeology. Suppose a specimen from Mohenjodaro gives an activity of 9 decays per minute per gram of carbon. Estimate the approximate age of the Indus-Valley civilisation.

409) The half-life of ${}_{38}^{90}\mathrm{Sr}$ is 28 years. What is the disintegration rate of 15 mg of this isotope?

410) Answer the following.
(i) Why is the binding energy per nucleon found to be constant for nuclei in the range of mass number (A) lying between 30 and 170?
(ii) When a heavy nucleus with mass number A = 240 breaks into two nuclei, A = 120, energy is released in the process.

411) In the study of Geiger-Marsdon experiment on scattering of α-particles by a thin foil of gold, draw the trajectory of α-particles in the Coulomb field of target nucleus. Explain briefly how one gets the information on the size of the nucleus from this study. From the relation $R = R_0 A^{1/3}$
where Ro is constant and A is the mass number of the nucleus, show that nuclear matter density is independent of A.

412) Nuclei with magic number of protons Z = 2, 8, 20, 28, 50, 52 and magic number of neutrons N = 2, 8, 20, 28, 50, 82 and 126 are found to be very stable.
(i) Verify this by calculating the proton separation energy S_p for ^{120}Sn(Z = 50) and ^{121}Sb(Z = 51). The proton separation energy for a nuclide is the minimum energy required to separate the least tightly bound proton from a nucleus of that nuclide. It is given by
$$S_p = \left(M_{Z-1,N} + M_H - M_{Z,N}\right) c^2$$
Given,^{119}In = 118.9058u, ^{120}Sn = 119.902199 u
^{121}Sb = 120.903824 u,
^{1}H = 1.0078252 u
(ii) What does the existence of magic number indicate?

413) Deuteron is a bound state of a neutron and a proton with a binding energy B = 2.2MeV. A γ-ray of energy E is aimed at a deuteron nucleus to try to break it into a (neutron + proton) such that the n and p move in the direction of the incident γ-ray. If E = B, show that this cannot happen. Hence, calculate how much bigger than B must be E be for such a process to happen?

414) (i) Two stable isotopes of lithium ${}_{3}^{6}\mathrm{Li}$ and ${}_{3}^{7}\mathrm{Li}$ have respective abundances of 7.5% and 92.5%. These isotopes have masses 6.01512u and 7.01600 u respectively. Find the atomic mass of lithium.
(ii) Boron has two stable isotopes ${}_{5}^{10}\mathrm{B}$ and ${}_{5}^{11}\mathrm{B}$. Their respective masses are 10.01294 u and 11.00931u, and the atomic mass of boron is 10.811u. Find the abundances of ${}_{5}^{10}\mathrm{B}$ and ${}_{5}^{11}\mathrm{B}$

415) In a periodic table, the average atomic mass of magnesium is given as 24.312 u. The average value is based on their relative natural abundance on the earth.
The three isotopes and their masses are
${}_{12}^{24}\mathrm{Mg}(23.98504\mathrm{u})$
${}_{12}^{25}\mathrm{Mg}(24.98584\mathrm{u})$ and ${}_{12}^{26}\mathrm{Mg}(25.98259\mathrm{u})$
The natural abundance of ${}_{12}^{24}\mathrm{Mg}$ is 78.99% by mass. Calculate the abundances of other two isotopes.

416) (i) What is the nuclear density of ${}_{90}^{228}\mathrm{Th}$?
(ii) Is the nuclear density of an a-particle (${}_{2}^{4}\mathrm{He}$) to be greater than, less than or equal to ${}_{90}^{228}\mathrm{Th}$? Explain.
(iii) Determine the nuclear density of an a-particle.

417) Obtain the binding energy of the nuclei $^{56}_{26}\mathrm{Fe}$ and $^{209}_{83}\mathrm{Bi}$ units of MeVfrom the following data:

$m\left(\begin{matrix}56\\26\end{matrix}\mathrm{F}\right)=55.934939\mathrm{u}$

$m\left(^{209}_{83}\mathrm{Bi}\right)=208.980388\mathrm{u}$

418) (ii) (a) Write symbolically the process expressing the β- decay of $^{22}_{11}\mathrm{Na}$. Also, write the basic nuclear process underlying this decay.
(b) Is the nucleus formed in the decay of the nucleus $^{22}_{11}\mathrm{Na}$,an isotope or isobar?

419) (i) A radioactive nucleus A undergoes a series of decays as given below

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

The mass number and atomic number of A^2 are 176 and 71, respectively. Determine the mass and atomic numbers of A^4 and A.
(ii) Write the basic nuclear processes underlying $\beta^+$and β^-decays.

420) (i) The number of nuclei of a given radioactive sample at time t = 0 and t = T are N_0 and N_0/n, respectively. Obtain an expression for the half-life ($T_{1/2}$) of the nucleus in terms of n and T.
(ii) Write the basic nuclear process underlying β^- - decay of a given radioactive nucleus

421) (i) Write the basic nuclear process involved in the emission of β^+ in a symbolic form by a radioactive nucleus.
(ii) In the reactions given below:
(a) $^{11}_{6}\mathrm{C} \rightarrow {}^{z}_{y}\mathrm{B}+x+\mathrm{v}$
(b) $^{12}_{6}\mathrm{C} \rightarrow {}^{12}_{6}\mathrm{C}+{}^{20}_{a}\mathrm{Ne}+{}^{c}_{b}\mathrm{He}$
Find the values of x, y and z and a, band c

422) A radioactive isotope has a half-life of T year. How long will it take the activity to reduce to
(i) 3.125% and
(ii) 1% of its original value?

