NUCLEI

1. A sample contains 16 g of a radioactive material, the half life of which is two days. After 32 days, the amount of radioactive material left in the sample is

a) Less than 1 mg b) $\frac{1}{4}g$ c) $\frac{1}{2}g$ d) $1g$

2. Neutron is a particle, which is

a) Charged and has spin b) Charged and has no spin
c) Charge less and has spin d) Charge less and has no spin

3. The ratio of half-life times of two elements A and B is $\frac{T_A}{T_B}$. The ratio of respectively decay constants $\frac{\lambda_A}{\lambda_B}$ is

a) $\frac{T_B}{T_A}$ b) $\frac{T_A}{T_B}$ c) $\frac{T_A+T_B}{T_A}$ d) $\frac{T_A-T_B}{T_A}$

4. In the following reaction the value of $'X'$ is
$_7N^{14} +_2 He^4 \to X + \,_1H^1$

a) $_8N^{17}$ b) $_8O^{17}$ c) $_7O^{16}$ d) $_7N^{16}$

5. If $N_1 = N_0e^{-\lambda t_1}$, then the number of atoms decayed during time interval from t_1 and $t_2 (t_2 > t_1)$ will be

a) $N_{t_1} = N_{t_2} = N_o[e^{-\lambda t_1} - e^{-\lambda r_2}]$ b) $N_{t_2} = N_{t_1} = N_o[e^{-\lambda t_2} - e^{-\lambda t_1}]$
c) $N_{t_2} - N_{t_1} = N_o[e^{\lambda t}2 - e^{-\lambda t_1}]$ d) None of the above

6. The possible quantum numbers for $3d$ electrons are

a) $n = 3, l = 1, m_l = +1, m_s = -\frac{1}{2}$ b) $n = 3, l = 2, m_l = +2, m_s = -\frac{1}{2}$
c) $n = 3, l = 1, m_l = -1, m_s = +\frac{1}{2}$ d) $n = 3, l = 0, m_l = +1, m_s = -\frac{1}{2}$

7. Calculate the energy released when three $\alpha -$ particles combined to from a ^{12}C nucleus , the mass defect is (atomic mass of $_2He^4$ is 4.002603 u)

a) 0.007809 u b) 0.002603 u c) 4.002603 u d) 0.5 u

8. In a hydrogen atom, which of the following electronic transitions would involve the maximum energy change

a) From $n = 2$ to $n = 1$ b) From $n = 3$ to $n = 1$ c) From $n = 4$ to $n = 2$ d) From $n = 3$ to $n = 2$

9. The energy equivalent to 1 mg of matter in MeV is

a) 56.25×10^{22} b) 56.25×10^{24} c) 56.25×10^{26} d) 56.25×10^{28}

10. The mass defect in particular nuclear reaction if 0.3 g. The amount of energy liberated in kilowatt hour is (Velocity of light= $3 \times 10^8\ ms^{-1}$)

a) 1.5×10^6 b) 2.5×10^6 c) 3×10^6 d) 7.5×10^6

11. An electron jumps from the 4^{th} orbit to the 2^{nd} orbit of hydrogen atom. Given the Rydberg's constant $R = 10^5 cm^{-1}$. The frequency in Hz of the emitted radiation will be

a) $\frac{3}{16} \times 10^5$ b) $\frac{3}{16} \times 10^{15}$ c) $\frac{9}{16} \times 10^{15}$ d) $\frac{3}{4} \times 10^{15}$

12. The electron in the hydrogen atom jumps from excited state ($n = 3$) to its ground state ($n = 1$) and the photons thus emitted irradiate a photosensitive material. If the work function of the material is 5.1 eV, the stopping potential is estimated to be (the energy of the electron in n^{th} state $E_n = -\frac{13.6}{n^2} eV$)

a) 5.1 V b) 12.1 V c) 17.2 V d) 7 V

13. The number of α-particles and β − particles respectively emitted in the reaction $_{88}A^{196} \to \,_{78}B^{164}$ are

a) 8 and 8 b) 8 and 6 c) 6 and 8 d) 6 and 6

14. An electron passing through a potential difference of 4.9 V collides with a memory atom and transfers it to the first excited state. What is the wavelength of a photon corresponding to the transition of the mercury atom to its normal state

a) 2050 Å b) 2240 Å c) 2525 Å d) 2935 Å

15. The half -life period of a radioactive substance is 3 days. Three fourth of substance decays in

a) 3 days b) 6 days c) 9 days d) 12 days

16. What is the Q-value of the reaction

$P + {}^{7}\mathrm{Li} \rightarrow {}^{4}\mathrm{He} + {}^{4}\mathrm{He}$

The atomic masses of ${}^{1}\mathrm{H}$, ${}^{4}\mathrm{He}$ *and* ${}^{7}\mathrm{Li}$ are 1.007825 u, 4.002603 u and 7.016004 u respectively

a) 17.35 MeV b) 18.06 MeV c) 177.35 MeV d) 170.35 MeV

17. If one starts with one curie of radioactive substance ($T_{1/2} = 12hrs$) the activity left after a period of 1 week will be about

a) 1 curie b) 120 micro curie c) 60 micro curie d) 8 mili curie

18. If the half life of a radioactive sample is 10 *hours*, its mean life is

a) 14.4 *hours* b) 7.2 *hours* c) 20 *hours* d) 6.93 *hours*

19. The half-life of ${}^{215}\mathrm{At}$ is 100 μs. The time taken for the radioactivity of a sample of ${}^{215}\mathrm{At}$ to decay to $\frac{1}{16}$ th of its initial value is

a) 400 μs b) 6.3 μs c) 40 μs d) 300 μs

20. Half life of a radio-active substance is 20 *minutes*. The time between 20% and 80% decay will be

a) 20 *minutes* b) 40 *minutes* c) 30 *minutes* d) 25 *minutes*

21. In which radioactive disintegration, neutron dissociates into proton and electron

a) He^{+1} emission b) β −emission c) γ −emission d) Positron emission

22. Using the following data

Mass hydrogen atom = 1.00783 u

Mass of neutron = 1.00867 u

Mass of nitrogen atom (${}_{7}\mathrm{N}^{14}$)= 14.00307 u

The calculated value of the binding energy of the nucleus of the nitrogen atom (${}_{7}\mathrm{N}^{14}$) is close to

a) 56 MeV b) 98 MeV c) 104 MeV d) 112 MeV

23. The ionization energy of Li^{++} is equal to

a) $9hcR$ b) $6hcR$ c) $2hcR$ d) hcR

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

a) $E_b + E_c = E_a$ b) $E_b + E_c > E_a$ c) $E_b + E_c < E_a$ d) $E_b . E_c = E_a$

25. According to Bohr's model, the radius of the second orbit of helium atom is

a) 0.53 Å b) 1.06 Å c) 2.12 Å d) 0.265 Å

26. An electron has a mass of $9.1 \times 10^{-31} kg$. It revolves around the nucleus in a circular orbit of radius $0.529 \times 10^{-10} metre$ at a speed of $2.2 \times 10^{6} m/s$. The magnitude of its linear momentum in this motion is

a) $1.1 \times 10^{-34} kg - m/s$ b) $2.0 \times 10^{-24} kg - m/s$ c) $4.0 \times 10^{-24} kg - m/s$ d) $4.0 \times 10^{-31} kg - m/s$

27. According to the quark model, it is possible to build all the hadrons using

a) 2 quarks and 3 antiquarks b) 3 quarks and 2 antiquarks

c) 3 quarks and 3 antiquarks d) 2 quarks and 2 antiquarks

28. Atomic number of a nucleus is Z and atomic mass is M. The number of neutron is

a) $M - Z$ b) M c) Z d) $M + Z$

29. An electron of an atom transits from n_1 to n_2. In which of the following maximum frequency of photon will be emitted

a) $n_1 = 1$ to $n_2 = 2$ b) $n_1 = 2$ to $n_2 = 1$ c) $n_1 = 2$ to $n_2 = 6$ d) $n_1 = 6$ to $n_2 = 2$

30. For uranium nucleus how does its mass vary with volume?

a) $m \propto V$ b) $m \propto 1/V$ c) $m \propto \sqrt{V}$ d) $m \propto V^2$

31. Which of the following isotopes is normally fissionable

a) ${}_{92}U^{238}$ b) ${}_{93}Np^{239}$ c) ${}_{92}U^{235}$ d) ${}_{2}He^{4}$

32. Which one of the following statements about uranium is correct

a) ${}^{235}U$ is fissionable by thermal neutrons

b) Fast neutrons trigger the fission process in ${}^{235}U$

c) ${}^{235}U$ breaks up into fragments when bombarded by slow neutrons

d) ${}^{235}U$ is an unstable isotope and undergoes spontaneous fission

33. Outside a nucleus

a) Neutron is stable b) Proton and neutron both are stable

c) Neutron is unstable d) Neither neutron nor proton is stable

34. If m, m_n and m_p are the masses of ${}_{Z}X^{A}$ nucleus, neutron and proton respectively, then

a) $m < (A-Z)m_n + Zm_p$ b) $m = (A-Z)m_n + Zm_p$

c) $m = (A-Z)m_p + Zm_n$ d) $m > (A-Z)m_n + Zm_p$

35. The average binding energy per nucleon is maximum for the nucleus

a) ${}_{2}He^{4}$ b) ${}_{8}O^{16}$ c) ${}_{26}Fe^{56}$ d) ${}_{92}He^{238}$

36. In the nuclear reaction: $X(n,\alpha)\ {}_{3}Li^{7}$ the term X will be

a) ${}_{5}B^{10}$ b) ${}_{5}B^{9}$ c) ${}_{5}B^{11}$ d) ${}_{2}He^{4}$

37. 3.8 days is the half-life period of a sample. After how many days, the sample will become 1/8th of the original substance

a) 11.4 b) 3.8 c) 3 d) None of these

38. The radius of nucleus is

a) Proportional to its mass number

b) Inversely Proportional to its mass number

c) Proportional to the cube root of its mass number

d) Not related to its mass number

39. Energy of an electron in n^{th} orbit of hydrogen atom is $\left(k = \frac{1}{4\pi\varepsilon_0}\right)$

a) $-\frac{2\pi^2 k^2 me^4}{n^2h^2}$ b) $-\frac{4\pi^2 mke^2}{n^2h^2}$ c) $-\frac{n^2h^2}{2\pi\, k\, me^4}$ d) $-\frac{n^2h^2}{4\pi^2 k\, me^2}$

40. The rest energy of an electron is

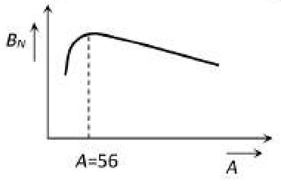
a) 510 KeV b) 931 KeV c) 510 MeV d) 931 MeV

41. Consider $\alpha -$ Particles, $\beta -$ Particles and $\gamma -$ rays, each having an energy of 0.5 MeV. In increasing order of penetrating powers, the radiations are

a) α, β, γ b) α, γ, β c) β, γ, α d) γ, β, α

42. The dependence of binding energy per nucleon, B_N on the mass number, A, is represented by

a)



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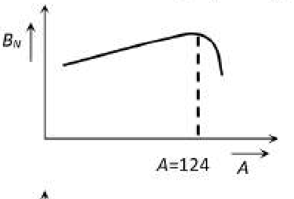
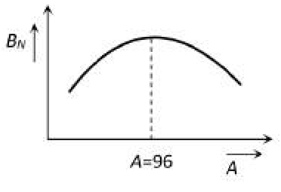
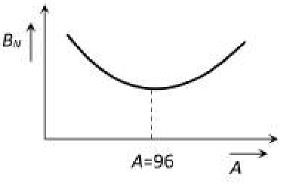


c)



d)



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

a) 3.2T year b) 4.6 T year c) 6.6 T year d) 9.2 T year

44. An artificial radioactive decay series begins with unstable ${}^{241}_{94}Pu$. The stable nuclide obtained after eight $\alpha -$decays and five $\beta -$decays is

a) $^{209}_{83}Bi$ b) $^{209}_{82}Pb$ c) $^{205}_{82}Ti$ d) $^{201}_{82}Hg$

45. A radioactive sample S_1 having an activity of 5μCi has twice the number of nuclei as another sample S_2 which has an activity of 10 μCi. The half lives of S_1 and S_2 can be

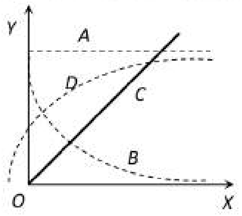
a) 20 yr and 5 yr ,respectively b) 20 yr and 10 yr ,respectively

c) 10 yr each d) 5 yr each

46. The rest mass of an electron as well as that of positron is 0.51 MeV. When an electron and positron are annihilate, they produce gamma-rays of wavelength(s)

a) 0.012 Å b) 0.024 Å c) 0.012 Å to ∞ d) 0.024 Å to ∞

47. In Fig. X represents time and Y represents activity of a radioactive sample. Then the activity of sample, varies with time according to the curve



a) A b) B c) C d) D

48. In the Bohr model of the hydrogen atom, let R, v and E represent the radius of the orbit, the speed of electron and the total energy of the electron respectively. Which of the following quantity is proportional to the quantum number n

a) R/E b) E/v c) RE d) uR

49. In Bohr's model of hydrogen atom, which of the following pairs of quantities are quantized

a) Energy and linear momentum b) Linear and angular momentum

c) Energy and angular momentum d) None of the above

50. Two nucleons are at a separation of one fermi. Protons have a charge of $+1.6 \times 10^{-19}$ C. The net nuclear force between them is F_1, if both are neutrons ,F_2 if both are protons and F_3 if one is proton and the other is neutron. Then

a) $F_1 = F_2 > F_3$ b) $F_1 = F_2 = F_3$ c) $F_1 < F_2 < F_3$ d) $F_1 > F_2 > F_3$

51. If r_1 and $r_2$are the radii of the atomic nuclei of mass numbers 64 and 125 respectively, then the ratio (r_1/r_2) is

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

52. In a material medium, when a positron meets an electron both the particles annihilate leading to the emission of two gamma ray photons. This process forms the basis of an important diagnostic procedure called

a) MRI b) PET c) CAT d) SPECT

53. If λ_{max} is 6563 Å, then wavelength of second line for Balmer series will be

a) $\lambda = \frac{16}{3R}$ b) $\lambda = \frac{36}{5R}$ c) $\lambda = \frac{4}{3R}$ d) None of the above

54. Rest mass energy of an electron is 0.54 MeV. If velocity of the electron is 0.8c, then $K.E.$ of the electron is

a) 0.36 MeV b) 0.41 MeV c) 0.48 MeV d) 1.32 MeV

55. If the binding energies of a deuteron and an alpha particle are 1.125MeV and 7.2MeV, respectively , then the more stable of the two is

a) deuteron

b) Alpha-particle

c) Both (a) and (b)

d) Sometimes deuteron and Sometimes Alpha-particle

56. Consider the following two statements

A. Energy spectrum of α-particles emitted in radioactive decay is discrete

B. Energy spectrum of β-particles emitted in radioactive decay is continuous

a) Only A is correct
b) Only B is correct
c) A is correct but B is wrong
d) Both A and B are correct

57. Two radioactive materials X_1 and X_2 have decay constants 10λ and λ repectively. If initially, they have the same number of nuclei, then the ratio of the number of nuclei of X_1 to that of X_2 will be $1/e$ after a time

a) $\frac{1}{10\lambda}$
b) $\frac{1}{11\lambda}$
c) $\frac{11}{10\lambda}$
d) $\frac{1}{9\lambda}$

58. If half life of radium is 77 days. Its decay constant in day will be

a) 3×10^{-13}/day
b) 9×10^{-3}/day
c) 1×10^{-3}/day
d) 6×10^{-3}/day

59. Which of the following atoms has the lowest ionization potential

a) ${}^{16}_{8}O$
b) ${}^{14}_{7}N$
c) ${}^{133}_{55}Cs$
d) ${}^{40}_{18}Ar$

60. Isobars are formed by

a) α −decay
b) β −decay
c) γ −deacy
d) h −decay

61. A nuclear bomb exploded 200 km above the surface of moon. The sound of explosion on the moon

a) Will be heard before the explosion is seen
b) Will be heard at the same time
c) Will be heard after explosion
d) Will not be heard at all

62. An electron jumps from 5th orbit of 4th orbit of hydrogen atom. Taking the Rydberg constant as 10^7 *per metre* what will be the frequency of radiation emitted

a) $6.75 \times 10^{12} Hz$
b) $6.75 \times 10^{14} Hz$
c) $6.75 \times 10^{13} Hz$
d) None of these

63. The fact that photons carry energy was established by

a) Doppler's effect
b) Compton's effect
c) Bohr's theory
d) Diffraction of light

64. The ratio of the longest to shortest wavelengths in Brackett series of hydrogen spectra is

a) $\frac{25}{9}$
b) $\frac{17}{6}$
c) $\frac{9}{5}$
d) $\frac{4}{3}$

65. After two hours, one-sixteenth of the starting amount of a certain radioactive isotope remained undecayed. The half life of the isotope is

a) 15 *minutes*
b) 30 *minutes*
c) 45 *minutes*
d) 1 *hour*

66. A reaction between a proton and ${}_8O^{18}$ that produces ${}_9F^{18}$ must also liberate

a) ${}_0n^1$
b) ${}_1e^0$
c) ${}_1n^0$
d) ${}_0e^1$

67. The half-life of a radioactive element is 3.8 days. The fraction left after 19 days will be

a) 0.124
b) 0.062
c) 0.093
d) 0.031

68. Select the wrong statement

a) Radioactivity is a statistical process.
b) Radioactivity is a spontaneous process.
c) Radioactivity is neutral characteristic of few elements.
d) Radioactive elements cannot be produced in the laboratory.