423) The radio nuclide ^{11}C decays according to

$^{11}_{6}\mathrm{C} \longrightarrow {}^{11}_{5}\mathrm{B}+e^{+}+\mathrm{v}, T_{1/2}=20.3\ \mathrm{min}$

The maximum energy of the emitted positron is 0.960 MeV. Given, the atomic mass values

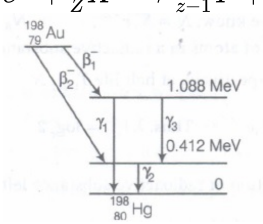
$m\left(^{11}_{6}\mathrm{C}\right)=11.011434\mathrm{u}$ and

$m\left(^{11}_{5}\mathrm{B}\right)=11.009305\mathrm{u}$

Calculate Q and compare it with the maximum energy of the positron emitted

424) For the β^+ (positron) emission from a nucleus, there is another competing process known as electron capture (electron from an inner orbit say, the K-shell is captured by the nucleus and a neutrino is emitted.

$e^{+}+{}^{A}_{Z}X \longrightarrow {}^{A}_{z-1}Y+v$



Show that if β^+ emission is energetically allowed, electron capture is necessarily allowed but not vice-versa.

425) Calculate and compare the energy released by
(i) fusion of 1kg of hydrogen deep with in sun and
(ii) the fission of 1kg of ^{235}U in a fission reactor.

426) (ii) The half-life of a radioactive substance is 50 s. Calculate
(a) the decay constant and
(b) time taken for the sample to decay by 3/4th of the initial value.

427) Obtain the approximate value of the radius of a nucleus $_{92}U^{238}$. Take, R_0 is 1.2 x 10^{-15} m.

428) (a) State the law of radioactive decay. Write the SI unit of 'activity'.
(b) There are $4\sqrt{2}\times10^{6}$ radioactive nuclei in a given radioactive sample. If the half life of the sample is 20 s, how many nuclei will decay in 10 s?

429) (a) Derive the relation between the decay constant and half life of a radioactive substance.
(b) A radioactive element reduces to 25% of its initial mass in 1000 years. Find its half life.

430) (a) Write the process of β-decay. How can radioactive nuclei emit β-particles even though they do not contain them? Why do all electrons emitted during β-decay not have the same energy?
(b) A heavy nucleus splits into two lighter nuclei. Which one of the two - parent nucleus or the daughter nuclei has more binding energy per nucleon?

431) (a) Write symbolically the β^- decay process of ${}_{15}^{32}\mathrm{P}$
(b) Derive an expression for the average life of a radionuclide. Give its relationship with the halflife.

432) (a) What is meant by half-life of a radioactive element?
(b) The half-life of a radioactive substance is 30 s.
Calculate
(i) the decay constant, and
(ii) time taken for the sample to decay by 3/4th of the initial value.

433) A radioactive sample can decay by two different processes. The half-life for the first process is T_1 and that for the second process is T_2. Show that the effective half-life T of the nucleus is given by
$\frac{1}{T}=\frac{1}{T_1}+\frac{1}{T_2}$

434) 'The half-life of ${}_{6}^{14}\mathrm{C}$ is 5700 years.' What does it mean?
Two radioactive nuclei X and Y initially contain an equal number of atoms. Their half-lives are 1 hour and 2 hours respectively. Calculate the ratio of their rates of disintegration after two hours.

435) Calculate the excitation energy the nuclei produced when ${}^{235}\mathrm{U}$ and ${}^{238}\mathrm{U}$ absorbs thermal neutrons. Given
$\mathrm{m_n}=1.0087\mathrm{u};\mathrm{m}\left({}^{235}\mathrm{U}\right)=235.0439\mathrm{u};\mathrm{m}\left({}^{236}\mathrm{U}\right)=236.0456\mathrm{u};\mathrm{m}\left({}^{238}\mathrm{U}\right)=238.05084;\mathrm{m}\left({}^{239}\mathrm{U}\right)=239.0$

436) A radioactive isotope has a half-life of T years. After how much time is its activity reduced to 6.25% of its original activity?

437) In a given sample, two radioisotopes, A and B, are initially present in the ratio 1 : 4. The half-lives of A and B are respectively 100 years and 50 years. Find the time after which the amounts of A and B become equal.

438) If 20% of a radioactive substance decay in 10 days. What percentage of original material is left after 30 days?

439) Calculate the energy released if ${}^{238}\mathrm{U}$ an α-particle.
Given: atomic mass of ${}^{238}\mathrm{U}$ = 238.0508 u, atomic mass of ^{234}Th = 234.04363 u, atomic mass of alpha particle = 4.00260 u and 1 u = 931 MeV/C^2

440) Find the ratio of radii of two nuclei of mass number 27 and 64, respectively.

441) (a) Distingush between nuclear fission and fusion giving an example of each.
(b) Explain the release of energy in nuclear fission and fusion on the basis of binding energy per nuclear curve.

442) (i) Differentiate between nuclear fission and nuclear fusion.
(ii) Deuterium undergoes fusion as per the reaction
${}_{1}^{2}\mathrm{H}+{}_{1}^{2}\mathrm{H}\longrightarrow{}_{2}^{3}\mathrm{He}+{}_{0}^{1}n+3.27\mathrm{MeV}$
Find the duration for which an electric bulb of 500 W can be kept glowing by the fusion of 100 g of deuterium.

Case Study Questions 7 x 4 = 28

443) In the year 1939, German scientist Otto Hahn and Strassmann discovered that when an uranium isotope was bombarded with a neutron, it breaks into two intermediate mass fragments. It was observed that, the sum of the masses of new fragments formed were less than the mass of the original nuclei. This difference in the mass appeared as the energy released in the process. Thus, the phenomenon of splitting of a heavy nucleus (usually A > 230) into two or more lighter nuclei by the bombardment of proton, neutron, a-particle, etc with liberation of energy is called nuclear fission.