69. Half life of a radioactive element is 10 days. The time during which quantity remains 1/10 of initial mass will be

a) 100 days
b) 50 days
c) 33 days
d) 16 days

70. $\mathbf{F}_{pe}$ represents electrical force on proton due to electron and $\mathbf{F}_{ep}$ on electron due to proton in a hydrogen atom.Similarly $\mathbf{F}_{pe}$ represents the gravitational force on proton due to electron and $\mathbf{F}_{ep}$ the corresponding force on electron due to proton. Which of the following is not true?

a) $\mathbf{F}_{Pe} + \mathbf{F}_{ep} = 0$
b) $\mathbf{F}'_{Pe} + \mathbf{F}'_{ep} = 0$
c) $\mathbf{F}_{Pe} + \mathbf{F}'_{Pe} + \mathbf{F}_{ep} + \mathbf{F}'_{ep} = 0$
d) $\mathbf{F}_{Pe} + \mathbf{F}'_{Pe} = 0$

71. An electron changes its position from orbit $n = 4$ to the orbit $n = 2$ of an atom. The wavelength of the emitted radiation is (R = Rydberg's constant)

a) $\frac{16}{R}$
b) $\frac{16}{3R}$
c) $\frac{16}{5R}$
d) $\frac{16}{7R}$

72. Nuclear fission was discovered by

a) Ottohann and F. Strassmann
b) Fermi

c) Bethe
d) Rutherford

73. The energy required to excite an electron from the ground state of hydrogen atom to the first excited state, is
a) $1.602 \times 10^{-14} J$
b) $1.619 \times 10^{-16} J$
c) $1.632 \times 10^{-18} J$
d) $1.656 \times 10^{-20} J$

74. If M is the atomic mass and A is the mass number, packing fraction is given by
a) $\frac{M}{M-A}$
b) $\frac{M-A}{A}$
c) $\frac{A}{M-A}$
d) $\frac{A-M}{A}$

75. A mixture consists of two radioactive materials A_1 and A_2 with half lives of 20 s and 10 s respectively. Initially the mixture has 40 g of A_1 and 160 g of A_2. The amount of the two in the mixture will become equal after
a) 60 s
b) 80 s
c) 20 s
d) 40 s

76. The average binding energy per nucleon in the nucleus of an atom is approximately
a) 8 eV
b) 8 KeV
c) 8 MeV
d) 8 J

77. The phenomenon of radioactivity is
a) Exothermic change which increases or decreases with temperature
b) Increases on applied pressure
c) Nuclear process does not depend on external factors
d) None of the above

78. The speed of daughter nuclei is
a) $c\frac{\Delta m}{M+\Delta m}$
b) $c\sqrt{\frac{2\Delta m}{M}}$
c) $c\sqrt{\frac{\Delta m}{M}}$
d) $c\sqrt{\frac{\Delta m}{M+\Delta m}}$

79. The most stable particle in Baryon group is
a) Proton
b) Lamda-particle
c) Neutron
d) Omega-particle

80. A radioactive sample is α-emitter with half life 138.6 days is observed by a student to have 2000 disintegration/s. The number of radioactive nuclei for given activity are
a) 3.45×10^{10}
b) 1×10^{10}
c) 3.45×10^{15}
d) 2.75×10^{11}

81. A radioactive material has a half life of 10 days. What fraction of the material would remain after 30 days
a) 0.5
b) 0.25
c) 0.125
d) 0.33

82. When a $_4Be^9$ atom is bombarded with α −particles, one of the products of nuclear transmutation is $_6C^{12}$. The other is
a) $_{-1}e^0$
b) $_1H^1$
c) $_1D^2$
d) $_0n^1$

83. Fission of nuclei is possible because the binding energy per nucleon in them
a) Increases with mass number at high mass numbers
b) Decreases with mass number at high mass numbers
c) Increases with mass number at low mass numbers
d) Decreases with mass number at low mass numbers

84. To explain his theory, Bohr used
a) Conservation of linear momentum
b) Conservation of angular momentum
c) Conservation of quantum frequency
d) Conservation of energy

85. A radioactive nucleus emits a beta particle. The parent and daughter nuclei are
a) Isotopes
b) Isotones
c) Isomers
d) Isobars

86. Nuclear fission experiments show that the neutrons split the uranium nuclei into two fragments of about same size. This process is accompanised by the emission of several
a) Protons and positrons
b) α-particles
c) Neutrons
d) Protons and α-particles

87. The shortest wavelength in the Lyman series of hydrogen spectrum is 912Å corresponding to a photon energy of 13.6 eV. The shortest wavelength in the Balmer series is about
a) 3648 Å
b) 8208 Å
c) 1228 Å
d) 6566 Å

88. The rest energy of an electron is 0.511 MeV. The electron is accelerated from rest to a velocity 0.5 c. The change in its energy will be

a) 0.026 MeV b) 0.051 MeV c) 0.079 MeV d) 0.105 MeV

89. In any fission process the ratio $\frac{\text{mass of fission products}}{\text{mass of parent nucleus}}$ is

a) Less than 1
b) greater than 1
c) Equal to 1
d) Depends on the mass of parent nucleus

90. Half-life of a substance is 10 $years$. In what time, it becomes $\frac{1}{4}th$ part of the initial amount

a) 5 $years$ b) 10 $years$ c) 20 $years$ d) None of these

91. α −particles of energy 400 KeV are bombarded on nucleus of $_{82}Pb$. In scattering of α −particles, its minimum distance from nucleus will be

a) 0.59 nm b) 0.59 Å c) 5.9 pm d) 0.59 pm

92. K_α and K_β X-rays are emitted when there is a transition of electron between the levels

a) $n = 2$ to $n = 1$ and $n = 3$ to $n = 1$ respectively
b) $n = 2$ to $n = 1$ and $n = 3$ to $n = 2$ respectively
c) $n = 3$ to $n = 2$ and $n = 4$ to $n = 2$ respectively
d) $n = 3$ to $n = 2$ and $n = 4$ to $n = 3$ respectively

93. The ratio of the radii of the nuclei $_{13}Al^{27}$ and $_{52}Te^{125}$ is approximately

a) 6: 10 b) 13: 52 c) 40: 17 d) 14: 73

94. The fraction of the initial number of radioactive nuclei which remain undecayed after half of a half-life of the radioactive sample is

a) $\frac{1}{\sqrt{2}}$ b) $\frac{1}{2}$ c) $\frac{1}{2\sqrt{2}}$ d) $\frac{1}{4}$

95. The nucleus $^{115}_{48}Cd$ after two successive β^- decays will give

a) $^{115}_{46}Pa$ b) $^{114}_{49}In$ c) $^{113}_{50}Sn$ d) $^{115}_{50}Sn$

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

97. Half-life of radioactive substance is 3.20 h. What is the time taken for a 75% of substance to be used?

a) 6.38 h b) 12 h c) 4.18 day d) 1.2 day

98. The spectral series of the hydrogen atom that lies in the visible region of the electromagnetic spectrum

a) Paschen b) Balmer c) Lyman d) Brackett

99. What is the particle x in the following nuclear reaction

$^9_4Be + ^4_2He \rightarrow ^{12}_6C + x$

a) Electron b) Proton c) Photon d) Neutron

100. The masses of two radioactive substances are same and their half-lives are 1 yr and 2 yr respectively. The ratio of their activities after 4 yr will be

a) 1:4 b) 1:2 c) 1:3 d) 1:6

101. Highly energetic electrons are bombarded on a target of an element containing 30 neutrons. The ratio of radii of nucleus to that of Helium nucleus is $14^{1/3}$. The atomic number of nucleus will be

a) 25 b) 26 c) 56 d) 30

102. Fusion reaction take place at high temperature because

a) Atoms are ionised at high temperature
b) Molecules break up at high temperature
c) Nuclei break up at high temperature
d) Kinetic energy is high enough to overcome repulsion between nuclei

103. In a sample of hydrogen like atoms all of which are in ground state, a photon beam containing photons of various energies is passed. In absorption spectrum, five dark lines, are observed. The number of bright lines in the emission spectrum will be (assume that all transitions takes place)

a) 5 b) 10 c) 15 d) None of these

104. The radioactive nucleus of mass number A, initially at rest, emits an $\alpha -$ particle with a speed$v$. The recoil speed of the daughter nucleus will be

a) $\frac{2v}{A-4}$ b) $\frac{2v}{A+4}$ c) $\frac{4v}{A-4}$ d) $\frac{4v}{A+4}$

105. A radioactive element $_{90}X^{238}$ decays into $_{83}Y^{222}$. The number of β −particles emitted are

a) 4 b) 6 c) 2 d) 1

106. A radioactive nucleus $_{92}X^{235}$ decays to $_{91}Y^{231}$. Which of the following particles are emitted

a) One alpha and one electron b) Two deuterons and one positron

c) One alpha and one proton d) One proton and four neutrons

107. In a mean life of a radioactive sample

a) About 1/3 of substance disintegrates b) About 2/3 of the substance disintegrates

c) About 90% of the substance disintegrates d) Almost all the substance disintegrates

108. The half life of a radioactive isotope X is 50 years. It decays to another element Y which is stable. The two elements X and Y were found to be in the ratio of 1:16 in a sample of a given rock. The age of the rock was estimated to be

a) 100 years b) 150 years c) 200 years d) 250 years

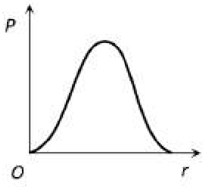
109. A hypothetical radioactive nucleus decays according to the following series

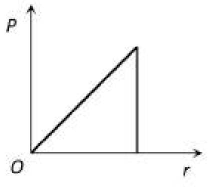
$$_{72}A^{180} \xrightarrow{\alpha} A_1 \xrightarrow{\beta^-} A_2 \xrightarrow{\alpha} A_3 \xrightarrow{\gamma} A_4$$

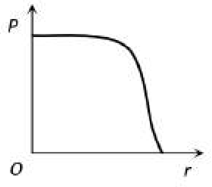
If the mass number and atomic number of A are respectively 180 and72. Then to atomic number and mass number of A will respectively be

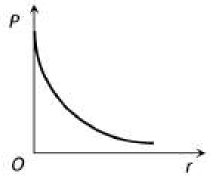
a) 69,171 b) 70,172 c) 68,172 d) 69,172

110. The change density in a nucleus varies with distance from the centre of the nucleus according to the curve in Fig.

a) 

b) 

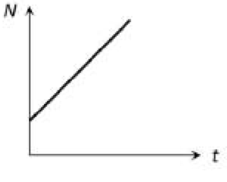
c) 

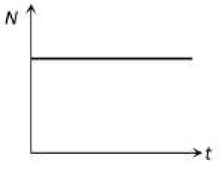
d) 

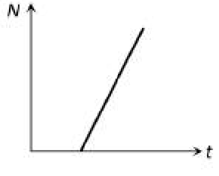
111. If the mass number of an atom is $A = 0$ and its electron configuration is $1s^2, 2s^2, 2p^6, 3s^2, 3p^6$, the number of neutrons and protons in its nucleus will be

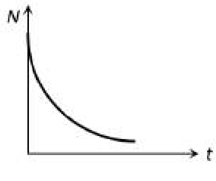
a) 22, 18 b) 18, 22 c) 20, 20 d) 18, 18

112. The graph between the instantaneous concentration (N) of a radioactive element and time (t) is

a) 

b) 

c) 

d) 

113. For a nuclear to be in critical condition, the value of neutron multiplication factor (k) must be

a) $k > 1$ b) $k < 1$ c) $k = 1$ d) $k = 0$

114. Which state of triply ionized Beryllium (Be^{+++}) has the same orbital radius as that of the ground state of hydrogen

a) $n = 4$ b) $n = 3$ c) $n = 2$ d) $n = 1$

115. The nuclear reactor at Kaiga is a

a) Research reactor b) Fusion reactor c) Breeder reactor d) Power reactor

116. If in nature there may not be an element for which the principle quantum number $n > 4$, then the total possible number of elements will be

a) 60 b) 32 c) 4 d) 64

117. If $_{92}U^{238}$ emits 8 α −particles and 6 β −particles, then the resulting nucleus is

a) $_{82}U^{206}$ b) $_{82}Pb^{206}$ c) $_{82}U^{210}$ d) $_{82}U^{214}$

118. The mass of a neutron is the same as that of

a) A proton b) A meson c) An epsilon d) An electron

119. Radon (Rn) decays into Polonium (Po) by emitting an α −particle with half-life of 4 days. A sample contains 6.4×10^{10} atoms of Rn. After 12 days, the number of atoms of Rn left in the sample will be

a) 3.2×10^{10} b) 0.53×10^{10} c) 2.1×10^{10} d) 0.8×10^{10}

120. Consider two nuclei of the same radioactive nuclide. One of the nuclei was created in a supernova explosion 5 billion years ago. The probability of decay during the next time is

a) Different for each nuclei b) Nuclei created in explosion decays first

c) Nuclei created in the reactor decays first d) Independent of the time of creation

121. The ratio of minimum to maximum wavelength in Balmer series is

a) 5 : 9 b) 5 : 36 c) 1 : 4 d) 3 : 4

122. The half-life period of radium is 1600 *years*. Its average life time will be

a) 3200 *years* b) 4800 *years* c) 2319 *years* d) 4217 *years*

123. The transition from the state $n = 4$ to $n = 3$ in a hydrogen like atom result in ultraviolet radiation. Infrared radiation will be obtained in the transition from

a) $2 \rightarrow 1$ b) $3 \rightarrow 2$ c) $4 \rightarrow 2$ d) $5 \rightarrow 4$

124. The count rate of a Geiger-Muller counter for the radiation of a radioactive material of half life of 30 *minutes* decreases to 5 s^{-1} after 2 hours. The initial count rate was

a) 25 s^{-1} b) 80 s^{-1} c) 625 s^{-1} d) 20 s^{-1}

125. In Raman effect, Stoke's lines are spectral lines having

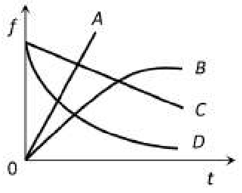
a) Frequency greater than that of the original line

b) Wavelength equal to that of the original line

c) Wavelength less than that of the original line

d) Wavelength greater than that of the original line

126. The fraction f of radioactive material that has decayed in time t, varies with time t. The correct variation is given by the curve



a) A b) B c) C d) D

127. White light is passed through a dilute solution of potassium permanganate. The spectrum produced by the emergent light is

a) Band emission spectrum b) Line emission spectrum

c) Band absorption spectrum d) Line absorption spectrum

128. The ratio of the frequencies of the long wavelength limits of Lyman and Balmer series of hydrogen spectrum is

a) 27 : 5 b) 5 : 27 c) 4 : 1 d) 1 : 4

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

a) hv b) $Mc^2 - hv$ c) $\frac{h^2v^2}{2Mc^2}$ d) Zero

130. In which of the following decay, the element does not change

a) β-decay b) α-decay c) γ-decay d) None of these

131. Light energy emitted by stars is due to

a) Breaking of nuclei b) Joining of nuclei

c) Burning of nuclei
d) Reflection of solar light

132. A nucleus decays by β^+-emission followed by aγ − emission. If the atomic and mass numbers of the parent nucleus are Z and A respectively, the corresponding numbers for the daughter nucleus are respectively
a) $Z-1$ and $A-1$
b) $Z+1$ and A
c) $Z-1$ and A
d) $Z+1$ and $A-1$

133. In radioactive decay process, the negatively charged emitted $\beta-$ particles are
a) The electrons present inside the nucleus
b) The electrons produced as a result of the decay of neutrons inside the nucleus
c) The electrons produced as a result of collisions between atoms.
d) The electrons orbiting around the nucleus.

134. The electron in a hydrogen atom makes a transition from $n=n_1$ to $n=n_2$ state. The time period of the electron in the initial state is eight times that in the final state. The possible values of n_1 and n_2 are
a) $n_1=6, n_2=2$
b) $n_1=2, n_2=1$
c) $n_1=8, n_2=2$
d) $n_1=4, n_2=2$

135. The ratio of the speed of the electron in the first Bohr orbit of hydrogen and the speed of light is equal to (where e, h and c have their usual meanings)
a) $2\pi hc/e^2$
b) $e^2h/2\pi c$
c) $e^2c/2\pi h$
d) $2\pi e^2/hc$

136. In Rutherford scattering experiment, what will be the correct angle for α scattering for an impact parameter $b=0$
a) $90°$
b) $270°$
c) $0°$
d) $180°$

137. For maintaining sustained chain reaction, the following is required
a) Protons
b) electrons
c) neutrons
d) positons

138. Which of the transitions in hydrogen atom emits a photon of lowest frequency (n = quantum number)
a) $n=2$ to $n=1$
b) $n=4$ to $n=3$
c) $n=3$ to $n=1$
d) $n=4$ to $n=2$

139. The spectral series of the hydrogen spectrum that lies in the ultraviolet region is the
a) Balmer series
b) Pfund series
c) Paschen series
d) Lyman series

140. The density of uranium is of the order of
a) 10^{20} kgm^{-3}
b) 10^{17} kgm^{-3}
c) 10^{14} kgm^{-3}
d) 10^{11} kgm^{-3}

141. The half-life of radon is 3.8 days. How many radon will be left out of 1024 mg after 38 days
a) 1 mg
b) 2 mg
c) 3 mg
d) 4 mg

142. For a radioactive nucleus, the mean life is T, If the number of decays per unit time is n at $t=0$, the number of decays between time 0 and t, is
a) $nTe^{-t/T}$
b) $n(1-e^{-t/T})$
c) $nT(1-e^{-t/T})$
d) $ne^{-t/T}$

143. $_7N^{14}$ is bombarded with $_2He^4$. The resulting nucleus is $_8O^{17}$ with the emission of
a) Neutrino
b) Antineutrino
c) Proton
d) Neutron

144. The example of nuclear fusion is
a) Formation of barium and krypton from uranium
b) Formation of helium from hydrogen
c) Formation of plutonium 235 from uranium 235
d) Formation of water from hydrogen and oxygen

145. Isotopes are atoms having
a) Same number of protons but different number of neutrons
b) Same number of neutrons but different number of protons
c) Same number of protons and neutrons
d) None of the above

146. If the radius of a nucleus of mass number 3 is R, then the radius of a nucleus of mass number 81 is
a) $3R$
b) $9R$
c) $(27)^{1/2}R$
d) $27R$

147. Which of the following radiations has the least wavelength
a) X-rays
b) γ-rays
c) β-rays
d) α-rays

148. An atomic power nuclear reactor can deliver 300 MW. The energy released due to fission of each nucleus of uranium atom U^{238} is 170 MeV. The number of uranium atoms fissioned per hour will be
a) 30×10^{25}
b) 4×10^{22}
c) 10×10^{20}
d) 5×10^{15}

149. The ratio of the kinetic energy to the total energy of an electron in a Bohr orbit is

a) -1 b) 2 c) $1:2$ d) None of these

150. The rad is the correct unit used to report the measurement of

a) The ability of a beam of gamma ray photons to produce ions in a target

b) The energy delivered by radiation to a target

c) The biological effect of radiation

d) The rate of decay of a radioactive source

151. It is easier to ionize hydrogen as compared to deuterium, because

a) Hydrogen is lighter than deuterium

b) Atomic number of hydrogen is lesser than deuterium

c) Hydrogen is a diatomic gas

d) The statements is wrong

152. The first line of Balmer series has wavelength 6563 Å. What will be the wavelength of the first member of Lyman series

a) 1215.4 Å b) 2500 Å c) 7500 Å d) 600 Å

153. Which of the following pairs is an isobar

a) ${}_1H^1$ and ${}_1H^2$ b) ${}_1H^2$ and ${}_1H^3$ c) ${}_6C^{12}$ and ${}_6C^{13}$ d) ${}_{15}P^{30}$ and ${}_{14}Si^{30}$

154. If N_0 is the original mass of the substance of half life period $T_{1/2} = 5\ years$, then the amount of substance left after 15 $years$ is

a) $N_0/8$ b) $N_0/16$ c) $N_0/2$ d) $N_0/4$

155. Mean life of neutron is about

a) 100 seconds b) 1000 seconds c) 10 seconds d) 1 seconds

156. An element A decays into element C by a two step process

$A \rightarrow B + {}_2\text{He}^4$

$B \rightarrow C + 2\,{}_{-1}e^0$

Then

a) A and C are isotopes b) A and C are isobars c) A and B are isotopes d) A and B are isobars

157. In the reaction identify X

${}_7N^{14} + \alpha \rightarrow {}_8X^{17} + {}_1p^1$

a) An oxygen nucleus with mass 17

b) An oxygen nucleus with mass 16

c) A nitrogen nucleus with mass 17

d) A nitrogen nucleus with mass 16

158. Ionisation potential of hydrogen atom is 13.6 eV. Hydrogen atoms in the ground state are excited by monochromatic radiation of photon energy 12.1eV. The spectral lines emitted by hydrogen atoms according to Bohr's theory will be

a) One b) Two c) Three d) Four

159. Heavy water is used in a nuclear reactor to

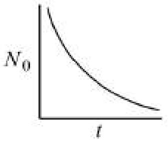
a) Absorb the neutrons

b) Slow down the neutrons

c) Act as coolant

d) None of the above

160. A radioactive element A decay into stable element B, initially a fresh sample of A is available. In this sample variation in number of nuclei of B with time is shown by

a)


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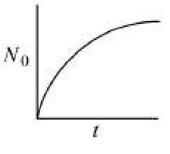
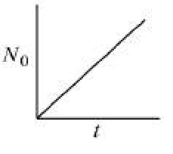


c)


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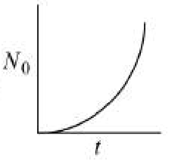


161. A radioactive sample of U^{238} decays to Pb through a process for which half life is $4.5 \times 10^9 years$. The ratio of number of nuclei of Pb to U^{238} after a time of $1.5 \times 10^9 years$ (given $2^{1/3} = 1.26$)

a) 0.12 b) 0.26 c) 1.2 d) 0.37

162. The mass and energy equivalent to 1 amu are respectively

a) $1.67 \times 10^{-27} gm, 9.30\ MeV$

b) $1.67 \times 10^{-27} kg, 930\ MeV$

c) $1.67 \times 10^{-27} kg, 1\ MeV$

d) $1.67 \times 10^{-34} kg, 1\ MeV$

163. Hydrogen atom from excited state comes to the ground state by emitting a photon of wavelength λ. If R is the Rydberg constant, the principal quantum number n of the excited state is

a) $\sqrt{\frac{\lambda R}{\lambda R-1}}$ b) $\sqrt{\frac{\lambda}{\lambda R-1}}$ c) $\sqrt{\frac{\lambda R^2}{\lambda R-1}}$ d) $\sqrt{\frac{\lambda R}{\lambda-1}}$

164. Energy generation in stars is mainly due to

a) Chemical reactions b) Fission of heavy nuclei
c) Fusion of light nuclei d) Fusion of heavy nuclei

165. A radioactive nucleus undergoes α-emission to form a stable element. What will be the recoil velocity of the daughter nucleus if V is the velocity of α-emission and A is the atomic mass of radioactive nucleus

a) $\frac{4V}{A-4}$ b) $\frac{2V}{A-4}$ c) $\frac{4V}{A+4}$ d) $\frac{2V}{A+4}$

166. When a slow neutron goes sufficiently close to a U^{235} nucleus, then the process that takes place is

a) Fission of U^{235} b) Fusion of neutron c) Fusion of U^{235} d) First (a) then (b)

167. The third line of Balmer series of an ion equivalent to hydrogen atom has wavelength of 108.5 nm. The ground state energy of an electron of this ion will be

a) 3.4 eV b) 13.6 eV c) 54.4 eV d) 122.4 eV

168. A nucleus of mass 214 amu in free state decays to emit an α-particle. Kinetic energy of the α-particle emitted is 6.7 MeV. The recoil energy (in MeV) of the daughter nucleus is

a) 1.0 b) 0.5 c) 0.25 d) 0.125

169. The binding energy of nucleus is a measure of its

a) Charge b) Mass c) Momentum d) Stability

170. Suppose an electron is attracted towards the origin by a force $\frac{k}{r}$ where 'k' is a constant and 'r' is the distance of the electron from the origin. By applying Bohr model to this system, the radius of the nth orbital of the electron is found to be 'r_n' and the kinetic energy of the electron to be 'T_n'. Then which of the following is true

a) T_n independent of n, $r_n \propto n$ b) $T_n \propto \frac{1}{n}, r_n \propto n$
c) $T_n \propto \frac{1}{n}, r_n \propto n^2$ d) $T_n \propto \frac{1}{n^2}, r_n \propto n^2$

171. v_1 is the frequency of the series limit of Lyman series, v_2 is the frequency of the first line of Lyman series and v_3 is the frequency of the series limit of the Balmer series. Then

a) $v_1 - v_2 = v_3$ b) $v_1 = v_2 - v_3$ c) $\frac{1}{v_2} = \frac{1}{v_1} + \frac{1}{v_3}$ d) $\frac{1}{v_1} = \frac{1}{v_2} + \frac{1}{v_3}$

172. Which of the following has the mass closest in value to that of the positron
($1\ a.m.u = 931\ MeV$)

a) Proton b) Electron c) Photon d) Neutrino

173. The set which represents the isotope, isobar and isotone respectively is

a) $({}_1H^2, {}_1H^3), ({}_{79}Au^{197}, {}_{80}Hg^{198})$ and $({}_2He^3, {}_1H^2)$ b) $({}_2He^3, {}_1H^1), ({}_{79}Au^{197}, {}_{80}Hg^{198})$ and $({}_1H^1, {}_1H^3)$
c) $({}_2He^3, {}_1H^3), ({}_1H^2, {}_1H^3)$ and $({}_{79}Au^{197}, {}_{80}Hg^{198})$ d) $({}_1H^2, {}_1H^3), ({}_2He^3, {}_1H^3)$ and $({}_{79}Au^{197}, {}_{80}Hg^{198})$

174. The nucleus ${}_6C^{12}$ absorbs an energetic neutron and emits a beta particle (β). The resulting nucleus is

a) ${}_7N^{14}$ b) ${}_7N^{13}$ c) ${}_5B^{13}$ d) ${}_6C^{13}$

175. The mass defect in a particular nuclear reaction is 0.3 $grams$. The amount of energy liberated in kilowatt hours is
(Velocity of light $= 3 \times 10^8 m/s$)

a) 1.5×10^6 b) 2.5×10^6 c) 3×10^6 d) 7.5×10^6

176. Consider the following statements

S1 : The nuclear force is independent of the charge of nucleons
S2 : The number of nucleons in the nucleus of an atom is equal to the number of electrons in the atom
S3 : All nuclei have masses that are less than the sum of the masses of constituent nucleons

S4 : Nucleons belong to the family of leptons while electrons are members of the family of hadrons

Choose the correct statement(s) from these

a) S1 only b) S1 and S4 c) S2, S3 and S4 d) S1 and S3

177. Alpha rays emitted from a radioactive substance are

a) Negatively charged particles

b) Ionized hydrogen nuclei

c) Doubly ionized helium atom

d) Unchanged particles having the mass equal to proton

178. A radioactive sample at any instant has its disintegration rate 5000 disintegrations per minute. After 5 min, the rate is 1250 disintegrations per min. Then, the decay constant (per minute) is

a) 0.4 In 2 b) 0.2 In 2 c) 0.1 In 2 d) 0.8 In 2

179. β-decay means emission of electron from

a) Innermost electron orbit b) A stable nucleus

c) Outermost electron orbit d) Radioactive nucleus

180. Excitation energy of a hydrogen like ion in its first excitation state is 40.8 eV. Energy needed to remove the electron from the ion in ground state is

a) 54.4 eV b) 13.6 eV c) 40.8 eV d) 27.2 eV

181. In a hydrogen atom, the distance between the electron and proton is $2.5 \times 10^{-11} m$. The electrical force of attraction between them will be

a) $2.8 \times 10^{-7} N$ b) $3.7 \times 10^{-7} N$ c) $6.2 \times 10^{-7} N$ d) $9.1 \times 10^{-7} N$

182. Sun energy is due to

a) Fission of hydrogen b) Fusion of hydrogen

c) Both fission and fusion d) Neither fusion nor fission

183. The α-particle is the nucleus of an atom of

a) Neon b) Hydrogen c) Helium d) Deuterium

184. The binding energy of an electron in the ground state of He is equal to 24.6 eV. The energy required to remove both the electrons is

a) 49.2 eV b) 24.6 eV c) 38.2 eV d) 79.0 eV

185. The mass of an α-particle is

a) Less than the sum of masses of two protons and two neutrons

b) Equal to mass of four protons

c) Equal to mass of four neutrons

d) Equal to sum of masses of two protons and two neutrons

186. In artificial radioactivity, 1.414×10^6 nuclei are disintegrated into 10^6 nuclei in 10 min. The half-life in minutes must be

a) 5 b) 20 c) 15 d) 30

187. The energy in MeV is released due to transformation of 1 kg mass completely into energy ($c = 3 \times 10^8 m/s$)

a) 7.625×10 MeV b) 10.5×10^{29} MeV c) 2.8×10^{-28} MeV d) 5.625×10^{29} MeV

188. A radioactive substance emits

a) α-rays b) β-rays c) γ-rays d) All of these

189. In the nuclear reaction ${}_{85}X^{297} \rightarrow Y + 4\alpha, Y$ is

a) ${}_{76}Y^{287}$ b) ${}_{77}Y^{285}$ c) ${}_{77}Y^{281}$ d) ${}_{77}Y^{289}$

190. The ratio of minimum wavelengths of Lyman and Balmer series will be

a) 5 b) 10 c) 1.25 d) 0.25

191. The atoms of same element having different masses but same chemical properties, are called

a) Isotones b) Isotopes c) Isobars d) Isomers

192. After 280 days, the activity of a radioactive sample is 6000 dps. The activity reduces to 3000dps after another 140 days. The initial activity of the sample(in dps) is

a) 6000 b) 9000 c) 3000 d) 24000

193. Hydrogen bomb is based upon

a) Fission b) fusion c) Chemical reaction d) Transmutation

194. What is the ground state energy of positronium

a) 13.6 eV b) 27.2 eV c) 5.4 eV d) 1.8 eV

195. Nuclear reactions are given as

(i) □ $(n, p)_{15}p^{32}$ (ii) □ $(p, \alpha)_8 O^{16}$ (iii) $_7N^{14}$ (iv) $_6C^{14}$

Missing particle or nuclide (in box □) in these reactions are respectively

a) $S^{32}, F^{19}, {}_0n^1$ b) $F^{19}, S^{32}, {}_0n^1$ c) $Be^9, F^{19}, {}_0n^1$ d) None of these

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

a) 69.3% b) 63% c) 50% d) 37%

197. If half life of a radioactive element is 3 *hours*, after 9 *hours* its activity becomes

a) 1/9 b) 1/27 c) 1/6 d) 1/8

198. The S.I. unit of radioactivity is

a) Roentgen b) Rutherford c) Curie d) Becquerel

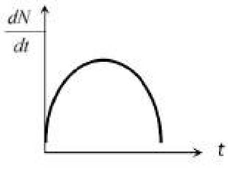
199. A nucleus $_nX^m$ emits one α and one β-particle. The resulting nucleus is

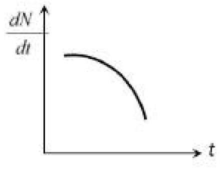
a) $_nX^{m-4}$ b) $_{n-2}X^{m-4}$ c) $_{n-4}Z^{m-4}$ d) $_{n-1}Z^{m-4}$

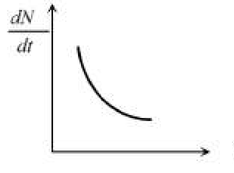
200. Which of the relation is correct between time period and number of orbits while an electron is revolving in an orbit

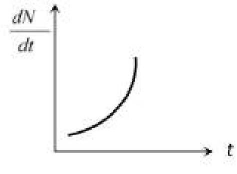
a) n^2 b) $\frac{1}{n^2}$ c) n^3 d) $\frac{1}{n}$

201. Radioactive element decays to form a stable nuclide, then the rate of decay of reactant $\left(\frac{dN}{dt}\right)$ will vary with time (t) as shown in figure

a) 

b) 

c) 

d) 

202. When a radioactive substance emits an α-particle, its position in the periodic table is lowered by

a) One place b) Two places c) Three places d) Four places

203. $^{232}_{90}Th$ an isotope of thorium decays in ten stages emitting six α-particles and four β-particles in all. The end product of the decay is

a) $^{206}_{82}Pb$ b) $^{209}_{82}Pb$ c) $^{208}_{82}Pb$ d) $^{209}_{83}Br$

204. In hydrogen atom, when electron jumps from second to first orbit, then energy emitted is

a) $-13.6\ eV$ b) $-27.2\ eV$ c) $-6.8\ eV$ d) None of these

205. The neutron was discovered by

a) Marie Curie b) Pierre Curie c) James Chadwick d) Rutherford

206. $_{92}\mathrm{U}^{235}$ undergoes successive disintegrations with the end product of $_{82}\mathrm{Pb}^{203}$. The number of α and β-particles emitted are

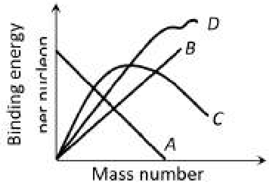
a) $\alpha = 6, \beta = 4$ b) $\alpha = 6, \beta = 0$ c) $\alpha = 8, \beta = 6$ d) $\alpha = 3, \beta = 3$

207. A nuclear reaction given by

$_ZX^A \rightarrow {}_{Z+1}Y^A + {}_{-1}e^0 + \bar{p}$ represents

a) γ-decays b) Fusion c) Fission d) β-decay

208. Binding energy per nucleon plot against the mass number for stable nuclei is shown in the figure. which curve is correct

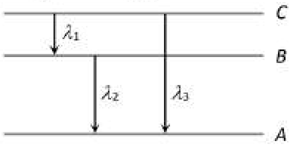


a) A b) B c) C d) D

209. As per Bohr model, the minimum energy (in eV) required to remove an electron from the ground state of doubly ionized Li atom ($Z = 3$) is

a) 1.51 b) 13.6 c) 40.8 d) 122.4

210. Energy levels A, B, C of a certain atom corresponding to increasing values of energy, $i.e., E_A < E_B < E_C$. If $\lambda_1, \lambda_2, \lambda_3$ are the wavelength of radiations corresponding to the transitions C to B, B to A and C to A respectively, which of the following statements is correct



a) $\lambda_3 = \lambda_1 + \lambda_2$ b) $\lambda_3 = \dfrac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$ c) $\lambda_1 + \lambda_2 + \lambda_3 = 0$ d) $\lambda_3^2 = \lambda_1^2 + \lambda_2^2$

211. A double charged lithium atom is equivalent to hydrogen whose atomic number is 3. The wavelength of required radiation for emitting electron from first to third Bohr orbit in Li^{++} will be (Ionisation energy of hydrogen atom is $13.6 eV$)

a) 182.51 Å b) 177.17 Å c) 142.25 Å d) 113.74 Å

212. The ratio of the longest to shortest wavelengths in Lyman series of hydrogen spectra is

a) $\dfrac{25}{9}$ b) $\dfrac{17}{6}$ c) $\dfrac{9}{5}$ d) $\dfrac{4}{3}$

213. A small quantity of solution containing Na^{24} radio nuclide of activity 1 *microcurie* is injected into the blood of a person. A sample of the blood of volume $1 cm^3$ taken after 5 hours shows an activity of 296 disintegration per minute. What will be the total volume of the blood in the body of the person. Assume that the radioactive solution mixes uniformly in the blood of the person

(Take 1 $curie = 3.7 \times 10^{10}$ disintegration per second and $e^{-\lambda t} = 0.7927$; where $\lambda =$ disintegration constant)

a) 5.94 *litre* b) 2 *litre* c) 317 *litre* d) 1 *litre*

214. A nuclear transformation is denoted by $X\ (n, \alpha) \rightarrow {}_3^7\text{Li}$. Which of the following is the nucleus of element X?

a) ${}_6^{12}\text{C}$ b) ${}_5^{10}\text{B}$ c) ${}_5^{9}\text{B}$ d) ${}_4^{11}\text{Be}$

215. The binding energy per nucleon of O^{16} is $7.97 MeV$ and that of O^{17} is $7.75\ MeV$. The energy (in MeV) required to remove a neutron from O^{17} is

a) 3.52 b) 3.64 c) 4.23 d) 7.86

216. The end product of the decay of ${}_{90}\text{Th}^{232}$ is ${}_{82}\text{Pb}^{208}$. The number of α and β-particles emitted are respectively

a) 6,4 b) 3,3 c) 4,6 d) 6,0

217. Half life of radioactive element depends upon

a) Amount of element present b) Temperature

c) Pressure d) Nature of element

218. A radioactive decay chain starts from ${}_{92}Np^{237}$ produces ${}_{90}Th^{229}$ by successive emissions. The emitted particles can be

a) Two α-particles and one β-particle b) Three β^+ particles

c) One α-particle and two β^+ particles d) One α-particle and two β^- particles

219. Most suitable element for nuclear fission is the element with atomic number near

a) 11 b) 21 c) 52 d) 92

220. A certain radioactive material ${}_{Z}X^{A}$ starts emitting α and β particles successively such that the end product is ${}_{Z-3}Y^{A-b}$. The number of αandβ particles emitted are

a) 4 and 3 respectively b) 2 and 1 respectively c) 3 and 4 respectively d) 3 and 8 respectively

221. ${}_{92}U^{238}$ on absorbing a neutron goes over to ${}_{92}U^{239}$. This nucleus emits an electron to go over electron goes over to Plutonium. The resulting Plutonium can be expressed as

a) ${}_{94}U^{239}$ b) ${}_{92}U^{239}$ c) ${}_{93}U^{240}$ d) ${}_{92}U^{240}$

222. The activity of a radioactive sample is measured as 9750 counts *per minute* at $t = 0$ and as 975 counts *per minute* at $t = 5$ *minutes*. The decay constant is approximately

a) 0.230 *per minute* b) 0.461 *per minute* c) 0.691 *per minute* d) 0.922 *per minute*

223. The radius of germanium (Ge) nuclide is measured to be twice the radius of ${}_{4}^{9}$Be. The number of nucleons in Ge are

a) 73 b) 74 c) 75 d) 72

224. The activity of a sample of a radioactive material is A at time t_1 and A_2 at time $t_2 (t_2 > t_1)$. If its mean life is T, then

a) $A_1 t_1 = A_2 t_2$ b) $A_1 - A_2 = t_2 - t_1$ c) $A_2 = A_1 e^{(t_1 - t_2)/T}$ d) $A_2 = A_1 e^{(t_1/t_2)/T}$

225. The first excited state of hydrogen atom is 10.2 eV above its ground state. The temperature is needed to excite hydrogen atoms to first excited level, is

a) $7.9 \times 10^4\ K$ b) $3.5 \times 10^4\ K$ c) $5.8 \times 10^4\ K$ d) $14 \times 10^4\ K$

226. A hydrogen atom in its ground state absorbs 10.2 eV of energy. The orbital angular momentum is increased by

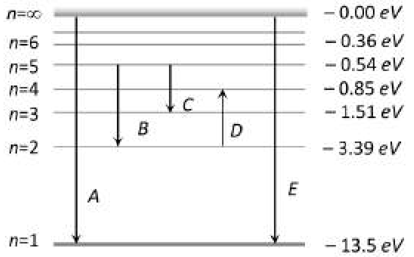
(Given Planck's constant $h = 6.6 \times 10^{-34} J - s$)

a) $1.05 \times 10^{-34} J\text{-}s$ b) $3.16 \times 10^{-34} J\text{-}s$ c) $2.11 \times 10^{-34} J\text{-}s$ d) $4.22 \times 10^{-34} J\text{-}s$

227. F_{pp}, F_{nn} and F_{np} are the nuclear forces between proton-proton, neutron-neutron and neutron-proton respectively. Then relation between them is

a) $F_{pp} = F_{nn} \neq F_{np}$ b) $F_{pp} \neq F_{nn} = F_{np}$ c) $F_{pp} = F_{nn} = F_{np}$ d) $F_{pp} \neq F_{nn} \neq F_{np}$

228. The energy levels of the hydrogen spectrum is shown in figure. There are some transition A, B, C, D and E. Transition A, B and C respectively represent



a) First member of Lyman series, third spectral line of Balmer series and the second spectral line of Paschen series

b) Ionization potential of hydrogen, second spectral line of Balmer series and third spectral line of Paschen series

c) Series limit of Lyman series, third spectral line of Balmer series and second spectral line of Paschen series

d) Series limit of Lyman series, second spectral line of Balmer series and third spectral line of Paschen series

229. Energy of 1g uranium is equal to

a) $9.0 \times 10^{13} J$ b) $9.0 \times 10^{19} J$ c) $3.0 \times 10^{16} J$ d) $3.0 \times 10^{17} J$

230. Energy required for the electron excitation in Li^{++} from the first to the third Bohr orbit is

a) 12.1 eV b) 36.3 eV c) 108.8 eV d) 122.4 eV

231. A radioactive substance has a half-life of four months. Three-fourth of the substance will decay in

a) 3 months b) 4 months c) 8 months d) 12 months

232. Energy E of a hydrogen atom with principal quantum number n is given by $E = \frac{-13.6}{n^2} eV$. The energy of a photon ejected when the electron jumps from $n = 3$ state to $n = 2$ state of hydrogen is approximately

a) 1.5 eV b) 0.85 eV c) 3.4 eV d) 1.9 eV

233. The example of nuclear fusion is

a) Formation of Ba and Kr from U^{235}
b) Formation of He from H
c) Formation of $Pu - 235$ from $U - 235$
d) Formation of water from hydrogen and oxygen

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

a) 28.4 MeV b) 20.8 MeV c) 27.3 MeV d) 14.2 MeV

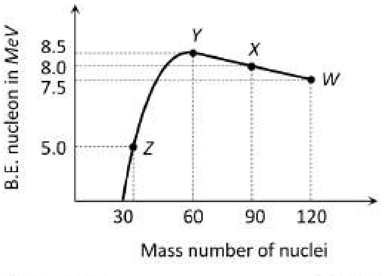
235. The nucleus $_{92}U^{234}$ splits exactly in half in a fission reaction in which two neutrons are released.The resultant nuclei are

a) $_{46}Pd^{116}$ b) $_{45}Rh^{117}$ c) $_{45}Rh^{116}$ d) $_{46}Pd^{117}$

236. When the number of nucleons in nuclei increase, the binding energy per nucleon

a) Increases continuously with mass number
b) Decreases continuously with mass number
c) Remains constant with mass number
d) First increases and then decreases with increases of mass number

237. Binding energy per nucleon verses mass number curve for nuclei is shown in the figure. W, X, Y and Z are four nuclei indicated on the curve. The process that would release energy is



a) $Y \rightarrow 2Z$ b) $W \rightarrow X + Z$ c) $W \rightarrow 2Y$ d) $X \rightarrow Y + Z$

238. Consider an initially pure $'M'g$ sample of ^{A}X, an isotope that has a half life of T hour. What is it's initial decay rate (N_A = Avogrado No.)

a) $\frac{MN_A}{T}$ b) $\frac{0.693MN_A}{T}$ c) $\frac{0.693MN_A}{AT}$ d) $\frac{2.303MN_A}{AT}$