$_{92}\mathrm{U}^{235} + {}_0n^1 \rightarrow \quad {}_{92}\mathrm{U}^{236} \rightarrow {}_{56}\mathrm{Ba}^{144} + {}_{36}\mathrm{Kr}^{89} + 3_0n^1 + Q$

Unstable nucleus

(i) Nuclear fission can be explained on the basis of

(a) Millikan's oil drop method

(b) Liquid. drop model

(c) Shell model

(d) Bohr's model

(ii) For sustaining the nuclear fission chain reaction in a sample (of small size) ${}^{235}_{92}\mathrm{U}$, it is desirable to slow down fast neutrons by

(a) friction (b) elastic damping/scattering

(c) absorption(d) none of these

(iii) Which of the following is/are fission reaction(s)?

$(\mathrm{I})\ {}^1_0n + {}^{235}_{92}\mathrm{U} \rightarrow {}^{236}_{92}\mathrm{U} \rightarrow {}^{133}_{51}\mathrm{Sb} + {}^{99}_{41}\mathrm{Nb} + 4^1_0n$

$(\mathrm{II})\ {}^1_0n + {}^{235}_{92}\mathrm{U} \rightarrow {}^{1.40}_{54}\mathrm{Xe} + {}^{94}_{38}\mathrm{Sr} + 2^1_0n$

$(\mathrm{III}){}^2_1\mathrm{H} + {}^2_1\mathrm{H} \rightarrow {}^3_2\mathrm{He} + {}^1_0n$

(a) Both II and III (b) Both I and III

(c) Only II (d) Both I and II

(iv) On an average, the number of neutrons and the energy of a neutron released per fission of a uranium atom are respectively

(a) 2.5 and 2 keV (b) 3 and 1 keV (c) 2.5 and 2 MeV (d) 2 and 2 keV

(v) In any fission process, ratio of mass of daughter nucleus to mass of parent nucleus is

(a) less than 1 (b) greater than 1

(c) equal to 1 (d) depends 0 the mass of parent nucleus

444) The nucleus was first discovered in 1911 by Lord Rutherford and his associates by experiments on scattering of a-particles by atoms. He found that the scattering results could be explained, if atoms consist of a small, central, massive and positive core surrounded by orbiting electrons. The experimental results indicated that the size of the nucleus is of the order of 10^{-14}m and is thus 10000 times smaller than the size of atom.

(i) Ratio of mass of nucleus with mass of atom is approximately

(a) 1 (b) 10 (c) 10^3 (d) 10^{10}

(ii) Masses of nuclei of hydrogen, deuterium and tritium are in ratio

(a) 1:2:3 (b) 1:1:1 (c) 1:1:2 (d) 1:2:4

(iii) Nuclides with same neutron number but different atomic number are

(a) isobars (b) isotopes (c) isotones (d) none of these

(iv) If R is the radius and A is the mass number, then log R versus log A graph will be

(a) a straight line (b) aparabola (c) anellipse (d) none of these

(v) The ratio of the nuclear radii of the gold isotope ${}^{197}_{79}\mathrm{Au}$ and silver isotope ${}^{107}_{47}\mathrm{Au}$ is

(a) 1.23 (b) 0.216 (c) 2.13 (d) 3.46

445) A heavy nucleus breaks into comparatively lighter nuclei which are more stable compared to the original heavy nucleus. When a heavy nucleus like uranium is bombarded by slow moving neutrons, it splits into two parts releasing large amount of energy. The typical fission reaction of ${}_{92}\mathrm{U}^{235}$.

$${}_{92}\mathrm{U}^{235} + {}_{0}n^{1} \rightarrow {}_{56}\mathrm{Ba}^{141} + {}_{36}\mathrm{Kr}^{92} + 3_{0}n^{1} + 200\mathrm{MeV}$$

The fission of ${}_{92}U^{235}$approximately released 200 MeV of energy.

(i) If 200 MeV energy is released in the fission of a single nucleus of ${}^{235}_{92}\mathrm{U}$,the fissions which are required to produce a power of 1kW is

(a) 3.125 x 10^{13} (b) 1.52 x 10^{6} (c) 3.125 x 10^{12} (d) 3.125 x 10^{14}

(ii) The release in energy in nuclear fission is consistent with the fact that uranium has

(a) more mass per nucleon than either ofthe two fragments

(b) more mass per nucleon as the two fragment

(c) exactly the same mass per nucleon as the two fragments

(d) less mass per nucleon than either of two fragments.

(iii) When ${}_{92}U^{235}$undergoes fission, about 0.1% of the original mass is converted into energy. The energy released when 1 kg of ${}_{92}U^{235}$undergoes fission is

(a) 9 x 10^{11}J (b) 9 x 10^{13}J (c) 9 x 10^{15}J (d) 9 x 10^{18}J

(iv) A nuclear fission is said to be critical when multiplication factor or K

(a) K= 1 (b) K > 1 (c) K< 1 (d) K=0

(v) Einstein's mass-energy conversion relation E = mc^2 is illustrated by

(a) nuclear fission (b) β-decay (c) rocket propulsion (d) steam engine

446) Neutrons and protons are identical particle in the sense that their masses are nearly the same and the force, called nuclear force, does into distinguish them. Nuclear force is the strongest force. Stability of nucleus is determined by the neutron proton ratio or mass defect or packing fraction. Shape of nucleus is calculated by quadrupole moment and spin of nucleus depends on even or odd mass number. Volume of nucleus depends on the mass number. Whole mass of the atom (nearly 99%) is centred at the nucleus.

(i) The correct statements about the nuclear force is/are

(a) change independent (b) short range force

(c) non-conservative force (d) all of these.