239. The nuclear radius of a certain nucleus is 7.2 fm and it has charge of 1.28×10^{-17} C. The number of neutrons inside the nucleus is

a) 136 b) 142 c) 140 d) 132

240. If the binding energy per nucleon in $_3Li^7$ and $_2He^4$ nuclei are respectively 5.60 MeV and 7.06 MeV, then the energy of proton in the reaction $_3Li + p \rightarrow 2_2He^4$ is

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

241. If the binding energy per nucleon in ^7_3Li and ^4_2He nuclei are 5.60 MeV and 7.06 MeV respectively, then in the reaction

$p + ^7_3Li \rightarrow 2\ ^4_2He$

energy of proton must be

a) 28.24MeV b) 17.28MeV c) 1.46MeV d) 39.2MeV

242. In nuclear fission, the fission reactions proceeds with a projectile. Which of the following suits the best

a) Slow proton b) Fast neutron c) Slow neutron d) None of these

243. Neutron decay in free space is given as follows

$_0n^1 \rightarrow {_1H^1} + {_{-1}e^0} + [\,]$ Then the parenthesis represents a

a) Neutrino b) Photon c) Antineutrino d) Graviton

244. What is the disintegration constant of radon if the number of its atoms diminishes by 18%in 24 h?

a) $2.1 \times 10^{-3}\ s^{-1}$ b) $2.1 \times 10^{-4}\ s^{-1}$ c) $2.1 \times 10^{-5}\ s^{-1}$ d) $2.1 \times 10^{-6}\ s^{-1}$

245. What is the mass of one curie of U^{234}?

a) 3.7×10^{10}g b) 3.7×10^{-10}g c) 6.25×10^{-34}g d) 1.438×10^{-11}g

246. Half-life of a radioactive substance is 20 *minutes*. Difference between points of time when it is 33% disintegrated and 67% disintegrated is approximately

a) 10 *min* b) 20 *min* c) 30 *min* d) 40 *min*

247. Which of these is non-divisible

a) Nucleus b) Photon c) Proton d) Atom

248. For principal quantum number $n = 3$, the possible values of orbital quantum number $'l'$ are

a) 1, 2, 3 b) 0, 1, 2, 3 c) 0, 1, 2 d) $-1, 0, +1$

249. 16 g sample of a radioactive element is taken from Bombay to Delhi in 2 *hour* and it was found that 1 g of the element remained (undisintegrated). Half life of the element is

a) 2 *hour* b) 1 *hour* c) 1/2 *hour* d) 1/4 *hour*

250. If 20 g of a radioactive substance due to radioactive decay reduces to 10 g in 4 minutes, then in what time 80 g of the same substance will reduce to 10 g

a) In 8 *minutes* b) In 12 *minutes* c) In 16 *minutes* d) In 20 *minutes*

251. In the nuclear reaction

${}^{14}_{7}N + X \rightarrow {}^{14}_{6}C + {}^{1}_{1}H$, the X will be

a) ${}^{0}_{-1}e$ b) ${}^{1}_{1}H$ c) ${}^{2}_{1}H$ d) ${}^{1}_{0}n$

252. The mass number of nucleus is

a) Sometimes equal to its atomic number

b) Sometimes less than and sometimes more than its atomic number

c) Always less than its atomic number

d) Always more than its atomic number

253. The magnetic moment (μ) of a revolving electron around the nucleus varies with principal quantum number n as

a) $\mu \propto n$ b) $\mu \propto 1/n$ c) $\mu \propto n^2$ d) $\mu \propto 1/n^2$

254. A and B are two radioactive substances whose half-lives are 1 and 2 yr respectively. Initially 10 g of A and 1 g of B is taken. The time (approximate) after which they will have same quantity remaining is

a) 6.62 yr b) 5 yr c) 3.2 yr d) 7yr

255. The particle that possesses half integral spin as

a) Photon b) Pion c) Proton d) K-meson

256. In a radioactive disintegration , the ratio of initial number of atoms to the number of atoms present at an instant of time equal to its mean life is

a) $\frac{1}{e^2}$ b) $\frac{1}{e}$ c) e d) e^2

257. Which of the following is true

a) Lyman series is a continuous spectrum

b) Paschen series is a line spectrum in the infrared

c) Balmer series is a line spectrum in the ultraviolet

d) The spectral series formula can be derived from the Rutherford model of the hydrogen atom

258. Nuclear forces are

a) Short ranged attractive and charge independent

b) Short ranged attractive and charge dependent

c) Long ranged repulsive and charge independent

d) Long ranged repulsive and charge dependent

259. The radioactivity of a certain radioactive element drops to 1/64 of its initial value in 30 *seconds*. Its half life is

a) 2 *seconds* b) 4 *seconds* c) 5 *seconds* d) 6 *seconds*

260. If M_0 is the mass of an oxygen isotope $_8O^{17}$, $M_p and\ M_n$ are the masses of a proton and a neutron, respectively, the nuclear binding energy of the isotope is

a) $(M_o - 8M_p)c^2$ b) $(M_o - 8M_p - 9M_n)c^2$ c) $M_o c^2$ d) $(M_o - 17\ M_n)c^2$

261. If the series limit of Lymen series for Hydrogen atom is equal to the series limit of Balmer series for a hydrogen like atom, then atomic number of this hydrogen like atom will be

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

262. The radius of the Bohr orbit in the ground state of hydrogen atom is 0.5 Å. The radius of the orbit of the electron in the third excited state of He^+ will be

a) 8 Å b) 4 Å c) 0.5 Å d) 0.25 Å

263. If an electron jumps from 1st orbital to 3rd orbital, then it will

a) Absorb energy b) Release energy c) No gain of energy d) None of these

264. The nuclide ^{131}I is radioactive, with a half-life of 8.04 days. At noon on January 1, the activity of a certain sample is 600 Bq. The activity at noon on January 24 will be

a) 75 Bq b) Less than 75 Bq c) More than 75 Bq d) 150 Bq

265. A π^0 at rest decays into 2γ rays, $\pi^0 \rightarrow \gamma + \gamma$. Then which of the following can happen

a) The two γ's move in same direction b) The two γ's move in opposite direction

c) Both repel each other d) Both attract each other

266. When a proton, anti-proton annihilate ,the energy released is

a) 1.5×10^{-10} J b) 28.8×10^{-10} J c) 6×10^{-10} J d) $9 \times 10 - 10$ J

267. $^{235}_{92}X \rightarrow ^{231}_{91}Y$

Number of particles emitted in the reaction is

a) One electron and one neutron b) One neutron and one electron

c) One α and one neutron d) One α and one electron

268. A sodium atom is in one of the states labeled 'Lowest excited levels'. It remains in that state for an average time of $10^{-8}s$, before it makes a transition back to a ground state. What is the uncertainty in energy of that excited state

a) $6.56 \times 10^{-8}eV$ b) $2 \times 10^{-8}eV$ c) $10^{-8}eV$ d) $8 \times 10^{-8}eV$

269. Age of a tree is determined using radio-isotope of

a) Carbon b) Cobalt c) Iodine d) Phosphorus

270. In hydrogen atom, if the difference in the energy of the electron in $n = 2$ and $n = 3$ orbits is E, the ionization energy of hydrogen atom is

a) 13.2 E b) 7.2 E c) 5.6 E d) 3.2 E

271. The large scale destruction, that would be caused due to the use of nuclear weapons is called

a) Nuclear holocaust b) Thermo-nuclear reaction

c) Neutron reproduction factor d) None of these

272. The half life of radium is 1620 years and its atomic weight is 226 $kg\ per\ kilomol$. The number of atoms that will decay from its 1 g sample $per\ second$ will be

(Avogadro's number $N = 6.02 \times 10^{26} atom/kilomol$)

a) 3.61×10^{10} b) 3.6×10^{12} c) 3.11×10^{15} d) 31.1×10^{15}

273. Which one of the following statement is true, if half-life of a radioactive substance is 1 month?

a) 7/8th part of the substance will disintegrate in 3 months

b) 1/8th part of the substance will remain undecayed at the end of 4 months.

c) The substance will disintegrate completely in 4 months.

d) 1.16th part of the substance will remain undecayed at the end of 3 months

274. Taking Rydberg's constant $R_H = 1.097 \times 10^7 m$, first and second wavelength of Balmer series in hydrogen spectrum is

a) 2000 Å, 3000Å b) 1575 Å, 2960 Å c) 6529 Å, 4280 Å d) 6552 Å, 4863 Å

275. Assume that a neutron breaks into a photon and an electron. The energy released during this process is (mass of neutron $= 1.6725 \times 10^{-27} kg$, Mass of proton $= 1.6725 \times 10^{-27} kg$, mass of electron $= 9 \times 10^{-31} kg$)

a) $0.73\ MeV$ b) $7.10\ MeV$ c) $6.30\ MeV$ d) $5.4\ MeV$

276. Which energy state of the triply ionized beryllium has the same electron orbital radius as that of ground state of hydrogen? Given Z for Be=4

a) $n = 4$ b) $n = 3$ c) $n = 2$ d) $n = 1$

277. Given a sample of $Radium$-226 having half-life of 4 days. Find the probability, a nucleus disintegrates after 2 half lives

a) 1 b) 1/2 c) 1.5 d) 3/4

278. Which of the following rays are not electromagnetic waves

a) γ-rays b) β-rays c) Heat rays d) X-rays

279. In hydrogen atom, electron makes transition from $n = 4$ to $n = 1$ level. Recoil momentum of the H atom will be

a) $3.4 \times 10^{-27} N - s$ b) $6.8 \times 10^{-27} N - s$ c) $3.4 \times 10^{-24} N - s$ d) $6.8 \times 10^{-24} N - s$

280. What is the respective number of α and β particles emitted in the following radioactive decay

$_{90}X^{200} \rightarrow {}_{80}Y^{168}$

a) 6 and 8 b) 8 and 8 c) 6 and 6 d) 8 and 6

281. The electron in a hydrogen atom makes a transition from an excited state to the ground state. Which of the following statements is true

a) Its kinetic energy increases and its potential and total energies decrease

b) Its kinetic energy decreases, potential energy increases and its total energy remains the same

c) Its kinetic and total energies decrease and its potential energy increases

d) Its kinetic, potential and total energies decrease

282. Which of the following is true for number of spectral lines in going from Lyman series to P-fund series

a) Increases b) Decreases

c) Unchanged d) May decrease and increase

283. There are two radioactive substances A and B. Decay constant of B is two times that of A. Initially, both have equal number of nuclei. After n half lives of A, rate of disintegration of both are equal. The value of n is

a) 4 b) 2 c) 1 d) 5

284. The energy released in the fission of 1Kg of $_{92}U^{235}$ is (energy per fission =200 MeV)

a) 5.1×10^{26}eV b) 5.1×10^{26} J c) 8.2×10^{13} J d) 8.2×10^{13} MeV

285. The fission of ^{235}U can be triggered by the absorption of slow neutrons by a nucleus. Similarly a slow proton can also be used. This statement is

a) Correct b) Wrong

c) Information is insufficient d) None of these

286. The mass equivalent at 931 MeV energy is

a) $1.66 \times 10^{-27} kg$ b) $6.02 \times 10^{-24} kg$ c) $1.66 \times 10^{-20} kg$ d) $6.02 \times 10^{-27} kg$

287. If a radioactive substance reduces to $\frac{1}{16}$ of its original mass in 40 $days$, what is its half life

a) 10 $days$ b) 20 $days$ c) 40 $days$ d) None of these

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

a) $\frac{5N_0}{2}$ b) $2N_0$ c) $3N_0$ d) $\frac{9N_0}{2}$

289. The ratio of longest wavelength and the shortest wavelength observed in the five spectral series of emission spectrum of hydrogen is

a) $\frac{4}{3}$ b) $\frac{525}{376}$ c) 25 d) $\frac{900}{11}$

290. Two nucleons are at a separation of 1 fm. The net force between them is F_1 if both neutrons, F_2 if both are protons, and F_3 if one is a proton and the other is a neutron.
a) $F_1 > F_2 > F_3$ b) $F_2 > F_1 > F_3$ c) $F_1 = F_3 > F_2$ d) $F_1 = F_2 > F_3$

291. The energy released in the explosion of an atom bomb is mainly due to
a) nuclear fusion b) nuclear fission
c) Controlled nuclear chain reaction d) None of the above

292. Consider the following two statements A and B identify the correct answer given
A: Nuclear density is same for all nuclei
B:Radius of the nucleus R and its mass the number A are related as $\sqrt{A} \propto R^{1/6}$
a) Both A and B are true b) Both A and B are false
c) A is true but B is false d) A is false but B is true

293. In the given nuclear reaction A, B, C, D, E represents ${}_{92}U^{238} \xrightarrow{\alpha} {}_{B}Th^{A} \xrightarrow{\beta} {}_{D}Pa^{C} \xrightarrow{e} {}_{92}U^{234}$
a) $A = 234, B = 90, C = 234, D = 91, E = \beta$ b) $A = 234, B = 90, C = 238, D = 94, E = \alpha$
c) $A = 238, B = 93, C = 234, D = 91, E = \beta$ d) $A = 234, B = 90, C = 234, D = 93, E = \alpha$

294. Minimum excitation potential of Bohr's first orbit in hydrogen atom is
a) 13.6 V b) 3.4 V c) 10.2 V d) 3.6 V

295. r_1 and r_2 are the radii of atomic nuclei of mass numbers 64 and 27 respectively. The ratio (r_1/r_2) is
a) 64/27 b) 27/64 c) 4/3 d) 1

296. A radioactive sample at any instant has its disintegration rate 5000 disintegrations per minute. After 5 min, the rate becomes 1250 disintegration per minute. Then ,its decay constant (per minute) is
a) $0.8 \log_e 2$ b) $0.4 \log_e 2$ c) $0.2 \log_e 2$ d) $0.1 \log_e 2$

297. On bombarding U^{235} by slow neutrons, 200MeV energy is released. If the power output of atomic reactor is 1.6 MW, then the rate of fission will be
a) $5 \times 10^{22}\ s^{-1}$ b) $5 \times 10^{16} s^{-1}$ c) $8 \times 10^{16}\ s^{-1}$ d) $20 \times 10^{16}\ s^{-1}$

298. Energy of an electron in an excited hydrogen atom is $-3.4\ eV$. Its angular momentum will be ($h = 6.626 \times 10^{-34} J - s$)
a) $1.11 \times 10^{34} J\ s$ b) $1.51 \times 10^{-31} J\ s$ c) $2.11 \times 10^{-34} J\ s$ d) $3.72 \times 10^{-34} J\ s$

299. The wavelength of radiation emitted is λ_0 when an electron jumps from the third to second orbit of hydrogen atom. For the electron jump from fourth to the second orbit of the hydrogen atom, the wavelength of radiation emitted will be
a) $(16/25)\lambda_0$ b) $(20/27)\lambda_0$ c) $(27/20)\lambda_0$ d) $(25/16)\lambda_0$

300. Consider an electron $(m = 9.1 \times 10^{-31} kg)$ confined by electrical forces to move between two rigid walls separated by $1.0 \times 10^{-9} metre$, which is about five atomic diameters. The quantized energy value for the lowest stationary state is
a) $12 \times 10^{-20} joule$ b) $6.0 \times 10^{-20} joule$ c) $6.0 \times 10^{-18} joule$ d) $6\ joule$

301. What is used as a moderator in a nuclear reactor?
a) Water b) Graphite c) Cadmium d) Steel

302. The half life of a radioactive element which has only $\frac{1}{32}$ of its original mass left after a lapse of 60 days is
a) 12 days b) 32 days c) 60 days d) 64 days

303. The half-life of radioactive Polonium (Po) is 138.6 $days$. For ten lakh Polonium atoms, the number of disintegration in 24 hours is
a) 2000 b) 3000 c) 4000 d) 5000

304. The rate of disintegration of fixed quantity of a radioactive element can be increased by
a) Increasing the temperature b) Increasing the pressure
c) Chemical reaction d) It is not possible

305. The ratio of the radii of the nuclei ${}_{13}Al^{27}$ and ${}_{54}Te^{125}$ is
a) $\sqrt{13}:\sqrt{52}$ b) $2\sqrt{13}:3\sqrt{52}$ c) $3\sqrt{3}:5\sqrt{5}$ d) 3: 5

306. In half life of a radio isotope is 2 seconds and number of atoms are only 4, then after one half life remaining (without decay) atoms are probably

a) 1 b) 2 c) 3 d) All the above

307. The extreme wavelengths of Paschen series are

a) $0.365\mu m$ and $0.565\mu m$
b) $0.818\mu m$ and $1.89\mu m$
c) $1.45\mu m$ and $0.04\mu m$
d) $2.27\mu m$ and $7.43\mu m$

308. The ratio of the speed of the electrons in the ground state of hydrogen to the speed of light in vacuum is

a) 1/2 b) 2/137 c) 1/137 d) 1/237

309. The absorption transitions between the first and the fourth energy states of hydrogen atom are 3. The emission transitions between these states will be

a) 3 b) 4 c) 5 d) 6

310. When an electron jumps from a level $n = 4$ to $n = 1$, momentum of the recoiled hydrogen atom will be

a) 6.8×10^{-27}kg – ms^{-1}
b) 12.75×10^{-19}kg – ms^{-1}
c) 136×10^{-19}kg – ms^{-1}
d) zero

311. If the radioactive decay constant of radium is 1.07×10^{-4} per year, then its half life period is approximately equal to

a) 8,900 *years* b) 7,000 *years* c) 6,476 *years* d) 2,520 *years*

312. Hydrogen (H), deuterium (D), singly ionized helium (He^+) and doubly ionized lithium (Li^{++}) all have one electron around the nucleus. Consider $n = 2$ to $n = 1$ transition. The wavelengths of emitted radiations are $\lambda_1, \lambda_2, \lambda_3$ and λ_4 respectively. Then approximately

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

313. Hydrogen bomb is based on which of the following phenomenon

a) Nuclear fission b) Nuclear fusion c) Radioactive decay d) None of these

314. The fossil bone has a ^{14}C : ^{12}C ratio, which is $\left[\frac{1}{16}\right]$ of that in a living animal bone. If the half-life of ^{14}C is 5730 yr, then the age of the fossil bone is

a) 11460 yr b) 17190 yr c) 22920 yr d) 45840yr

315. The decay constant of a radioactive sample is λ.The half-life and mean life of the sample are respectively given by

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

316. The binding energy per nucleon of deuteron ($^2_1$H)and helium nucleus ($^4_2$He)is 1:1MeV and 7MeV respectively. If two deuteron nuclei react to form a single helium nucleus , then the energy released is

a) 13.9MeV b) 26.9MeV c) 23.6MeV d) 19.2MeV

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

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

318. The composition of an α-particle can be expressed be

a) $1P + 1N$ b) $1P + 2N$ c) $2P + 1N$ d) $2P + 2N$

319. Who discovered spin quantum number

a) Uhlenbeck & Goudsmit
b) Niels's Bohr
c) Zeeman
d) Sommerfeld

320. Mean life of a radioactive sample is 100 s. Then its half-life(in minutes) is

a) 0.693 b) 1 c) 10^{-4} d) 1.155

321. A radioactive nucleus A finally transforms into a stable nucleus B. Then A and B can be

a) Isobars b) Isotones c) Isotopes d) None of these

322. The frequency of 1st line of Balmer series in H_2 atom is v_0. The frequency of line emitted by singly ionized He atom is

a) $2v_0$ b) $4v_0$ c) $v_0/2$ d) $v_0/4$

323. From a newly formed radioactive substance (Half life 2 *hours*), the intensity of radiation is 64 times the permissible safe level. The minimum time after which work can be done safely from this source is

a) 6 *hours* b) 12 *hours* c) 24 *hours* d) 128 *hours*

324. During negative β-decay

a) Neutron converts into proton b) Proton converts into neutron

c) Neutron proton ratio increases d) None of these

325. The ratio of speed of an electron in ground state in Bohrs first orbit of hydrogen atom to velocity of light in air is

a) $\frac{e^2}{2\varepsilon_0 hc}$ b) $\frac{2e^2\varepsilon_0}{hc}$ c) $\frac{e^3}{2\varepsilon_0 hc}$ d) $\frac{2\varepsilon_0 hc}{e^2}$

326. The half-life of a sample of a radioactive substance is 1 hour. If 8×10^{10} atoms are present at $t = 0$, then the number of atoms decayed in the duration $t = 2$ hour to $t = 4$ hour will be

a) 2×10^{10} b) 1.5×10^{10} c) Zero d) Infinity

327. If electron in a hydrogen atom has moved from $n = 1$ to $n = 10$ orbit, the potential energy of the system has

a) Increased b) Decreased c) Remained unchanged d) Become zero

328. Which of the following cannot cause fission in a heavy nucleus

a) α-particle b) Proton c) Deutron d) Laser rays

329. The binding energy per nucleon for the parent nucleus is $E_1$and that for the daughter nuclei is E_2. Then

a) $E_2 = 2E_1$ b) $E_1 > E_2$ c) $E_2 > E_1$ d) $E_1 = 2E_2$

330. Which one of the series of hydrogen spectrum is in the visible region

a) Lyman series b) Balmer series c) Paschen series d) Bracket series

331. Electrons in the atom are held to the nucleus by

a) Coulomb's forces b) Nuclear forces c) Vander waal's forces d) Gravitational forces

332. If the energy released in the fission of one nucleus is 200 *MeV* then the number of nuclei required per second in a power plant of 16 *kW* will be

a) 0.5×10^{14} b) 0.5×10^{12} c) 5×10^{12} d) 5×10^{14}

333. If λ is decay constant and N the number of radioactive nuclei of an element , then the decay rate (R) of that element is

a) λN^2 b) λN c) $\frac{\lambda}{N}$ d) $\lambda^2 N$

334. The approximate nuclear radius is proportional to (A is the mass number and Z the atomic number)

a) $\sqrt{A}$ b) $A^{1/3}$ c) $\sqrt{Z}$ d) $Z^{1/3}$

335. A nucleus $_ZX^A$emits an α-particle. The resultant nucleus emits a β^+particle. The respective atomic and mass numbers of the final nucleus will be

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

336. The wavelengths involved in the spectrum of deuterium (^2_1D) are slightly different from that of hydrogen spectrum, because

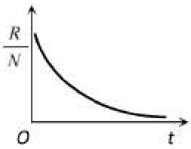
a) The attraction between the electron and the nucleus is different in the two cases

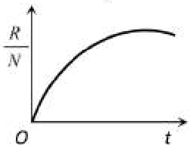
b) The size of the two nuclei are different

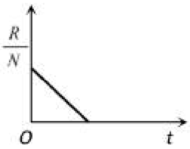
c) The nuclear forces are different in the two cases

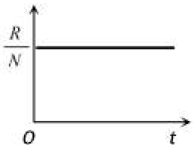
d) The masses of the two nuclei are different

337. A radioactive sample has N_0 active atoms $t = 0$. If the rate of disintegration at any time is R and the number of atoms is N, then the ratio R/N varies with time as

a) 

b) 

c) 

d) 

338. Complete the equation for the following fission process $_{92}U^{235} + {_0n^1} \rightarrow {_{38}Sr^{90}} + \cdots$

a) $_{54}Xe^{143} + 3\,{_0n^1}$ b) $_{54}Xe^{145}$ c) $_{57}Xe^{142}$ d) $_{54}Xe^{142} + {_0n^1}$

339. The Bohr model of atom

a) Assumes that the angular momentum of electrons is quantized
b) Uses Einstein's photo-electric equation
c) Predicts continuous emission spectra for atoms
d) Predicts the same emission spectral for all types of atoms

340. A common example of β-decay is

${}_{15}P^{32} \rightarrow {}_{16}P^{32} + x + y$

Then x and y stand for

a) Electron and neutrino
b) Positron and neutrino
c) Electron and antineutrino
d) Positron and antineutrino

341. Half-life of radioactive sample, when activity of material initially was 8 counts and after 3 h it becomes 1 count, is

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

342. The wavelength of light emitted from second orbit to first orbits in a hydrogen atom is

a) $1.215 \times 10^{-7} m$
b) $1.215 \times 10^{-5} m$
c) $1.215 \times 10^{-4} m$
d) $1.215 \times 10^{-3} m$

343. When ${}_{3}\mathrm{Li}^{7}$ nuclei are bombarded by protons, and the resultant nuclei are ${}_{4}\mathrm{Be}^{8}$,the emitted particles will be

a) alpha particles
b) beta particles
c) gamma photons
d) neutrons

344. If 200 MeV energy is released in the fission of a single U^{235} nucleus, the number of fissions required per second to produce 1 *kilowatt* power shall be (Given 1 $eV = 1.6 \times 10^{-19} J$)

a) 3.125×10^{13}
b) 3.125×10^{14}
c) 3.125×10^{15}
d) 3.125×10^{16}

345. As compound ${}^{12}C$ atom, ${}^{14}C$ atom 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

346. M_p denotes the mass of a proton and M_n that of a neutron. A given nucleus, of binding energy B, contains Z protons and N neutrons. The mass $M(N, Z)$ of the nucleus is given by (c is the velocity of light)

a) $M(N, Z) = NM_n + ZM_p - Bc^2$
b) $M(N, Z) = NM_n + ZM_p + Bc^2$
c) $M(N, Z) = NM_n + ZM_p - B/c^2$
d) $M(N, Z) = NM_n + ZM_p + B/c^2$

347. In nuclear reaction ${}_{2}He^{4} + {}_{z}X^{A} \rightarrow {}_{z+2}Y^{A+3} + A$, A denotes

a) Electron
b) Positron
c) Proton
d) Neutron

348. Li nucleus has three protons and four neutrons. Mass of lithium nucleus is 7.016005 amu. Mass of proton is 1.007277 amu and mass of neutron is 1.008665 amu. Mass defect for lithium nucleus in amu is

a) 0.04048 amu
b) 0.04050 amu
c) 0.04052 amu
d) 0.04055 amu

349. The energy of an electron in nth orbit of hydrogen atom is $-13.6/n^2$eV. Energy required to excite the electron from the first orbit to the third orbit is

a) 10.2 J
b) 12.09 J
c) 12.09 eV
d) 13.6 eV

350. In the following nuclear reaction

${}_{6}C^{11} \rightarrow {}_{5}B^{11} + \beta^{+} + X$

What does X stand for?

a) A neutron
b) A neutrino
c) An electron
d) A proton

351. The ionization potential of hydrogen atom is $-13.6\ eV$. An electron in the ground state of a hydrogen atom absorbs a photon of energy $12.75 eV$. How many different spectral lines can one expect when the electron make a downward transition

a) 1
b) 4
c) 2
d) 6

352. The half-life of radioactive Radon is 3.8 days. The time at the end of which (1/20)th of the Radon sample will remain undecayed is (given $\log_{10} e = 0.4343$)

a) 13.8 days
b) 16.5 days
c) 33 days
d) 76 days

353. The splitting of line into groups under the effect of magnetic field is called

a) Zeeman's effect b) Bohr's effect c) Heisenberg's effect d) Magnetic effect

354. 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

355. Thermal neutrons can cause fission in

a) U^{235} b) U^{238} c) Pu^{238} d) Th^{232}

356. Complete the reaction $n + {}^{235}_{92}U \rightarrow {}^{144}_{56}Ba + \cdots + 3n$

a) ${}^{89}_{36}Kr$ b) ${}^{90}_{36}Kr$ c) ${}^{91}_{36}Kr$ d) ${}^{92}_{36}Kr$

357. Following process is known as $hv \rightarrow e^+ + e^-$

a) Pair production b) Photoelectric effect c) Compton effect d) Zeeman effect

358. Rutherford's α-particle experiment showed that the atoms have

a) Proton b) Nucleus c) Neutron d) Electrons

359. The radioactive decay of uranium into thorium is expressed by the equation ${}^{238}_{92}U \rightarrow {}^{234}_{90}Th + X$, where $'X'$ is

a) An electron b) A proton c) A deuteron d) An alpha particle

360. The binding energy per nucleon for deuteron and helium are 1.1MeV and 7.0MeV. The energy released when two deuterons fuse to form a helium nucleus is

a) 23.6MeV b) 2.2MeV c) 30.2MeV d) 3.6MeV

361. A radioactive material decays by simultaneous emission of two particles with half-lives 1620 yr and 810 yr respectively. The time in year after which one-fourth of the material remains , is

a) 4860 yr b) 3240 yr c) 2340 yr d) 1080yr

362. The nucleus of atomic mass A and atomic number Z emits a β-particle. The atomic mass and atomic number of the resulting nucleus are

a) A, Z b) $A + 1, Z$ c) $A, Z + 1$ d) $A - 4, Z - 2$

363. Antiparticle of electron is

a) ${}_0n^1$ b) ${}_1H^1$ c) Positron d) Neutrino

364. Which of the following processes represents a γ-decay?

a) ${}_ZX^A + \gamma \longrightarrow_{(Z-1)} X^{A+a+b}$ b) ${}_ZX^A + {}_0n^1 \longrightarrow_{(Z-2)} X^{(A-3)} + C$

c) ${}_ZX^A \longrightarrow_Z X^A + \gamma$ d) ${}_ZX^A + {}_{-1}e^0 \longrightarrow {}_{A-1}X^{A+g}$

365. A free neutron decays spontaneously into

a) A proton ,an electron and antineutrino

b) A proton ,an electron and aneutrino

c) A proton and electron

d) A proton, and electron , a neutrino and an antineutrino

366. When hydrogen atom is in its first excited level, its radius is ...... its ground state radius

a) Half b) Same c) Twice d) Four times

367. A radioactive nucleus can decay simultaneously by two different processes which have decay constant λ_1 and λ_2.The effective decay constant of the nuclide is λ, where

a) $\lambda = \lambda_1 + \lambda_2$ b) $\lambda = 2(\lambda_1 + \lambda)$ c) $\frac{1}{\lambda} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$ d) $\lambda = \sqrt{\lambda_1 \lambda_2}$

368. Ionisation energy of an electron present in the second Bohr's orbit of hydrogen is

a) 54.4 eV b) 13.6 eV c) 1.5 eV d) 3.4 eV

369. The electron in a hydrogen atom makes a transition $n_1 \rightarrow n_2$where $n_1$and n_2 are the principal quantum numbers of the two states. Assume the Bohr model to be valid. The time period of electron in the initial state is 8 times that in the final state. The possible values of n_1 and n_2 are

a) $n_1 = 6, n_2 = 3$ b) $n_1 = 8, n_2 = 2$ c) $n_1 = n_2 = 1$ d) $n_1 = 8, n_2 = 1$

370. The wavelength of the first spectral line in the Balmer series of hydrogen atom is 6561 Å. The wavelength of the second spectral line in the Balmer series of singly ionized helium atom is

a) 1215 Å b) 1640 Å c) 2430 Å d) 4687 Å

371. The half life period of a radioactive substance is 5 min. The amount of substance decayed in 20 min will be
a) 93.75% b) 75% c) 25% d) 6.25%

372. A count rate meter shows a count of 240 per minute from a given radioactive source. One hour later the meter shows a count rate of 30 per minute. The half-life of the source is
a) 120 min b) 80 min c) 30 min d) 20 min

373. Half lives of two radioactive substances A and B are respectively 20 $minutes$ and 40 $minutes$. Initially the sample of A and B have equal number of nuclei. After 80 minutes, the ratio of remaining number of A and B nuclei is
a) 1 : 16 b) 4 : 1 c) 1 : 4 d) 1 : 1

374. The energy equivalent to a kilogram of matter is about
a) 10^{20} J b) 10^{17} J c) 10^{14} J d) 10^{11} J

375. Electron in hydrogen atom first jumps from third excited state to second excited state and then from second excited to the first excited state. The ratio of the wavelengths $\lambda_1 : \lambda_2$ emitted in the two cases is
a) 7/5 b) 27/20 c) 27/5 d) 20/7

376. The subatomic particles proton and neutron fall under the group of
a) Mesons b) Photons c) Leptons d) Baryons

377. If the wavelength of the first line of the Balmer series of hydrogen is 6561 Å, the wavelength of the second line of the series should be
a) 13122 Å b) 3280 Å c) 4860 Å d) 2187 Å

378. Radioactive substances do not emit
a) Electron b) Helium nucleus c) Positron d) Proton

379. Which one is correct about fission?
a) Approx 0.1 % mass converts into energy
b) Most of energy of fission is in the form of heat
c) In a fission of U^{235} about 200 eV energy is released
d) On an average, one neutron is released per fission of U^{235}

380. Half-life is measured by
a) Geiger-Muller counter b) Carbon dating
c) Spectroscopic method d) Wilson-Cloud chamber

381. If a proton and anti-proton come close to each other and annihilate, how much energy will be released
a) $1.5 \times 10^{-10} J$ b) $3 \times 10^{-10} J$ c) $4.5 \times 10^{-10} J$ d) None of these

382. The transition of an electron from $n_2 = 5,6, \dots \dots$ to $n_1 = 4$ gives rise to
a) Pfund series b) Lyman series c) Paschen series d) Brackett series

383. The radioactivity of a certain material drops to $\frac{1}{16}$ of the initial value in 2h. The half-life of this radio nuclide is
a) 10 min b) 20 min c) 30 min d) 40 min

384. Mass spectrometric analysis of potassium and argon atoms in a Moon rock sample shows that the ratio of the number of (stable) ^{40}Ar atoms present to the number of (radioactive) ^{40}K atoms is 10.3. Assume that all the argon atoms were produced by the decay of potassium atoms, with a half-life of 1.25×10^9 yr. How old is the rock?
a) 2.95×10^{11}yr b) 2.95×10^{9}yr c) 437×10^{9}yr d) 437×10^{11}yr

385. The correct order of ionizing capacity of α, β and γ −rays is
a) $\alpha > \gamma > \beta$ b) $\alpha > \beta > \gamma$ c) $\alpha < \beta < \gamma$ d) $\gamma > \alpha > \beta$

386. A chain reaction is continuous due to
a) Large mass defect b) Large energy
c) Production of more neutrons in fission d) None of these

387. A nucleus of $_{84}Po^{210}$ originally at rest emits an α-particle with speed v. What will be recoil speed of the daughter nucleus?
a) $4v/206$ b) $4v/214$ c) $v/206$ d) $v/214$

388. In which of the following systems will the radius of the first orbit ($n = 1$) be minimum
a) Single ionized helium
b) Deuterium atom
c) Hydrogen atom
d) Doubly ionized lithium

389. 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 1 kW?
a) 3.125×10^{13}
b) 6.250×10^{13}
c) 1.525×10^{13}
d) None of these

390. Which of the following is not conserved in nuclear reaction?
a) Total energy
b) Mass number
c) Charge number
d) Number of fundamental particles

391. 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) $A_1t_1 - A_2t_2$
b) $A_1 - A_2$
c) $(A_1 - A_2)/\lambda$
d) $\lambda(A_1 - A_2)$

392. In hydrogen atom which quantity is integral multiple of $\frac{h}{2\pi}$
a) Angular momentum
b) Angular velocity
c) Angular acceleration
d) Momentum

393. The particles emitted by radioactive decay are deflected by magnetic field. The particles will be
a) Protons and α −particles
b) Electrons, protons and α −particles
c) Electrons, protons and neutrons
d) Electrons and α −particles

394. Starting with a sample of pure ^{66}Cu, 7/8 of it decays into Zn in 15 min. The corresponding half-life is
a) 10 min
b) 15 min
c) 5 min
d) $7\frac{1}{2}$ min

395. Out of the following which one is not a possible energy for a photon to be emitted by hydrogen atom according to Bohr's atomic model
a) 13.6 eV
b) 0.65 eV
c) 1.9 eV
d) 11.1 eV

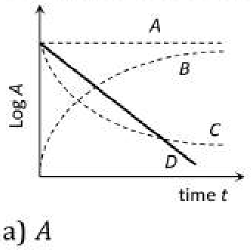
396. For ionizing an excited hydrogen atom, the energy required (in eV) will be
a) A little less then 13.6
b) 13.6
c) More than 13.6
d) 3.4 or less

397. The radius of a nucleus of a mass number A is directly proportional to
a) A^3
b) A
c) $A^{2/3}$
d) $A^{1/3}$

398. Which of the following statements about the Bohr model of the hydrogen atom is false
a) Acceleration of electron in $n = 2$ orbit is less than that in $n = 1$ orbit
b) Angular momentum of electron in $n = 2$ orbit is more than that in $n = 1$ orbit
c) Kinetic energy of electron in $n = 2$ orbit is less than that in $n = 1$ orbit
d) Potential energy of electron in $n = 2$ orbit is less than that in $n = 1$ orbit

399. The nuclear fusion reaction is given ${}_1H^2 + {}_1H^2 \rightarrow {}_0He^3 + {}_0n^1 + Q$ (energy). If 2 mole of deuterium are fused the total released energy is
a) $2Q$
b) $4Q$
c) $Q \times 6.02 \times 10^{23}$
d) $Q \times 2 \times 6 \times 10^{23}$

400. The graph which represents the correct variation of logarithm of activity ($\log A$) versus time, in figure is



a) A
b) B
c) C
d) D

401. In ${}_{88}Ra^{226}$ nucleus, there are
a) 138 protons and 88 neutrons
b) 138 neutrons and 88 protons
c) 226 protons and 88 electrons
d) 226 neutrons and 138 electrons

402. In Bohr's model of hydrogen atom, let PE represents potential energy and TE the total energy. In going to a higher level
a) PE decreases, TE increases
b) PE increases, TE increases
c) PE decreases, TE decreases
d) PE increases, TE decreases

403. Minimum energy required to takeout the only one electron from ground state of He^+ is

a) 13.6 eV b) 54.4 eV c) 27.2 eV d) 6.8 eV

404. The first member of the Paschen series in hydrogen spectrum is of wavelength 18,800 Å. The short wavelength limit of Paschen series is

a) 1215 Å b) 6560 Å c) 8225 Å d) 12850 Å

405. If half-life of a radioactive atom is 2.3 $days$, then its decay constant would be

a) 0.1 b) 0.2 c) 0.3 d) 2.3

406. Pick out the correct statement from the following.

a) Energy released per unit mass of the reactant is less in case of fusion reaction

b) Packing fraction may be positive or may be negative

c) Pu^{239} is not suitable for a fission reaction

d) For stable nucleus, the specific binding energy is low

407. For the stability of any nucleus

a) Binding energy per nucleon will be more b) Binding energy per nucleon will be less

c) Number of electrons will be more d) None of the above

408. 80 kg of a radioactive material reduces to 10 kg in 1 h. The decay constant of the material is

a) $5.80 \times 10^{-4}\ s^{-1}$ b) $1.16 \times 10^{-3}\ s^{-1}$ c) $2.32 \times 10^{-3}\ s^{-1}$ d) $4.64 \times 10^{-3}\ s^{-1}$

409. When an electron in hydrogen atom is excited, from its 4^{th} to 5^{th} stationary orbit, the change in angular momentum of electron is (Planck's constant: $h = 6.6 \times 10^{-34} J\text{-}s$)

a) $4.16 \times 10^{-34} J\text{-}s$ b) $3.32 \times 10^{-34} J\text{-}s$ c) $1.05 \times 10^{-34} J\text{-}s$ d) $2.08 \times 10^{-34} J\text{-}s$

410. A moderator is used in nuclear reactors in order to

a) Slow down the speed of the neutrons b) Accelerate the neutrons

c) Increase the number of neutrons d) Decrease the number of neutrons

411. When $_{92}U^{235}$ is bombarded with one neutron, fission occurs and the products are three neutrons, $_{36}Kr^{94}$, and

a) $_{56}Ba^{141}$ b) $_{54}Xe^{139}$ c) $_{56}Ba^{139}$ d) $_{58}I^{142}$

412. Activity of radioactive element decreased to one third of original activity R_0 in 9 years. After further 9 years, its activity will be

a) R_0 b) $\frac{2}{3}R_0$ c) $R_0/9$ d) $R_0/6$

413. A radioactive element forms its own isotope after 3 consecutive disintegrations. The particles emitted are

a) 3 β-particles b) 2 β-particles - 1 α-particle

c) 2 β-particles - 1 γ-particle d) 2 α-particles - 1 β-particle

414. In any Bohr orbit of the hydrogen atom, the ratio of kinetic energy to potential energy of the electron is

a) 1/2 b) 2 c) $-1/2$ d) -2

415. Best neutron moderator is

a) Beryllium oxide b) Pure water c) Heavy water d) Graphite

416. Some radioactive nucleus may emit

a) Only one α, β or γ at a time b) All the three α, β and γ one after another

c) All the three α, β and γ simultaneously d) Only α and β simultaneously

417. Which of the following cannot be emitted by radioactive substances during their decay?

a) Protons b) Neutrinos c) Helium nuclei d) Electrons

418. If the ionization potential of helium atom is 24.6 $volt$, the energy required to ionize it will be

a) 24.6 eV b) 24.6 V c) 13.6 V d) 13.6 eV

419. The number of neutrons released when $_{92}U^{235}$ undergoes fission by absorbing $_0n^1$ and ($_{56}Ba^{144}$ + $_{36}Kr^{89}$) are formed is

a) 0 b) 1 c) 2 d) 3

420. The first line in the Lyman series has wavelength λ. The wavelength of the first line in Balmer series is

a) $\frac{2}{9}\lambda$ b) $\frac{9}{2}\lambda$ c) $\frac{5}{27}\lambda$ d) $\frac{27}{5}\lambda$