(ii) The range of nuclear force is the order of

(a) 2 x 10^{-10} m (b) 1.5 x 10^{-20} m (c) 1.2 x 10^{-4} m (d) 1.4 x 10^{-15} m

(iii) A force between two protons is same as the force between proton and neutron. The nature of the force is

(a) electrical force (b) weak nuclear force (c) gravitational force (d) strong nuclear force.

(iv) Two protons are kept at a separation of 40 $\dot{A}$. Fn 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) $F_n \approx F_e$

(v) All the nucleons in an atom are held by

(a) nuclear forces (b) van der Waal's forces

(c) tensor forces (d) coulomb forces

447) The density of nuclear matter is the ratio of the mass of a nucleus to its volume. As the volume of a nucleus is directly proportional to its mass number A, so the density of nuclear matter is independent of the size of the nucleus. Thus, the nuclear matter behaves like a liquid of constant density. Different nuclei are like drops of this liquid, of different sizes but of same density.

Let A be the mass number and R be the radius of a nucleus. If m is the average mass of a nucleon, then

Mass of nucleus = mA

$$\text{Volume of nucleus } = \frac{4}{3}\pi R^3 = \frac{4}{3}\pi\left(R_0 A^{1/3}\right)^3 = \frac{4}{3}\pi R_0^3 A$$

$$\text{Nuclear density, } \rho_{\text{nu}} = \frac{\text{Mass of nucleus}}{\text{Volume of nucleus}} \text{ or } \rho_{\text{nu}} = \frac{mA}{\frac{4}{3}\pi R_0^3 A} = \frac{3m}{4\pi R_0^3}$$

Clearly, nuclear density is independent of mass number A or the size of the nucleus. The nuclear mass density is of the order 10^{17} kg m^{-3}. This density is very large as compared to the density of ordinary matter, say water, for which p = 1.0 x 10^3 kg m^{-3}.

(i) The nuclear radius of ${}^{16}_{8}\mathrm{O}$ is 3 X 10^{-15} m. The density of nuclear matter is

(a) 2.9 x 10^{34} kg m^{-3} (b) 1.2 x 10^{17}kg m^{-3} (c) 16 x 10^{27}kg m^{-3} (d) 2.4 x 10^{17}kg m^{-3}

(ii) What is the density of hydrogen nucleus in SI units? Given R_o = 1.1 fermi and m_p = 1.007825 amu

(a) 2.98 x 10^{17}kg m^{-3} (b) 3.0 x 10^{34} kg m^{-3} (c) 1.99 x 10^{11} kg m^{-3} (d) 7.85 x 10^{17}kg m^{-3}

(iii) Density of a nucleus is

(a) more for lighter elements and less for heavier elements.

(b) more for heavier elements and less for lighter elements

(c) very less compared to ordinary matter

(d) a constant

(iv) The nuclear mass of ${}^{56}_{26}\mathrm{Fe}$ is 55.85 amu. The its nuclear density is

(a) 5.0 x 10^{19}kg m^{-3}. (b) 1.5 x 10^{19}kg m^{-3} (c) 2.9 x 10^{17}kg m^{-3} (d) 9.2 x 10^{26}kg m^{-3}

(v) If the nucleus of ${}^{27}_{13}\mathrm{Al}$ has a nuclear radius of about 3.6 fm, then ${}^{125}_{52}\mathrm{Te}$ would have its radius approximately as

(a) 9.6 fm (b) 12 fm (c) 4.8 fm (d) 6 fm

448) When subatomic particles undergo reactions, energy is conserved, but mass is not necessarily conserved.However, a particle's mass "contributes" to its total energy, in accordance with Einstein's famous equation, $E = mc^2$, In this equation, E denotes the energy carried by a particle because of its mass. The particle can also have additional energy due to its motion and its interactions with other particles. Consider a neutron at rest and well separated from other particles. It decays into a proton, an electron and an undetected third particle as given here: Neutron $\rightarrow$ proton + electron + ???

The given table summarizes some data from a single neutron decay. Electron volt is a unit of energy. Column 2 shows the rest mass of the particle times the speed of light squared.

Particle	**Mass x c^2 (MeV)**	**Kinetic energy (MeV)**
Neutron	940.97	0.00
Proton	939.67	0.01
Electron	0.51	0.39

(i) From the given table, which properties of the undetected third particle can be calculate?

(a) Total energy, but not kinetic energy **(b) Kinetic energy, but not total energy**

(c) Both total energy and kinetic energy **(d) Neither total energy nor kinetic energy**

(ii) Assuming the table contains no major errors, what can we conclude about the (mass x c^2) of the undetected third particle?

(a) It is 0.79 MeV

(b) It is 0.39 MeV

(c) It is less than or equal to 0.79 MeV; but we cannot be more precise.

(d) It is less than or equal to 0.40 MeV; but we cannot be more precise.

(iii) Could this reaction occur?

Proton $\rightarrow$ neutron + other particles

(a) Yes, if the other particles have much more kinetic energy than mass energy.

(b) Yes, but only if the proton has potential energy (due to interactions with other particles).

(c) No, because a neutron is more massive than a proton.

(d) No, because a proton is positively charged while a neutron is electrically neutral.

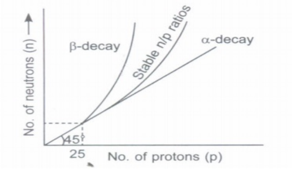
(iv) How much mass has to be converted into energy to produce electric power of 500 MW for one hour?

(a) 2×10^{-5} kg **(b) 1×10^{-5} kg** **(c) 3×10^{-5} kg** **(d) 4×10^{-5} kg**

(v) The equivalent energy of 1 g of substance is

(a) 9×10^{13}J **(b) 6×10^{12}J** **(c) 3×10^{13}J** **(d) 6×10^{13}J**

449) If all the known isotopes of the elements are plotted on a graph of number of neutrons (n) vs number of protons (P), it is observed that all isotopes lying outside of a "stable" $\frac{n}{p}$ ratio region are radioactive as shown in the figure below.