421. Half-life of a radio active substance A is 4 days. The probability that a nucleus will decay in two half-lives is

a) $\frac{1}{4}$ b) $\frac{3}{4}$ c) $\frac{1}{2}$ d) 1

422. Radium has a half-life of 5 yr. The probability of decay of a radium nucleus in 10 yr is

a) 50 % b) 75% c) 100% d) 60%

423. For a nucleus to be stable, the correct relation between neutron number N and proton number Z is

a) $N > Z$ b) $N = Z$ c) $N < Z$ d) $N \geq Z$

424. According to classical theory, the circular path of an electron in Rutherford atom is

a) Spiral b) Circular c) Parabolic d) Straight line

425. First Bohr radius of an atom with $Z = 82$ is R. Radius of its third orbit is

a) $9R$ b) $6R$ c) $3R$ d) R

426. In an atomic bomb, the energy is released due to

a) Chain reaction of neutrons and $_{92}U^{235}$
b) Chain reaction of neutrons and $_{92}U^{238}$
c) Chain reaction of neutrons and $_{92}U^{240}$
d) Chain reaction of neutrons and $_{92}U^{236}$

427. In nuclear reactions, we have the conservation of

a) Mass only
b) Energy only
c) Momentum only
d) Mass, energy and momentum

428. If the energy of a hydrogen atom in nth orbit is E_n, then energy in the nth orbit of a singly ionized helium atom will be

a) $4E_n$ b) $E_n/4$ c) $2E_n$ d) $E_n/2$

429. The shortest wavelength in hydrogen spectrum of Lyman series when $R_H = 109678\ cm^{-1}$ is

a) 1002.7 Å b) 1215.67 Å c) 1127.30 Å d) 911.7 Å

430. Nuclear binding energy is equivalent to

a) Mass of proton
b) Mass of neutron
c) Mass of nucleus
d) Mass defect of nucleus

431. Two lithium nuclei in a lithium vapour at room temperature do not combine to form a carbon nucleus because

a) Carbon nucleus is an unstable particle
b) It is not energetically favourable
c) Nuclei do not come very close due to Coulombic repulsion
d) Lithium nucleus is more tightly bound than a carbon nucleus

432. The velocity of an electron in the second orbit of sodium atom (atomic number = 11) is v. The velocity of an electron in its fifth orbit will be

a) v b) $\frac{22}{5}v$ c) $\frac{5}{2}v$ d) $\frac{2}{5}v$

433. The ratio of ionization energy of Bohr's hydrogen atom and Bohr's hydrogen like lithium atom is

a) 1 : 1 b) 1 : 3 c) 1 : 9 d) None of these

434. If 10% of a radioactive material decays in 5 days, then the amount of original material left after 20 days is approximately

a) 60% b) 65% c) 70% d) 75%

435. Which of the following is most unstable

a) Electrons b) Protons c) Neutrons d) α-particle

436. Neutrons are used in nuclear fission, because

a) Neutrons are attracted by nucleus
b) Mass of neutrons is greater than protons
c) Neutrons are neutral and hence are not repelled by the nucleus
d) Neutrons could be accelerated to a greater energy

437. According to Bohr's theory the radius of electron in an orbit described by principle quantum number n and atomic number Z is proportional to

a) Z^2n^2 b) $\frac{Z^2}{n^2}$ c) $\frac{Z^2}{n}$ d) $\frac{n^2}{Z}$

438. The ratio between total acceleration of the electron in singly ionized helium atom and hydrogen atom (both in ground state) is

a) 1 b) 8 c) 4 d) 16

439. On the bombardment of neutron with Boron. α-particle is emitted and product nuclei formed is

a) ${}_6C^{12}$ b) ${}_3Li^6$ c) ${}_3Li^7$ d) ${}_4Be^9$

440. The concept of stationary orbits was proposed by

a) Neil Bohr b) J.J. Thomson c) Rutherford d) I. Newton

441. The volume of a nucleus is directly proportional to

a) A b) A^3

c) $\sqrt{A}$ d) $A^{1/3}$ (where A=mass number of the nucleus)

442. The mass number of a nucleus is equal to the number of

a) Electrons it contains b) Protons it contains c) Neutrons it contains d) Nucleons it contains

443. The counting rate observed from a radioactive source at t =9s was 1600 counts^{-1} and at t =8 sit was 100 counts s^{-1}. The counting rate observed as counts per second at t =6s,will be

a) 400 b) 300 c) 250 d) 200

444. In a radioactive material the activity at time t_1 is R_1 and at a later timet_2, it is R_2. If the decay constant of the material is λ , then

a) $R_1 = R_2e^{-\lambda(t_1-t_2)}$ b) $R_1 = R_2e^{\lambda(t_1-t_2)}$ c) $R_1 = R_2\ (t_2/t_1)$ d) $R_1 = R_2$

445. An electron in the $n = 1$ orbit of hydrogen atom is bounded by 13.6 eV. Energy requires to ionize it is

a) 13.6 eV b) 6.53 eV c) 5.4 eV d) 1.51 eV

446. Energy released in the fission of a single nucleus is 200MeV. The fission rate of a ${}^{235}_{92}U$ filled reactor operating at a power level of 5W is

a) $1.56 \times 10^{-10}s^{-1}$ b) $1.56 \times 10^{11}s^{-1}$ c) $1.56 \times 10^{-16}s^{-1}$ d) $1.56 \times 10^{-17}s^{-1}$

447. In hydrogen atom, the electron is moving round the nucleus with velocity $2.18 \times 10^6 m/s$ in an orbit of radius 0.528Å. The acceleration of the electron is

a) $9 \times 10^{18} m/s^2$ b) $9 \times 10^{22} m/s^2$ c) $9 \times 10^{-22} m/s^2$ d) $9 \times 10^{12} m/s^2$

448. A radioactive material has an initial amount 16g. After 120 $days$ it reduces to 1g, then the half-life of radioactive material is

a) 60 $days$ b) 30 $days$ c) 40 $days$ d) 240 $days$

449. The ratio of the wavelengths for $2 \to 1$ transition on Li^{++}, He^+ and H is

a) 1 : 2 : 3 b) 1 : 4 : 9 c) 4 : 9 : 36 d) 3 : 2 : 1

450. Pick out the incorrect statement from the following

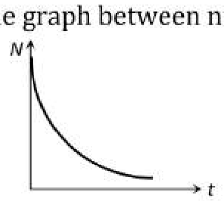
a) β-emission from the nucleus is always accompanied with a neutrino

b) The energy of the α-particle emitted from a given nucleus is always constant

c) γ-ray emission makes the nucleus more stable

d) Nuclear force is charge-independent

451. The graph between number of decayed atoms N' of a radioactive element and time t is

a)


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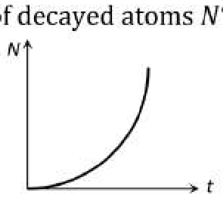

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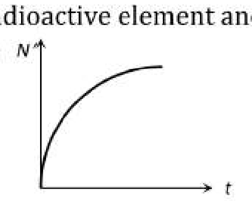
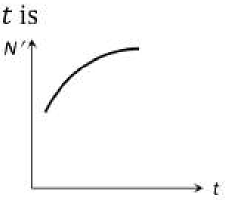


d)


452. In gamma ray emission from a nucleus

a) Both the neutron number and the proton number change

b) There is no change in the proton number and the neutron number

c) Only the neutron number changes

d) Only the proton number changes

453. $^{238}_{92}\text{U}$ has 92 protons and 238 nucleons. It decays by emitting an alpha particle and becomes

a) $^{234}_{92}\text{U}$ b) $^{234}_{90}\text{Th}$ c) $^{235}_{92}\text{U}$ d) $^{237}_{93}\text{Np}$

454. Which of the following is suitable for the fusion process

a) Heavy nuclei b) Light nuclei c) Atom bomb d) Radioactive decay

455. A nucleus with $Z = 92$emits the following in a sequence : $\alpha, \alpha, \beta^-, \beta^-, \alpha, \alpha, \alpha, \alpha : \beta^-, \beta^-, \alpha, \beta^+, \beta^+, \alpha$. The Z of the resulting nucleus is

a) 76 b) 78 c) 82 d) 74

456. Two protons are kept at a separation of 40 Å. F_n is the nuclear force and F_e is the electrostatic force between them. Then

a) $F_n >> F_e$ b) $F_n = F_e$ c) $F_n << F_e$ d) $F_n \approx F_e$

457. Every series of hydrogen spectrum has an upper and lower limit in wavelength. The spectral series which has an upper limit of wavelength equal to 18752 Å is

(Rydberg constant $R = 1.097 \times 10^7$ *per metre*)

a) Balmer series b) Lyman series c) Paschen series d) Pfund series

458. The ionisation energy of 10 times ionised sodium atom is

a) $13.6\ eV$ b) $13.6 \times 11\ eV$ c) $\frac{13.6}{11} eV$ d) $13.6 \times (11)^2 eV$

459. $_{92}\text{U}^{235}$ and $_{92}\text{U}^{238}$differ as

a) $_{92}\text{U}^{235}$has 2 protons less

b) $_{92}\text{U}^{238}$has 3 protons more

c) $_{92}\text{U}^{238}$has 3 neutrons more

d) None of the above

460. In the following reaction

$_{12}Mg^{24} + {_2}He^4 \rightarrow {_{14}}Si^X + {_0}n^1$, X is

a) 28 b) 27 c) 26 d) 22

461. Consider a hydrogen like atom whose energy in n^{th} excited state is given by $E_n = -\frac{13.6Z^2}{n^2}$. When this excited atom makes a transition from excited state to ground state, most energetic photons have energy $E_{\max} = 52.224\ eV$ and least energetic photons have energy $E_{\min} = 1.224\ eV$. The atomic number of atom is

a) 2 b) 5 c) 4 d) None of these

462. γ-rays radiation can be used to create electron-positron pair. In this process of pair production, γ-rays energy cannot be less than

a) $5.0\ MeV$ b) $4.02\ MeV$ c) $15.0\ MeV$ d) $1.02\ MeV$

463. Two radioactive samples have decay constant $15x$ and $3x$. If they have the same number of nuclei initially, the ratio of number of nuclei after a time $\frac{1}{6x}$ is

a) $\frac{1}{e}$ b) $\frac{e}{2}$ c) $\frac{1}{e^4}$ d) $\frac{1}{e^2}$

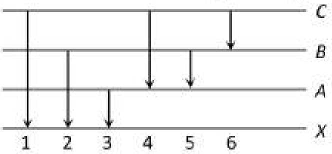
464. If radius of the $^{27}_{13}Al$ nucleus is estimated to be 3.6 *fermi* then the radius of $^{125}_{52}Te$ nucleus be nearly

a) 4 *Fermi* b) 5 *Fermi* c) 6 *Fermi* d) 8 *Fermi*

465. The wavelength of Lyman series is

a) $\frac{4}{3 \times 10967} cm$ b) $\frac{3}{4 \times 10967} cm$ c) $\frac{4 \times 10967}{3} cm$ d) $\frac{3}{4} \times 10967 cm$

466. The figure indicates the energy level diagram of an atom and the origin of six spectral lines in emission ($e.g.$ line no. 5 arises from the transition from level B to A). Which of the following spectral lines will also occur in the absorption spectra



a) 1, 4, 6 b) 4, 5, 6 c) 1, 2, 3 d) 1, 2, 3, 4, 5, 6

467. In a radioactive substance at $t=0$, the number of atoms is 8×10^4. Its half life period is 3 $years$. The number of atoms 1×10^4 will remain after interval

a) 9 $years$ b) 8 $years$ c) 6 $years$ d) 24 $years$

468. If ${}_{92}U^{238}$ undergoes successively 8 α-decays and 6 β-decays, then resulting nucleus is

a) ${}_{82}U^{206}$ b) ${}_{82}Pb^{206}$ c) ${}_{82}U^{210}$ d) ${}_{82}U^{214}$

469. As the electron in Bohr orbit of Hydrogen atom passes from state $n=2$ to $n=1$, the kinetic energy K and potential energy U change as

a) K two-fold, U four-fold b) K four-fold, U two-fold

c) K four-fold, U also four-fold d) K two-fold, U also two-fold

470. The largest wavelength in the ultraviolet region of the hydrogen spectrum is 122 nm. The smallest wavelength in the infrared region of the hydrogen spectrum (to the nearest integer is)

a) 802 nm b) 823 nm c) 1882 nm d) 1648 nm

471. Nucleus of an atom whose atomic mass is 24 consists of

a) 11 electrons, 11 protons and 13 neutrons b) 11 electrons, 13 protons and 11 neutrons

c) 11 protons and 13 neutrons d) 11 protons and 13 electrons

472. Ionization power and penetration range of radioactive radiation increases in the order

a) γ, β, α and γ, β, α respectively b) γ, β, α and α, β, γ respectively

c) $\alpha, \beta, \gamma$and α, β, γ respectively d) $\alpha, \beta, \gamma$and γ, β, α respectively

473. The relationship between λ and half life ($T_{1/2}$) of a radioactive substance is

a) $\lambda=\frac{\log_{10}2}{T_{1/2}}$ b) $\lambda=\frac{\log_e 2}{T_{1/2}}$ c) $\lambda=\frac{\log_2 10}{T_{1/2}}$ d) $\lambda=\frac{\log_2 e}{T_{1/2}}$

474. The ratio of molecular mass of two radioactive substances is 3/2 and the ratio of their decay constants is 4/3. Then, the ratio of their initial activity per mole will be

a) 2 b) 4/3 c) $\frac{8}{9}$ d) 9/8

475. Which one of the following is a possible nuclear reaction?

a) ${}^{10}_{5}B+{}^{4}_{2}He\rightarrow{}^{13}_{7}N+{}^{1}_{1}H$ b) ${}^{23}_{11}Na+{}^{1}_{1}H\rightarrow{}^{20}_{10}Ne+{}^{4}_{2}He$

c) ${}^{239}_{93}Np\rightarrow{}^{239}_{94}Pu+\beta^-+\bar{\nu}$ d) ${}^{11}_{7}N+{}^{1}_{1}H\rightarrow{}^{12}_{6}C+\beta^-+\bar{\nu}$

476. Radius of the first orbit of the electron in a hydrogen atom is 0.53 Å. So, the radius of the third orbit will be

a) 2.12 Å b) 4.77 Å c) 1.06 Å d) 1.59 Å

477. When ${}_{88}Ra^{236}$ decays in a series by emission of 3α-particles and one β-particle, isotope X formed is

a) ${}_{83}X^{224}$ b) ${}_{84}X^{218}$ c) ${}_{84}X^{220}$ d) ${}_{82}X^{223}$

478. The sun radiates energy in all directions. The average radiations received on the earth surface from the sun is 1.4 $kilowatt/m^2$. The average earth sun distance is $1.5\times10^{11}metres$. The mass lost by the sun per day is (1 day = 86400 $seconds$)

a) 4.4×10^9kg b) $7.6\times10^{14}kg$ c) $3.8\times10^{12}kg$ d) $3.8\times10^{14}kg$

479. According to the Rutherford's atomic model, the electrons inside the atom are

a) Stationary b) Not stationary c) Centralized d) None of these

480. The time of revolution of an electron around a nucleus of charge Ze in n^{th} Bohr orbit is directly proportional to

a) n b) $\frac{n^3}{Z^2}$ c) $\frac{n^2}{Z}$ d) $\frac{Z}{n}$

481. A${}^{238}_{92}U$ nucleus at rest is decayed by emitting alpha particle into${}^{234}_{90}Th$. The speeds of the alpha particle and the thorium nucleus are in the ratio.

a) 3:58 b) 58:3 c) 1:58 d) 58:1

482. 1 atomic mass unit is equal to

a) $\frac{1}{25}$(mass of F_2 molecule) b) $\frac{1}{14}$(mass of N_2 molecule)

c) $\frac{1}{12}$(mass of one C-atom) d) $\frac{1}{16}$(mass of O_2 molecule)

483. An atom of mass number 15 and atomic number 7 captures an α −particle and then emits a proton. The mass number and atomic number of the resulting product will respectively be
a) 14 and 2 b) 15 and 3 c) 16 and 4 d) 18 and 8
484. 1 g of hydrogen is converted into 0.993 g of helium in a thermonuclear reaction. The energy released is
a) $63 \times 10^7 J$ b) $63 \times 10^{10} J$ c) $63 \times 10^{14} J$ d) $63 \times 10^{20} J$
485. The mass number of a nucleus is 216. The size of an atom without changing its chemical properties are called
a) 7.2×10^{-13}cm b) 7.2×10^{-11}cm c) 7.2×10^{-10}cm d) 3.6×10^{-11}cm
486. In a sample of radioactive material, what fraction of the initial number of active nuclei will remain undisintegrated after half of a half-life of the sample
a) $\frac{1}{4}$ b) $\frac{1}{2\sqrt{2}}$ c) $\frac{1}{\sqrt{2}}$ d) $2\sqrt{2}$
487. The average number of prompt neutrons produced per fission of U^{235} is
a) More than 5 b) 3 to 5 c) 2 to 3 d) 1 to 2
488. In Bohr's model, if the atomic radius of the first orbit is r_0, then the radius of the fourth orbit is
a) r_0 b) $4r_0$ c) $r_0/16$ d) $16r_0$
489. In a Rutherford scattering experiment when a projectile of charge z_1 and mass M_1 approaches a target nucleus of charge z_2 and mass M_2, the distance of closest approach is r_0. The energy of the projectile is
a) Directly proportional to $M_1 \times M_2$ b) Directly proportional to $z_1 z_2$
c) Inversely proportional to z_1 d) Directly proportional to mass M_1
490. Nuclear fusion is common to the pair
a) Thermonuclear reactor, uranium based nuclear reactor
b) Energy production in sun, uranium based nuclear reactor
c) Energy production in sun, hydrogen bomb
d) Disintegration of heavy nuclei, hydrogen bomb
491. If in Rutherford's experiment, the number of particles scattered at 90° angle are 28 per min, then number of scattered particles at an angle 60° and 120° will be
a) $112/min, 12.5/min$ b) $100/min, 200/min$ c) $50/min, 125.5/min$ d) $117/min, 25/min$
492. Consider an electron in the n^{th} orbit of a hydrogen atom in the Bohr model. The circumference of the orbit can be expressed in terms of the de Broglie wavelength λ of that electron as
a) $(0.259)n\lambda$ b) $\sqrt{n}\lambda$ c) $(13.6)\lambda$ d) $n\lambda$
493. Boron rods in nuclear reactor are used as a
a) Moderator b) Control rods c) Coolants d) Protective shield
494. The element used for radioactive carbon dating for more than 56000 yr is
a) C-14 b) U-234 c) U-238 d) Po-94
495. The energy equivalent of the atomic mass unit is
a) 1.6×10^{-19}J b) 6.02×10^{-23}J c) 931 J d) 931 MeV
496. The half-life period of a radioactive element X is same as the mean life time of another radioactive element Y. Initially they have the same number of atoms. Then
a) X will decay faster than Y b) Y will decay faster than X
c) Y and X have same decay rate initially d) X and Y decay at same rate always.
497. The half-life for the α-decay of uranium $_{92}U^{238}$ is 4.47×10^9 yr. If a rock contains sixty percent of its original $_{92}U^{238}$ atoms, its age is [$\log 6 = 0.778$; $\log 2 = 0.3$]
a) 3.3×10^9yr b) 6.6×10^9yr c) 1.2×10^8yr d) 5.4×10^7yr
498. A freshly prepared radioactive source of half-life 2 h emits radiation of intensity which is 64 times the permissible safe level. Calculate the minimum time after which it would be possible to work safely with this source.
a) 12 h b) 24 h c) 6 h d) 130 h
499. If the distance between nuclei is 2×10^{-13}cm, the density of nuclear material is
a) 3.21×10^{-12}kgm^{-3} b) 1.6×10^{-3}kgm^{-3}

c) $2 \times 10^9 \text{kgm}^{-3}$ d) $4 \times 10^{17} \text{kgm}^{-3}$

500. Hydrogen atom emits blue light when it changes from $n = 4$ energy level to the $n = 2$ level. Which colour of light would the atom emit when it changes from the $n = 5$ level to the $n = 2$ level

a) Red b) Yellow c) Green d) Violet

501. The counting rate observed from a radioactive source at $t = 0$ was 1600 counts^{-1} and at $t = 8$ s it was 100counts^{-1}. The counting rate observed as counts per seconds at $t = 6$s, will be

a) 400 b) 300 c) 250 d) 200

502. In Bohr model of the hydrogen atom, the lowest orbit corresponds to

a) Infinite energy b) The maximum energy

c) The minimum energy d) Zero energy

503. Which of the following particle has similar mass to electron

a) Proton b) Neutron c) Positron d) Neutrino

504. Mark the correct statement

a) Nuclei of different elements can have the same number of neutrons

b) Every element has only two stable isotopes

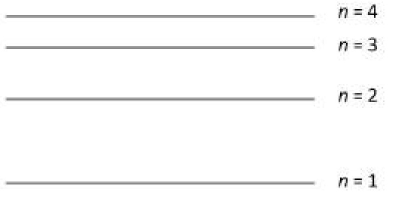
c) Only one isotope of each element is stable

d) All isotopes of every element are radioactive

505. The nucleus which has radius one-third of the radius of Cs^{189} is

a) Be^9 b) Li^7 c) F^{19} d) C^{12}

506. Four lowest energy levels of H-atom are shown in the figure. The number of possible emission lines would be



a) 3 b) 4 c) 5 d) 6

507. For a substance the average life for α-emission is 1620 *years* and for β emission is 405 *years*. After how much time the 1/4 of the material remains after α and β emission

a) 1500 *years* b) 300 *years* c) 449 *years* d) 810 *years*

508. In the Bohr's hydrogen atom model, the radius of the stationary orbit is directly proportional to ($n =$ principle quantum number)

a) n^{-1} b) n c) n^{-2} d) n^2

509. Which one of the following nuclear reactions is a source of energy in the sun

a) ${}^{9}_{4}Be + {}^{4}_{2}He \rightarrow {}^{12}_{6}C + {}^{-1}_{0}n$ b) ${}^{3}_{2}He + {}^{3}_{2}He \rightarrow {}^{4}_{2}He + {}^{1}_{1}H + {}^{1}_{1}H$

c) ${}^{144}_{56}Ba + {}^{92}_{56}Kr \rightarrow {}^{235}_{92}U + {}^{-1}_{0}n$ d) ${}^{56}_{26}Fe + {}^{112}_{48}Ca \rightarrow {}^{167}_{74}W + {}^{-1}_{0}n$