The graph exhibits straight line behaviour upto

p = 25 $\left(\frac{n}{p}=1\right)$

For p > 25, $\frac{n}{p}>1$

all these isotopes above the stable region generally undergo beta decay. Very heavy isotopes (p > 83) are unstable as their nucleus is very large, and undergoes a-decay. y-ray emission does not involve the release of a particle. It represents a change in an atom from a higher energy level to a lower energy level.

(i) How would the radioisotope of aluminium with atomic mass 29 decay?

(ii) Thorium-230 undergoes a series of radioactive decay processes resulting in Bi-214 being the final product what was the sequence of the processes that occured? Atomic No. of Thorium = 90, At. No. of Bismuth = 83

(iii) Which of the radioactive emission has (a) maximum ionizing power (b) max penetrating power?

5 Marks 67 x 5 = 335

450) Answer the following questions:

(a) Are the equations of nuclear reactions (such as those given in Section 13.7) 'balanced' in the sense a chemical equation (e.g.,$2H_2+O_2 \rightarrow 2H_2O$) is? If not, in what sense are they balanced on both sides?

(b) If both the number of protons and the number of neutrons are conserved in each nuclear reaction, in what way is mass converted into energy (or vice-versa) in a nuclear reaction?

(c) A general impression exists that mass-energy interconversion takes place only in nuclear reaction and never in chemical reaction. This is strictly speaking, incorrect. Explain

451) Obtain the binding energy (in MeV) of a nitrogen nucleus $\left(\begin{matrix}14\\7\end{matrix}\mathrm{N}\right)$ given m $\left(\begin{matrix}14\\7\end{matrix}\mathrm{N}\right)$=14.00307 u

452) Obtain the binding energy of the nuclei $\begin{matrix}26\\56\end{matrix}\mathrm{Fe}$ and $\begin{matrix}209\\83\end{matrix}\mathrm{Bi}$ in units of MeV from the following data:

m ($\begin{matrix}26\\56\end{matrix}\mathrm{Fe}$) = 55.934939 u

m ($\begin{matrix}209\\83\end{matrix}\mathrm{Bi}$) = 208.980388 u

453) A given coin has a mass of 3.0 g. Calculate the nuclear energy that would be required to separate all the neutrons and protons from each other. For simplicity assume that the coin is entirely made of $^{63}_{29}\mathrm{Cu}$ atoms (of mass 62.92960 u).

454) The Q value of a nuclear reaction $A+b \rightarrow C+d$ is defined by $Q=\left[m_A+m_b-m_C-m_d\right]c^2$ where the masses refer to the respective nuclei. Determine from the given data the Q-value of the following reactions and state whether the reactions are exothermic or endothermic.

$\text{(i) } {}^1_1\mathrm{H}+{}^3_1\mathrm{H} \rightarrow {}^2_1\mathrm{H}+{}^2_1\mathrm{H}$

$\text{(ii) } {}^{12}_6\mathrm{C}+{}^{12}_6\mathrm{C} \rightarrow {}^{20}_{10}\mathrm{Ne}+{}^4_2\mathrm{He}$

Atomic masses are given to be

$m\left({}^2_1\mathrm{H}\right)=2.014102\mathrm{u}$

$m\left({}^3_1\mathrm{H}\right)=3.016049\mathrm{u}$

$m\left(\begin{matrix}12\\6\end{matrix}\mathrm{C}\right)=12.000000\mathrm{u}$

$m\left(\begin{matrix}20\\10\end{matrix}\mathrm{Ne}\right)=19.992439\mathrm{u}$

455) How long can an electric lamp of 100W be kept glowing by fusion of 2.0 kg of deuterium? Take the fusion reaction as

${}^2_1\mathrm{H}+{}^2_1\mathrm{H} \rightarrow {}^3_2\mathrm{He}+\mathrm{n}+3.27\mathrm{MeV}$

456) Calculate the height of the potential barrier for a head on collision of two deuterons. (Hint: The height of the potential barrier is given by the Coulomb repulsion between the two deuterons when they just touch each other. Assume that they can be taken as hard spheres of radius 2.0 fm.)

457) The nuclear mass is$_{26}Fe^{56}$ 55.85 u. Calculate its nuclear density.

458) Calculate number of protons and neutrons in $_{92}U^{235}$and the isotope $_{88}Ra^{236}$

459) Express 1 Joule in eV. Taking 1 a.m.u.= 931 MeV, calculate the mass of $_6C^{12}$.

460) Find the effective mass of a photon if the wavelength of radiation is $3000\mathring{A}$

461) Calculate the nuclear mass density of $_{92}U^{238}$Given $R_0 = 1.5\ fermi$ and mass of each nucleon is $1.6 \times 10^{-27}kg$

462) Calculate the binding energy per nucleon of the nucleus $_{26}Fe^{56}$. Given that mass of $_{26}Fe^{56}$ = 55.934939 u, the mass of proton = 1.007825 u and mass of neutron = 1.008665 u and 1u = 931 MeV.

463) Calculate the B.E/nucleon of $_{17}Cl^{35}$ the nucleus. Given that mass of proton = 1.007825 u, mass of neutron = 1.008665 u, mass of $_{17}Cl^{35}$ = 34.980000 u; 1 u = 931 MeV.