510. Which of the following is a fusion reaction?

a) ${}_1H^2 + {}_1H^2 \rightarrow {}_2He^4$ b) ${}_1H^2 + {}_1H^2 \rightarrow 2({}_1H^2)$

c) ${}_1H^1 + {}_1H^1 \rightarrow {}_2H^4$ d) ${}_1H^1 + {}_1H^2 \rightarrow {}_2H^4 + n$

511. A radioactive nucleus emits 3α-particles and 5β-particles. The ratio of number of neutrons to that of protons will be

a) $\frac{A - Z - 12}{Z - 6}$ b) $\frac{A - Z}{Z - 1}$ c) $\frac{A - Z - 11}{Z - 6}$ d) $\frac{A - Z - 11}{Z - 1}$

512. An electron with kinetic energy 5 eV is incident on a H-atom in its ground state. The collision

a) Must be elastic b) May be partially elastic

c) Must be completely elastic d) May be completely inelastic

513. The radius of a nucleus with atomic mass number 7 is 2fermi. Find the radius of nucleus with atomic number 189.

a) 3 fermi b) 4 fermi c) 5 fermi d) 6 fermi

514. How much work must be done to pull apart the electron and the proton that make up the Hydrogen atom, if the atom is initially in the state with $n = 2$

a) $13.6 \times 1.6 \times 10^{-19} J$ b) $3.4 \times 1.6 \times 10^{-19} J$ c) $1.51 \times 1.6 \times 10^{-19} J$ d) 0

515. When a hydrogen atom is raised from the ground state to an excited state

a) P.E. increases and K.E. decreases
b) P.E. decreases and K.E. increases
c) Both kinetic energy and potential energy increase
d) Both K.E. and P.E. decrease

516. For thorium A=232,Z =90 at the end of some radioactive disintegration we obtain an isotope of lead with A =208 and Z =82, then the number of emitted αandβ particles are

a) $\alpha = 4, \beta = 6$ b) $\alpha = 5, \beta = 5$ c) $\alpha = 6, \beta = 4$ d) $\alpha = 6, \beta = 6$

517. A hydrogen atom emits a photon corresponding to an electron transition from $n = 5$ to $n = 1$. The recoil speed of hydrogen atom is almost (mass of proton $= 1.6 \times 10^{-27} kg$)

a) $10\ ms^{-1}$ b) $2 \times 10^{-2}\ ms^{-1}$ c) $4\ ms^{-1}$ d) $8 \times 10^{2}\ ms^{-1}$

518. When a hydrogen atom emits a photon in going from $n = 5$to $n = 1$, its recoil speed is almost

a) 10^{-4} ms^{-1} b) 8×10^{2} ms^{-1} c) 2×10^{-2} ms^{-1} d) 4 ms^{-1}

519. Which of the following is true for a sample of isotope containing U^{235} and U^{238}

a) Number of neutrons are same in both
b) Number of protons, electrons and neutrons are same in both
c) Contain same number of protons and electrons but U^{238} contains 3 more neutrons than U^{235}
d) U^{238} contains 3 less neutrons than U^{235}

520. The binding energies per nucleon of Li^7 and He^4 are 5.6 MeV and 7.06 MeV respectively, then the energy of the reaction

$\text{Li}^7 + p = 2[{}_2\text{He}^4]$ will be

a) 17.28 MeV b) 39.2 MeV c) 28.24 MeV d) 1.46 MeV

521. The wavelength of the first line of Lyman series for hydrogen atom is equal to that of the second line of Balmer series for a hydrogen like ion. The atomic number Z of hydrogen like ion is

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

522. In the following transitions, which one has higher frequency

a) 3 – 2 b) 4 – 3 c) 4 – 2 d) 3 – 1

523. During the $\beta -$ decay

a) An atomic electron is ejected
b) An electron, already present within the nucleus, is ejected.
c) A proton in the nucleus decays emitting an electron
d) A neutron in the nucleus decays emitting an electron

524. The half-life of Radioactive substance is 20 min. The approximate time interval$(t_2 - t_1)$ between the time t_2 when $\frac{2}{3}$ of it has decayed and time t_1 when $\frac{1}{3}$ of it had decayed is

a) 14 min b) 20 min c) 28 min d) 7 min

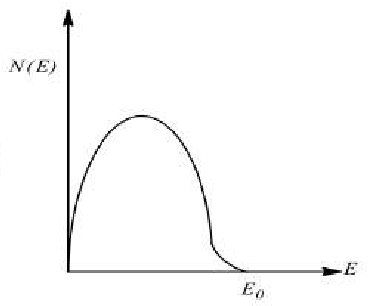
525. A radioactive substance has a half-life of 1 *year*. The fraction of this material, that would remain after 5 *years* will be

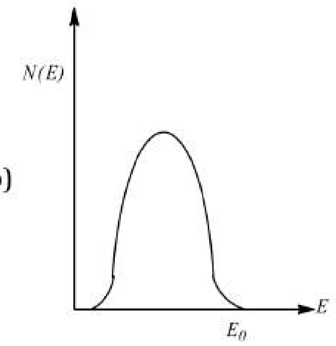
a) $\frac{1}{32}$ b) $\frac{1}{5}$ c) $\frac{1}{2}$ d) $\frac{4}{5}$

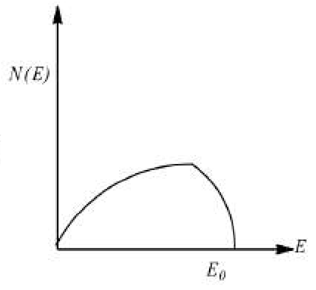
526. The radius of hydrogen atom in its ground state is $5.3 \times 10^{-11} m$. After collision with an electron it is found to have a radius of $21.2 \times 10^{-11} m$. What is the principal quantum number n of the final state of the atom

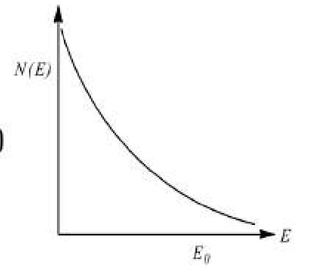
a) $n = 4$ b) $n = 2$ c) $n = 16$ d) $n = 3$

527. The energy spectrum of $\beta -$ particles [number N(E) as a function of $\beta -$energy E] emitted from a radioactive source is

a) 

b) 

c) 

d) 

528. We have seen that a gamma-ray dose of 3Gy is lethal to half the people exposed to it. If the equivalent energy were absorbed as heat, what rise in body temperature would result?

a) 300 μK b) 700 μK c) 455 μK d) 390 μK

529. The number of neutrons released during the fission reaction is ${}_0^1n + {}_{92}^{235}\text{U} \rightarrow {}_{51}^{133}\text{Sb} + {}_{41}^{99}\text{Nb}$ +neutrons

a) 1 b) 92 c) 3 d) 4

530. Two radioactive nuclides x and y have half-lifes 1 h and 2 h respectively. Initially the samples have equal number of nuclei. After 4 h the ratio of the numbers x of y and is

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

531. A radioactive substance contains 10000 nuclei and its half-life period is 20 days. The number of nuclei present at the end of 10 days is

a) 7070 b) 9000 c) 8000 d) 7500

532. Which shows radioactivity?

a) Protium b) Deuterium c) Tritium d) None of these

533. The activity of a radioactive element decreases to one-third of the original activity A_0 in a period of 9 yr. After a further lapes of 9 yr, its activity will be

a) A_0 b) $\frac{2}{3}A_0$ c) $\frac{A_0}{9}$ d) $\frac{A_0}{6}$

534. Curie is a unit of

a) Energy of gamma-rays b) Half-life
c) Radioactivity d) Intensity of gamma-rays

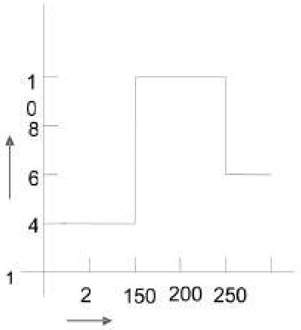
535. A nucleus is bombarded with a high speed neutron so that resulting nucleus is a radioactive one. This phenomenon is called

a) Artificial radioactivity b) Fusion
c) Fission d) Radioactivity

536. The force acting between proton and proton inside the nucleus is

a) Coulombic b) Nuclear c) Both d) None of these

537. Assume the graph of specific binding energy *verses* mass number is as shown in the figure. Using this graph, select the correct choice from the following.



a) Fusion of two nuclei of mass number lying in the range of $100 < A < 200$ will release energy.

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

c) Fusion of two nuclei of mass number lying in the range of $1 < A < 50$ will release energy.

d) Fusion of the nucleus of mass number lying in the range of $100 < A < 200$ will release energy when broken into two fragments.

538. The kinetic energy of electron in the first Bohr orbit of the hydrogen atom is

a) $-6.5\ eV$ b) $-27.2\ eV$ c) $13.6\ eV$ d) $-13.6\ eV$

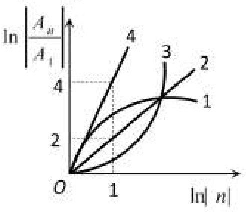
539. Atomic weight of boron is 10.81 and it has two isotopes ${}_5B^{10}$ and ${}_5B^{11}$. Then ratio of ${}_5B^{10}$: ${}_5B^{11}$ in nature would be

a) 19:81 b) 10:11 c) 15:16 d) 81:19

540. If T is the half life of a radioactive material, then the fraction that would remain after a time $\frac{T}{2}$ is

a) $\frac{1}{2}$ b) $\frac{3}{4}$ c) $\frac{1}{\sqrt{2}}$ d) $\frac{\sqrt{2}-1}{\sqrt{2}}$

541. The figure shows a graph between $\ln\left|\frac{A_n}{A_1}\right|$ and $\ln|n|$, where A_n is the area enclosed by the nth orbit in a hydrogen like atom. The correct curve is



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

542. In a beryllium atom, if a_0 be the radius of the first orbit, then the radius of the second orbit will be will be in general

a) na_0 b) a_0 c) n^2a_0 d) $\frac{a_0}{n^2}$

543. Ionization energy of hydrogen is $13.6\ eV$. If $h = 6.6 \times 10^{-34} J - s$, the value of R will be of the order of

a) $10^{10} m^{-1}$ b) $10^7 m^{-1}$ c) $10^4 m^{-1}$ d) $10^{-7} m^{-1}$

544. The decay constant of radium is 4.28×10^{-4} *per year*. Its half life will be

a) 2000 *years* b) 1240 *years* c) 63 *years* d) 1620 *years*

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

a) Can easily be broken up
b) Is very stable
c) Can be used as fissionable material
d) Is radioactive

546. Activity of a radioactive element decreased to one-third of original activity I_0 in 9 yr. After further 9 yr, its activity will be

a) I_0 b) $\frac{2}{3}I_0$ c) $I_0/9$ d) $I_0/3$

547. An electron is

a) Hadron b) Baryon c) A nucleon d) A lepton

548. Imagine an atom made up of a proton and a hypothetical particle of double the mass of the electron but having the same charge as the electron. Apply the Bohr's atom model and consider all possible transitions of this hypothetical particle to the first excited level. The longest wavelength photon that will be emitted has wavelength λ (given in terms of the Rydberg constant R for the hydrogen atom) is equal to

a) $9/(5R)$ b) $36/(5R)$ c) $18/(5R)$ d) $4/R$

549. A radio isotope has a half life of 75 $years$. The fraction of the atoms of this material that would decay in 150 $years$ will be

a) 66.6% b) 85.5% c) 62.5% d) 75%

550. Which is the correct expression for half-life

a) $(t)_{1/2} = \log 2$ b) $(t)_{1/2} = \frac{\lambda}{\log 2}$ c) $(t)_{1/2} = \frac{\lambda}{\log 2}(2.303)$ d) $(t)_{1/2} = \frac{2.303 \log 2}{\lambda}$

551. Two protons exert a nuclear force on each other, the distance between them is

a) $10^{-14} m$ b) $10^{-10} m$ c) $10^{-12} m$ d) $10^{-8} m$

552. A radioactive sample S1 having an activity of $5\mu Ci$ has twice the number of nuclei as another sample S2 which has an activity of $10\mu Ci$. The half lives of S1 and S2 can be

a) 20 years and 5 years, respectively b) 20 years and 10 years, respectively

c) 10 years each d) 5 years each

553. An electron of a stationary hydrogen atom passes from the fifth energy level to the ground level. The velocity that the atom acquired as a result of photon emission will be

a) $24hR/25m$ b) $25hR/24m$ c) $25m/24hR$ d) $24m/25hR$

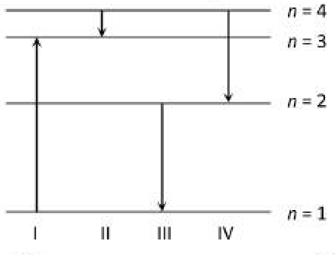
554. The radius of electron's second stationary orbit in Bohr's atom is R. The radius of the third orbit will be

a) $3\,R$ b) $2.25\,R$ c) $9\,R$ d) $\frac{R}{3}$

555. A hydrogen like atom of atomic number Z is in an excited state of quantum number $2n$. It can emit a maximum energy photon of 204 eV. If it makes a transition to quantum state n, a photon of energy 40.8 eV is emitted. The value of n will be

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

556. The diagram shows the energy levels for an electron in a certain atom. Which transition shown represents the emission of a photon with the most energy



a) I b) II c) III d) IV

557. A particle moving with a velocity of $\frac{1}{100}$th of that of light will cross a nucleus on about

a) 10^{-8}s b) 10^{-12}s c) 6×10^{-15}s d) 10^{-20}s

558. If Avogadro number is 6×10^{23}, then number of protons, neutrons and electrons is 14 g of $_6C^{14}$ are respectively

a) $36 \times 10^{23}, 48 \times 10^{23}, 36 \times 10^{23}$ b) $36 \times 10^{23}, 36 \times 10^{23}, 36 \times 10^{23}$

c) $48 \times 10^{23}, 36 \times 10^{23}, 48 \times 10^{23}$ d) $48 \times 10^{23}, 48 \times 10^{23}, 36 \times 10^{23}$

559. Fusion reaction takes place at high temperature because

a) KE is high enough to overcome repulsion between nuclei

b) nuclei are most stable at this temperature

c) nuclei are unstable at this temperature

d) None of the above

560. Two radioactive sources A and B of half lives 1h and 2h respectively initially contain the same number of radioactive atoms. At the end of two hours, their rates of disintegration are in the ratio of

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

561. m_p and $m_n$are masses of proton and neutron respectively. An element of mass M has Z protons and N neutrons then

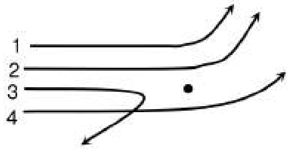
a) $M > Zm_p + Nm_n$

b) $M = Zm_p + Nm_n$

c) $M < Zm_p + Nm_n$

d) M may be greater than less than or equal to $Zm_p + Nm_n$,depending on nature of element

562. The diagram shows the path of four α-particles of the same energy being scattered by the nucleus of an atom simultaneously. Which of these are/is not physically possible



a) 3 and 4 b) 2 and 3 c) 1 and 4 d) 4 only

563. The process by which a heavy nucleus splits into light nuclei is known as

a) Fission b) α-decay c) Fusion d) Chain reaction

564. In the above figure D and E respectively represent

a) Absorption line of Balmer series and the ionization energy of hydrogen

b) Absorption line of Balmer series and the wavelength lesser than lowest of the Lyman series

c) Spectral line of Balmer series and the maximum wavelength of Lyman series

d) Spectral line of Lyman series and the absorption of greater wavelength of limiting value of Paschen series

565. Complete the equation for the following fission process $_{92}U^{235} + _0n^1 \rightarrow \dots\dots\dots \, _{38}Kr^{90} + \dots\dots\dots$

a) $_{50}Xe^{143} + 3\,_0n^1$ b) $_{54}Xe^{145}$ c) $_{57}Xe^{142}$ d) $_{54}Xe^{142} + _0n^1$

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

a) α, β, γ b) β, α, γ c) γ, α, β d) γ, β, α

567. During a nuclear fusion reaction

a) A heavy nucleus breaks into two fragments by itself

b) A light nucleus bombarded by thermal neutrons break up

c) A heavy nucleus bombarded by thermal neutrons break up

d) Two light nuceli combine to give a heavier nucleus and possible other products

568. A deutron is bombarded on $_8O^{16}$ nucleus and α-particle is emitted. The product nucleus is

a) $_7N^{13}$ b) $_5B^{10}$ c) $_4Bc^9$ d) $_7N^{14}$

569. The number of beta particles emitted by a radioactive substance is twice the number of alpha particles emitted by it. The resulting daughter is an

a) Isobar of parent b) Isomer of parent c) Isotone of parent d) Isotope of parent

570. 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) $5 \log_e 2$ b) $\log_e 2/5$ c) $\frac{5}{\log_e 2}$ d) $5 \log_{10} 2$

571. Equivalent energy of mass equal to 1 $a.m.u.$ is

a) 931 KeV b) 931 eV c) 931 MeV d) 9.31 MeV

572. Two energy levels of an electron in an atom are separated by 2.3 eV. The frequency of radiation emitted when the electrons goes from higher to the lower level is

a) $6.95 \times 10^{14} Hz$ b) $3.68 \times 10^{15} Hz$ c) $5.6 \times 10^{14} Hz$ d) $9.11 \times 10^{15} Hz$

573. A radio-isotope has a half-life of 5 $years$. The fraction of the atoms of this material that would decay in 15 $years$ will be

a) 1/8 b) 2/3 c) 7/8 d) 5/8

574. If a H_2 nucleus is completely converted into energy, the energy produced will be around
a) 1 MeV b) 938 MeV c) 9.38 MeV d) 238 MeV