464) Calculate the binding energy per nucleon of $_{20}Ca^{40}$ the nucleus. Given
$m(_{20}Ca^{40}) = 39.962589\ u; m_n = 1.008665u;$
$m_p = 1.007825\ u$
$Take\ 1a.m.u. = 931\ MeV$

465) Calculate binding energy per nucleon of $_{83}Bi^{209}$Given that
$m_p = 1.00727\ amu,\ m_n = 1.00866\ amu,$
$m(_{83}Bi^{209}) = 208.980388\ amu$
$m(neutron) = 1.008665\ amu$
$m(proton) = 1.007825\ amu$

466) The decay constant for a given radioactive sample is.$0.3465day^{-1}$ What percentage of this sample will get decayed in a period of 4 days?

467) The half-life of radium is 1500 years. After how many years will one gram of pure radium
(i) reduce to 1 centigram?
(ii) lose one milligram?

468) It is observed that only 6.25% of a given radioactive sample is left undecayed after a period of 16 days. What is the decay constant of this sample in day^{-1} ?

469) A radioactive material is reduced to $\frac{1}{16}$ of its original amount in 4days. How much material should one begin with so that $4 \times 10^{-3}kg$ of the material is left over after 6 days?

470) One MeV positron encounters one MeV electron traveling in opposite direction. What is the wavelength of photons produced, given rest mass energy of electron or positron=0.512 MeV? Take h=6.62×10^{-34}Js

471) Complete the decay reaction
$_{10}Ne^{23} \to ? +_{-1} e^0 + ?$
Also, find the maximum KE of electrons emitted during this decay. Given of $_{10}Ne^{23}$=22.994465 u, the mass of $_{11}Na^{23}$ = 22.989768u.

472) A neutron is absorbed by a $_3Li^6$ nucleus with subsequent emission of $\alpha - particle$. Write corresponding nuclear reaction. Calculate the energy released in this reaction.
Given $m(_3Li^6) = 6.015126u;$
$m(_2He^4) = 4.00026044u$
$m(_0n^1) = 1.0086654u$
$m(_1H^3) = 3.016049u$

473) In a star, three alpha particles join in a single reaction to form nucleus ${}_6C^{12}$. Calculate the energy released in the reaction.
$Given\ m({}_2He^4) = 4.00026044u$
$m({}_6C^{12}) = 12.000000u$
$1\ amu = 931\ MeV$

474) If in a nuclear fusion reaction, mass defect is 0.3%, then find energy released in fusion of 1kg mass.

475) If 200 MeV energy is released in the fission of a single nucleus of ${}_{92}U^{235}$, how many fissions must occur per second to produce a power of 1kW?

476) The mean lives of a radioactive substance are 1620 years and 405 years for $\alpha - emission\ and\ \beta - emission$ respectively. Find out the time during which three-fourth of a sample will decay if it is decaying both by $\alpha - emission\ and\ \beta - emission$ simultaneously.

477) A nuclear reactor is a powerful device, wherein nuclear energy is utilised for peaceful purposes. It is based upon controlled nuclear chain reaction. The nuclear chain reaction is controlled by the use of control rods (of boron or cadmium) and moderators like heavy water, graphite, etc. The whole reactor is protected with concrete walls 2 to 2.5 metre thick, so that radiations emitted during nuclear reactions may not produce harmful effects.
Read the above passage and answer the following questions:
(i) Give any two merits of nuclear reactors.
(ii) What is radiactive waste?
(iii) Why do people often oppose the location site of a nuclear reactor? What do you suggest?

478) Einstein was the first to establish the equivalence between mass energy. According to him, whenever a certain mass (Δm) disappears in some process, the amount of energy released is $E = (\Delta m)\, c^2$, where c is velocity of light vacuum $\left(= 3 \times 10^8 m/s\right)$. The reverse is also true, i.e., whenever energy E disappears, an equivalent mass $(\Delta m) = E/c^2$ appears.
Read the above passage and answer the following questions :
(i) What is the energy released when 1 a.m.u. of mass disappears in a nuclear reaction?
(ii) Do you know any phenomenon in which energy materialises?
(iii) What values of life do you learn from this famous relation?

479) Poonam's mother is diagnosed cancer. The attending physician told her that she has to undergo radiotherapy. While telling her the side effects of the treatment, the doctor told that her beautiful hair may fall and she may become bald. Poonam's mother refuses to get the treatment.
Read the above passage and answer the following questions:
(i) What would you do if you were in Poonam's place?
(ii) What values are associated with your attitude?

480) Marie Curie and her teacher turned husband Pierre Curie worked hard to extract radium chloride (R_aCl_2) from uranium ore. They succeeded in 192 after a long struggle. About 0.19 g of R_aCl_2 was extracted and its radioactivity was studied. They were awarded by the noble prize, which they shared it which they shared it which they shared it with Henri Becquerel.
Read the above passage and answer following questions:
(i) What are the values shown by Marie Curie and her husband?
(ii) What do you understand by radioactivity? How the half-life period is related to the disintegration constant?
(iii) How is average-life of radioactive element related to half-life?

481) Shyamsaw his younger brother wondering with a question which deals with emission of light from a vapour lamp. He was anxious to know how different colours wre being emitted by different lights. He also saw mercury and sodium vapour lamps in the Physics lab and was curious to know what is inside the lamps. On seeing his anxiety to know more about it, Shyam explained about absorption of energy and re-emission of photons in the visible region. He also advised him not to touch or break any items in the lab for the knowledge.
Read the above passage and answer the following questions:
(i) What is the moral you derive from Shyam's behaviour?
(ii) Which series in the hydrogen spectrum is in the visible region?
(iii) Write the quality displayed by Shyam's brother.

482) (a) Define the terms
(i) half life ($T_{1/2}$) and
(ii) average life (τ). Find their relationships with the decay constant (λ)
(b) A radioactive nucleus has a decay constant, λ = 0.3465 (day)$^{-1}$. How long would it take the nucleus to decay to 75% of its initial amount?

483) A radioactive nucleus has a decay constant, $\lambda = 0.3465(day)^{-1}$ How long would it take the nucleus to decay to 75% of its initial amount?

484) For the past some time.Arti has been observing some erratic body movement, unsteadiness and lack of aoordination in the activities of hersister Radha, who also used to complain of serve headache occasionally.Aarti suggested to her parents to get a medical check-up of Radha. The doctor throughly examined Radha and diagnosed that she has a brain tumour
(a) What,according to you,are the value displayed by Arti?
(b) How can radioisotopes help a doctor to diagnose brain tumour?

485) Draw the plot of binding energy per nucleon (BE/A) as a function of mass number A. Write two important conclusions that can be drawn regarding the nature of nuclear force.
Use this graph to explain the release of energy in both the processes of nuclear fusion and fission.
Write the basic nuclear process of neutron undergoing p-decay. Why is the detection of neutrinos found very difficult?

486) Define the Q-value of a nuclear process. When can a nuclear process not proceed spontaneously? If both the number of protons and the number of neutrons are conserved in a nuclear reaction in what way is mass converted into energy (or vice-versa) in the nuclear reaction?

487) Asha's mother read an article in the newspaper about a disaster that took place at Chernobyl. She could not understand much from the article and asked a few questions from Asha regarding the article.
Asha tried to answer her mother's questions based on what she learnt in Class XII Physics?

488) (i) In Rutherford scattering experiment, draw the trajectory traced by a-particles in the coulomb field of target nucleus and explain how this led to estimate the size of the nucleus.
(ii) Describe briefly how wave nature of moving electrons was established experimentally.
(iii) Estimate the ratio of de Broglie wavelengths associated with deuterons and a-particles when they are accelerated from rest through the same accelerating potential V.

489) We are given the following atomic masses:
$^{238}_{92}\mathrm{U} = 238.05079\mathrm{u} \qquad ^{4}_{2}\mathrm{He} = 4.00260\mathrm{u}$
$^{234}_{90}\mathrm{Th} = 234.04363\mathrm{u} \quad ^{1}_{1}\mathrm{H} = 1.00783\mathrm{u}$
$^{237}_{91}\ \mathrm{Pa} = 237.05121\mathrm{u}$
Here the symbol Pa is for the element protactinium (Z = 91).
(a) Calculate the energy released during the alpha decay of $^{238}_{92}\mathrm{U}$.
(b) Show that $^{238}_{92}\mathrm{U}$. Can not spontaneously emit a proton.

490) (a) Two stable isotopes of lithium $\frac{6}{3}\mathrm{Li}$ and $^{7}_{3}\mathrm{Li}$ have respective abundances of 7.5% and 92.5%.These isotopes have masses 6.01512 u and 7.01600 u, respectively. Find the atomic mass of lithium.
(b) Boron has two stable isotopes, $^{10}_{5}\ \mathrm{B}$ and $^{11}_{5}\ \mathrm{B}$ Their respective masses are 10.01294 u and 11.00931 u, and the atomic mass of boron is 10.811 u. Find the abundance of $^{10}_{5}\ \mathrm{B}$ and $^{11}_{5}\ \mathrm{B}$.

491) Write nuclear reaction equations for
(i) α -decay of $^{226}_{88}\mathrm{Ra}$
(ii) α -decay of $^{242}_{94}\mathrm{Pu}$
(iii) β -decay of $^{32}_{15}\mathrm{P}$
(iv) β^{-}-decay of $^{210}_{83}\mathrm{Bi}$
(v) β^{+}-decay of $^{11}_{6}\mathrm{C}$
(vi) β^{+}-decay of $^{97}_{43}\mathrm{Tc}$
(vii) Electron capture of $^{120}_{54}\mathrm{Xe}$

492) A radioactive isotope has a half-life of T years. How long will it take the activity to reduce to a) 3.125%, b) 1% of its original value?

493) Obtain the amount of ${}^{60}_{27}\mathrm{Co}$ necessary to provide a radioactive source of 8.0 mCi strength. The half-life of ${}^{60}_{27}\mathrm{Co}$ is 5.3 years.

494) Find the Q-value and the kinetic energy of the emitted (-particle in the (-decay of (a) ${}^{226}_{88}\mathrm{Ra}$ and (b) ${}^{220}_{86}\mathrm{Rn}$.
Given $m\left({}^{226}_{88}\mathrm{Ra}\right)=226.02540\mathrm{u}$
$m\left({}^{222}_{86}\mathrm{Rn}\right)=222.01750\mathrm{u}$
$m\left({}^{222}_{86}\mathrm{Rn}\right)=220.01137\mathrm{u}$
$m\left({}^{216}_{84}\mathrm{Po}\right)=216.00189\mathrm{u}$

495) The radionuclide ^{11}C decays according to
${}^{11}_{6}\mathrm{C}\rightarrow{}^{11}_{5}\mathrm{B}+e^{+}+v: \quad T_{1/2}=20.3\ \mathrm{min}$
The maximum energy of the emitted positron is 0.960 MeV. Given the mass values:
$m\left({}^{11}_{6}\mathrm{C}\right)=11.011434\mathrm{u}$ and $m\left({}^{11}_{6}\mathrm{B}\right)=11.009305\mathrm{u}$,
calculate Q and compare it with the maximum energy of the positron emitted.

496) The nucleus ${}^{23}_{10}\mathrm{Ne}$ decays by $\beta-$ emission. Write down the β-decay equation and determine the maximum kinetic energy of the electrons emitted. Given that:
$m\left({}^{23}_{10}\mathrm{Ne}\right)=22.994466\mathrm{u}$
$m\left({}^{23}_{11}\mathrm{Na}\right)=22.089770\mathrm{u}.$

497) A 1000 MW fission reactor consumes half of its fuel in 5.00 y. How much ${}^{235}_{92}\mathrm{U}$ did it contain initially? Assume that the reactor operates 80% of the time, that all the energy generated arises from the fission of ${}^{235}_{92}\mathrm{U}$ and that this nuclide is consumed only by the fission process.

498) For the β+ (positron) emission from a nucleus, there is another competing process known as electron capture (electron from an inner orbit, say, the K–shell, is captured by the nucleus and a neutrino is emitted).
$e^{+}+{}^{A}_{Z}X\rightarrow{}^{A}_{Z-1}Y+v$
Show that if β+ emission is energetically allowed, electron capture is necessarily allowed but not vice–versa.

499) In a periodic tabl=s given as 24.312 u. The average value is based on their relative natural abundance on earth. The three isotopes and their masses are ${}^{24}_{12}\mathrm{Mg}$(23.98504u), ${}^{25}_{12}\mathrm{Mg}$ (24.98584u) and ${}^{26}_{12}\mathrm{Mg}$ (25.98259u). The natural abundance of ${}^{24}_{12}\mathrm{Mg}$ is 78.99% by mass. Calculate the abundances of other two isotopes.

500) The neutron separation energy is defined as the energy required to remove a neutron from the nucleus. Obtain the neutron separation energies of the nuclei ${}^{41}_{20}\mathrm{Ca}$ and ${}^{27}_{13}\mathrm{Al}$ from the following data:
$m\left(\begin{array}{c}40\\20\end{array}\mathrm{Ca}\right)=39.962591\mathrm{u}$
$m\left(\begin{array}{c}41\\20\end{array}\mathrm{Ca}\right)=40.962278\mathrm{u}$
$m\left(\begin{array}{c}26\\13\end{array}\mathrm{Al}\right)=25.986895\mathrm{u}$
$m\left(\begin{array}{c}27\\13\end{array}\mathrm{Al}\right)=26.981541\mathrm{u}$

501) A source contains two phosphorous radio nuclides ${}^{22}_{15}\mathrm{P}\left(T_{1/2}=14.3\ \mathrm{d}\right)$ and ${}^{33}_{15}\mathrm{P}\left(T_{1/2}=25.3\ \mathrm{d}\right)$.Initially, 10% of the decays come from ${}^{33}_{15}\mathrm{P}$. How long one must wait until 90% do so?

502) Under certain circumstances, a nucleus can decay by emitting a particle more massive than an (-particle. Consider the following decay processes:
${}^{223}_{88}\mathrm{Ra}\rightarrow{}^{209}_{82}\mathrm{Pb}+{}^{14}_{6}\mathrm{C}$
${}^{223}_{88}\mathrm{Ra}\rightarrow{}^{219}_{86}\mathrm{Rn}+{}^{4}_{2}\mathrm{He}$
Calculate the Q-values for these decays and determine that both are energetically allowed.

503) Consider the fission of $\begin{matrix} 238 \\ 92 \end{matrix} \mathrm{U}$ by fast neutrons. In one fission event, no neutrons are emitted and the final end products, after the beta decay of the primary fragments, are $\begin{matrix} 140 \\ 58 \end{matrix} \mathrm{Ce}$ and $\begin{matrix} 99 \\ 44 \end{matrix} \mathrm{Ru}$. Calculate Q for this fission process. The relevant atomic and particle masses are

$m\left({}_{92}^{238}\mathrm{U}\right) = 238.05079\mathrm{u}$

$m\left({}_{58}^{140}\mathrm{Ce}\right) = 139.90543\mathrm{u}$

$n\left(\begin{matrix} 99 \\ 44 \end{matrix} \mathrm{R}_1\right) = 98.90594\mathrm{u}$

504) Consider the D−T reaction (deuterium−tritium fusion)

${}_1^2\mathrm{H} + {}_1^3\mathrm{H} \rightarrow {}_2^4\mathrm{He} + \mathrm{n}$

(a) Calculate the energy released in MeV in this reaction from the data:

$m\left({}_1^2\mathrm{H}\right) = 2.014102\mathrm{u}$

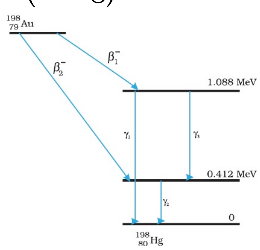
$m\left({}_1^3\mathrm{H}\right) = 3.016049\mathrm{u}$

(b) Consider the radius of both deuterium and tritium to be approximately 2.0 fm. What is the kinetic energy needed to overcome the coulomb repulsion between the two nuclei? To what temperature must the gas be heated to initiate the reaction?

505) Obtain the maximum kinetic energy of β-particles, and the radiation frequencies of " decays in the decay scheme . You are given that

$m\left({}^{198}\mathrm{Au}\right) = 197.968233\mathrm{u}$

$m\left({}^{198}\mathrm{Hg}\right) = 197.966760\mathrm{u}$



506) Calculate and compare the energy released by a) fusion of 1.0 kg of hydrogen deep within Sun and b) the fission of 1.0 kg of ^{235}U in a fission reactor.

507) Suppose India had a target of producing by 2020 AD, 200,000 MW of electric power, ten percent of which was to be obtained from nuclear power plants. Suppose we are given that, on an average, the efficiency of utilization (i.e. conversion to electric energy) of thermal energy produced in a reactor was 25%. How much amount of fissionable uranium would our country need per year by 2020? Take the heat energy per fission of ^{235}U to be about 200MeV.

508) If both the number of protons and the number of neutrons are conserved in a nuclear reaction, in what way is mass converted into energy (or vice-versa) in nuclear reaction

509) Suppose that protons and neutrons have equal masses. Calculate how many times nuclear matter is denser than