575. A radioactive sample has 4×10^{10} nuclei at a certain time. The number of active nuclei still remaining after 4 half lives is
a) 1×10^{10} b) 5×10^{9} c) 25×10^{8} d) 5×10^{8}

576. In β^+ decay process, the following changes take place inside the nucleus
a) ${}_{Z}^{A}X \rightarrow {}_{Z_{-1}}^{A}Y + e^+ + \gamma$
b) ${}_{Z}^{A}X \rightarrow {}_{Z+_1}^{A}Y + e^- + \bar{r}$
c) ${}_{Z}^{A}X \rightarrow {}_{Z}^{A}Y + e^- + \gamma$
d) ${}_{Z}^{A}X \rightarrow {}_{Z}^{A}Y + e^- + \bar{\gamma}$

577. The average kinetic energy of the thermal neutrons is of the order of
a) 0.03 eV b) 3 eV c) 3 KeV d) 3 MeV

578. The wavelength of yellow line of sodium is 5896Å. Its wave number will be
a) 50883×10^{10} per second
b) 16961 per cm
c) 17581 per cm
d) 50883 per cm

579. The penetrating powers of α, β and γ radiations, in decreasing order are
a) γ, α, β b) γ, β, α c) α, β, γ d) β, γ, α

580. Hydrogen atom excites energy level from fundamental state to $n = 3$. Number of spectrum lines according to Bohr, is
a) 4 b) 3 c) 1 d) 2

581. The equation ${}_{Z}X^{A} \rightarrow {}_{Z+1}Y^{A} + {}_{-1}e^{0} + \bar{v}$ is
a) β-emission b) α-emission c) e^-capture d) Fission

582. A hydrogen atom and a Li^{++}ion are both in second excited state. If l_H and l_{Li} are their respective electronic angular momenta, and $E_H$and E_{Li}their respective energies, then
a) $l_H > l_{Li}$and $|E_H| > |>|E_{Li}|$
b) $L_H = L_i$and $|E_H| < E_{Li}|$
c) $l_H > l_{Li}$and $|E_H| > E_{Li}|$
d) $l_H > l_{Li}$and $|E_H| << E_{Li}|$

583. The decay constant λ of the radioactive sample is the probability of decay of an atom in unit time, then
a) λ decreases as atoms become older
b) λ increases as the age of atoms increases
c) λ is independent of the age
d) Behavior of λ with time depends on the nature of the activity

584. The binding energy of two nuclei P^n and Q^{2n} are x joule and y joule respectively. If $2x > y$, then the energy released in the reaction $P^n + P^n = Q^{2n}$ will be
a) $2x + y$ b) $2x - y$ c) xy d) $x + y$

585. The de-Broglie wavelength of an electron in the first Bohr orbit is
a) Equal to one fourth the circumference of the first orbit
b) Equal to half the circumference of the first orbit
c) Equal to twice the circumference of the first orbit
d) Equal to the circumference of the first orbit

586. One Becquerel is defined as
a) 1 disintegration per sec
b) 10^6 disintegration per sec
c) 3.7×10^{10} disintegration per sec
d) 10^3 disintegration per sec

587. The nucleus ${}_{6}C^{12}$absorbs an energetic neutron and emits a beta particle (β). The resulting nucleus is
a) ${}_{7}N^{14}$ b) ${}_{5}B^{13}$ c) ${}_{7}N^{13}$ d) ${}_{6}C^{13}$

588. The proper life of pion (π^+) is 2.5×10^{-8}s. In a beam of pions travelling with a speed of 0.9 c, the pion, in the laboratory frame, can travel a maximum distance of
a) 6.75 m b) 15.49 m c) 7.50 m d) 17.10 m

589. If the binding energy of the electron in a hydrogen atom is 13.6 eV, the energy required to remove the electron from the first excited state of Li^{++} is

a) $122.4\ eV$ b) $30.6\ eV$ c) $13.6\ eV$ d) $3.4\ eV$

590. A radioactive nucleus with Z protons and N neutrons emits an α-particle, 2β-particles and 2 gamma rays. The number of protons and neutrons in the nucleus left after the decay respectively, are

a) $Z-3, N-1$ b) $Z-2, N-2$ c) $Z-1, N-3$ d) $Z, N-4$

591. Which of the following statements are true regarding radioactivity

(I) All radioactive elements decay exponentially with time

(II) Half life time of a radioactive element is time required for one half of the radioactive atoms to disintegrate

(III) Age of each can be determined with the help of radioactive dating

(IV) Half life time of a radioactive element is 50% of its average life period

Select correct answer using the codes given below

Codes:

a) I and II b) I, III and IV c) I, II and III d) II and III

592. Three fourth of the active decays in a radioactive sample in $\frac{3}{4}s$. The half life of the sample is

a) $\frac{1}{2}s$ b) $1s$ c) $\frac{3}{8}s$ d) $\frac{3}{4}s$

593. Carbon dating is best suited for determining the age of fossils of their age in years is of the order of

a) 10^3 b) 10^4 c) 10^5 d) 10^6

594. The particle A is converted into C via following reaction.

$A \rightarrow B + {}_2He^4$

$B \rightarrow C + 2e^-$

Then

a) A and C are isobars b) A and C are isotopes c) A and B are isobars d) A and B are isotopes

595. Unit of radioactivity is $Rutherford$. Its value is

a) $3.7 \times 10^{10}\ disintegrations/s$ b) $3.7 \times 10^{6}\ disintegrations/s$

c) $1.0 \times 10^{10}\ disintegrations/s$ d) $1.0 \times 10^{6}\ disintegrations/s$

596. In Bohr model of hydrogen atom, the ratio of periods of revolution of an electron in $n = 2$ and $n = 1$ orbits is

a) 2 : 1 b) 4 : 1 c) 8 : 1 d) 16 : 1

597. Which of the following is not conserved in nuclear reaction?

a) Total energy b) Mass number

c) Charge Number d) Number of fundamental particles

598. Carbon – 14 decays with half-life of about 5,800 years. In a sample of bone, the ratio of carbon – 14 to carbon – 12 is found to be $\frac{1}{4}$ of what it is in free air. This bone may belong to a period about x centuries ago, where x is nearest to

a) 2×58 b) 58 c) 58/2 d) 3×58

599. During mean life of a radioactive element, the fraction that disintegrates is

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

600. Which of the following spectral series in hydrogen atom give spectral line of 4860 Å

a) Lyman b) Balmer c) Paschen d) Brackett

601. The Rutherford α-particle experiment shows that most of the α-particles pass through almost unscattered while some are scattered through the large angles. What information does it give about the structure of the atom

a) Atom is hollow

b) The whole mass of the atom is concentrated in a small centre called nucleus

c) Nucleus is positively charged

d) All the above

602. If the binding energy per nucleon of deutron is 1.115 MeV, its mass defect in atomic mass unit is

a) 0.0048 b) 0.0024 c) 0.0012 d) 0.0006

603. In a radioactive decay, neither the atomic number nor the mass number of changes. Which of the following would be emitted in the decay process

a) Proton b) Neutron c) Electron d) Photon

604. The half life (T) and the disintegration constant (λ) of a radioactive substance are related as

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

605. A radioactive material has a half-life of 8 years. The activity of the material will decrease to about 1/8 of its original value in

a) 256 years b) 128 years c) 64 years d) 24 years

606. What is the ratio of wavelength of radiations emitted when an electron in hydrogen atom jumps from fourth orbit to second orbit and from third orbit to second orbit

a) 27 : 25 b) 20 : 27 c) 20 : 25 d) 25 : 27

607. The half life period of radium is 1600 *years*. The fraction of a sample of radium that would remain after 6400 *years* is

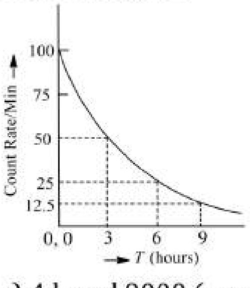
a) 1/4 b) 1/2 c) 1/8 d) 1/16

608. The Rydberg constant R for hydrogen is

a) $R = -\left(\frac{1}{4\pi\varepsilon_0}\right).\frac{2\pi^2 me^2}{ch^2}$ b) $R = \left(\frac{1}{4\pi\varepsilon_0}\right).\frac{2\pi^2 me^4}{ch^2}$

c) $R = \left(\frac{1}{4\pi\varepsilon_0}\right)^2.\frac{2\pi^2 me^4}{c^2h^2}$ d) $R = \left(\frac{1}{4\pi\varepsilon_0}\right)^2.\frac{2\pi^2 me^4}{ch^3}$

609. The count rate for 10g of radioactive material was measured at different times and this has been shown in figure with scale given. The half-life of the material and the total count in the first half value period, respectively are



a) 4 h and 9000 (approximately) b) 3 h and 14100 (approximately)

c) 3 h and 235 (approximately) d) 10 h and 157 (approximately)

610. Nuclear fusion is common to the pair

a) Thermonuclear reactor, uranium based nuclear reactor

b) Energy production in sun, uranium based nuclear reactor

c) Energy production in sun, hydrogen bomb

d) Disintegration of heavy nuclei, hydrogen bomb

611. 99% of a radioactive element will decay between

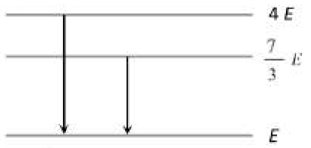
a) 6 and 7 half lives b) 7 and 8 half lives c) 8 and 9 half lives d) 9 half lives

612. Which of the following particles are constituents of the nucleus

a) Protons and electrons b) Protons and neutrons

c) Neutrons and electrons d) Neutrons and positrons

613. The following diagram indicates the energy levels of a certain atom when the system moves from $4E$ level to E. A photon of wavelength λ_1 is emitted. The wavelength of photon produced during it's transition from $\frac{7}{3}E$ level to E is λ_2. The ratio $\frac{\lambda_1}{\lambda_2}$ will be



a) $\frac{9}{4}$ b) $\frac{4}{9}$ c) $\frac{3}{2}$ d) $\frac{7}{3}$

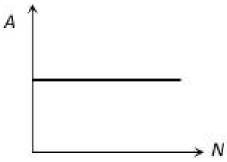
614. The ionization potential of H-atom is $13.6V$. When it is excited from ground state by monochromatic radiations of 970.6 Å, the number of emission lines will be (according to Bohr's theory)

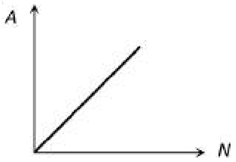
a) 10 b) 8 c) 6 d) 4

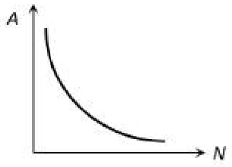
615. The colour of the second line of Balmer series is

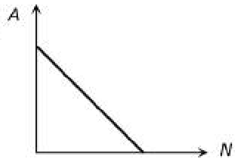
a) Blue b) Yellow c) Red d) Violet

616. The curve between the activity A of a radioactive sample and the number of active atoms N is

a) 

b) 

c) 

d) 

617. A radioactive sample with a half life of 1 month has the label: "Activity = 2 *micro curies* on 1.8.1991." What will be its activity two months later

a) 1.0 *micro curies* b) 0.5 *micro curies* c) 4 *micro curies* d) 8 *micro curies*

618. Sun maintains its shining because of the

a) Fission of helium b) chemical reaction

c) Fusion of hydrogen nuclei d) Burning of carbon

619. Activity of a radioactive sample decreases to $(1/3)^{rd}$ of its original value in 3 days. Then, in 9 days its activity will become

a) (1/27) of the original value b) (1/9) of the original value

c) (1/18) of the original value d) (1/3) of the original value

620. The energy liberated on complete fission of 1 kg of ${}_{92}U^{235}$ is (Assume 200 MeV energy is liberated on fission of 1 nucleus)

a) $8.2 \times 10^{10} J$ b) $8.2 \times 10^{9} J$ c) $8.2 \times 10^{13} J$ d) $8.2 \times 10^{16} J$

621. One milligram of matter converted into energy will give

a) $90\ J$ b) $9 \times 10^{3}\ J$ c) $9 \times 10^{10}\ J$ d) $9 \times 10^{5}\ J$

622. An ionic atom equivalent to hydrogen atom has wavelength equal to 1/4 of the wavelength of hydrogen lines. The ion will be

a) He^{+} b) Li^{++} c) Ne^{9+} d) Na^{10+}

623. If the mass of a radioactive sample is doubled, the activity of the sample and the disintegration constant of the sample are respectively

a) Increases, remains the same b) Decreases, increases

c) Decreases, remains same d) Increases, decreases

624. The energy of the highest energy photon of Balmer series of hydrogen spectrum is close to

a) 13.6 eV b) 3.4 eV c) 1.5 eV d) 0.85 eV

625. Nucleus produced due to α-decay of the nucleus ${}_{Z}X^{A}$ is

a) ${}_{Z+2}Y^{A+4}$ b) ${}_{Z}Y^{A}$ c) ${}_{Z-2}Y^{A-4}$ d) ${}_{Z-4}Y^{A-2}$

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

a) 79.0 b) 51.8 c) 49.2 d) 38.2

627. ${}_{2}^{4}\text{He} + {}_{4}^{9}\text{Be} \rightarrow {}_{0}^{1}n + ?$

The missing ion in the above nuclear reaction is

a) proton b) Oxygen-12 c) Carbon-12 d) Nitrogen-12

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

a) 2400 years b) 3200 years c) 4800 years d) 6400 years

629. A nucleus disintegrates into two nuclear parts which have their velocities in the ratio 2:1. The ratio of their nuclear sizes will be

a) $2^{1/3}:1$ b) $1:3^{1/2}$ c) $3^{1/2}:1$ d) $1:2^{1/3}$

630. What percentage of original radioactive atoms is left after five half lives

a) 0.3% b) 1% c) 31% d) 3.125%

631. Number of spectral lines in hydrogen atom is

a) 3 b) 6 c) 15 d) Infinite

632. Half life of Bi^{210} is 5 $days$. If we start with 50,000 atoms of this isotope, the number of atoms left over after 10 $days$ is

a) 5,000 b) 25,000 c) 12,500 d) 20,000

633. Select the true statement from the following. Nuclear force is

a) Strong, short range and charge independent force.

b) charge independent, attractive and long range force.

c) Strong, charge dependent and short range attractive force

d) Long range, charge dependent and attractive force.

634. The ratio of areas within the electron orbits for the first excited state to the ground state for hydrogen atom is

a) 16 : 1 b) 18 : 1 c) 4 : 1 d) 2 : 1

635. At a given instant there are 25% undecayed radioactive nuclei. After 10 s the number of undecayed nuclei reduces to 6.25%, the mean life of the nuclei is

a) 14.43 s b) 7.21 s c) 5 s d) 10 s

636. For effective nuclear forces, the distance should be

a) $10^{-10}m$ b) $10^{-13}m$ c) $10^{-15}m$ d) $10^{-20}m$

637. Radio carbon dating is done by estimating in specimen the

a) Amount of ordinary carbon still present b) Amount of radio carbon still present

c) Ratio of amount of $^{14}C_6$ to $^{12}C_6$ still present d) Ratio of amount of $^{12}C_6$ to $^{14}C_6$ still present

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

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

639. What will be ratio of radii of Li^7 nucleus to Fe^{56} nucleus?

a) 1:3 b) 1:2 c) 1:8 d) 2:6

640. Bohr's atom model assumes

a) The nucleus is of infinite mass and is at rest

b) Electrons in a quantized orbit will not radiate energy

c) Mass of electron remains constant

d) All the above conditions

641. If an electron and a positron annihilate, then the energy released is

a) $3.2 \times 10^{-13}J$ b) $1.6 \times 10^{-13}J$ c) $4.8 \times 10^{-13}J$ d) $6.4 \times 10^{-13}J$

642. The fusion process is possible at high temperatures, because at higher temperatures

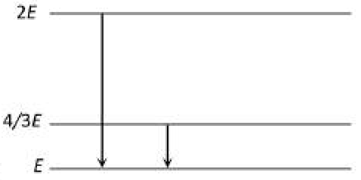
a) The nucleus disintegrates

b) The molecules disintegrates

c) Atom become ionized

d) The nucleus get sufficient energy to overcome the strong forces of repulsion

643. The following diagram indicates the energy levels of a certain atom when the system moves from $2E$ level to E, emitting a photon of wavelength λ. The wavelength of photon produced during its transition from $\frac{4E}{3}$ level to E is



a) $\lambda/3$ b) $3\lambda/4$ c) $4\lambda/3$ d) 3λ

644. A nucleus with mass number 220 initially at rest emits an α-particle. If the Q value of the reaction is 5.5 MeV, calculate the kinetic energy of the α-particle

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

645. If half-life of a substance is 3.8 days and its quantity is 10.38 g. Then substance quantity remaining left after 19 days will be

a) 0.151 g b) 0.32 g c) 1.51 g d) 0.16 g

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

a) 1:3 b) 3:1 c) $(3)^{1/3}$:1 d) 1:1

647. As mass number increases ,surface area

a) Decreases b) Increases
c) Remains the same d) Remains the same and Increases

648. The control rod in a nuclear reactor is made of

a) Uranium b) Cadmium c) Graphite d) Plutonium

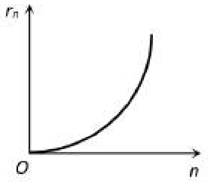
649. An archaeologist analysis the wood in a prehistoric structure and finds that C^{14} (Half life = 5700 *years*) to C^{12} is only one-fourth of that found in the cells of buried plants. The age of the wood is about

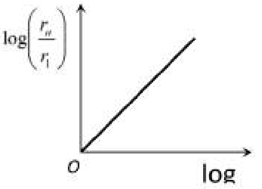
a) 5700 *years* b) 2850 *years* c) 11,400 *years* d) 22,800 *years*

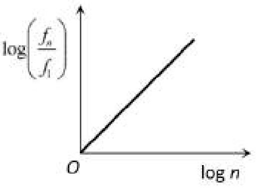
650. A radioactive element A decays into B with a half-life of 2 days. A fresh prepared sample of A has a mass of 12 g. What mass of A and B are there in the sample after 4 days?

a) $A = 3g, B = 9g$ b) $A = 6g, B = 6g$ c) $A = 12g, B = 0g$ d) $A = 9g, B = 3g$

651. If in hydrogen atom, radius of n^{th} Bohr orbit is r_n, frequency of revolution of electron in n^{th} orbit is f_n, choose the correct option

a) 

b) 

c) 

d) Both (a) and (b)

652. The functions of moderators in nuclear reactor is to

a) Decrease the speed of neutrons b) Increase the speed of neutrons
c) Decrease the speed of electrons d) Increase the speed of electrons

653. For electron moving in n^{th} orbit of H-atom the angular velocity is proportional to

a) n b) $1/n$ c) n^3 d) $1/n^3$

654. Which of the following transitions will have highest emission wavelength

a) $n = 2$ to $n = 1$ b) $n = 1$ to $n = 2$ c) $n = 2$ to $n = 5$ d) $n = 5$ to $n = 2$

655. The radioactivity isotope X with a half-life of 10^9year decays to Y which is stable. A sample of rocks were found to contain both the elements X and Y in the ratio 1: 7. What is the age of the rocks?

a) 2×10^9yr b) 3×10^9yr c) 6×10^9yr d) 7×1^9yr

656. 1 curie represents

a) 1 disintegration per second b) 10^6 disintegration per second
c) 3.7×10^{10} disintegration per second d) 3.7×10^7 disintegration per second

657. The phenomena in which proton flips is

a) Nuclear magnetic resonance b) Lasers

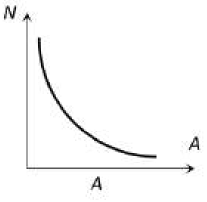
c) Radioactivity d) Nuclear fusion

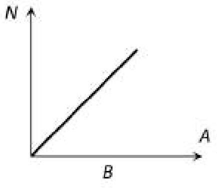
658. The ratio of the energies of the hydrogen atom in its first to second excited state is
   a) 1/4 b) 4/9 c) 9/4 d) 4
659. When two deuterium nuclei fuse together to form a tritium nuclei, we get a
   a) Neutron b) Deuteron c) α −particle d) Proton
660. A radioactive substance has half-life of 60 min. During 3 h, the fraction of the substance that has to be decayed. will be
   a) 87.5 % b) 52.5% c) 25.5% d) 8.5%
661. An observer A sees an asteroid with a radioactive element moving by at a speed $= 0.3\ c$ and measures the radioactivity decay time to be T_A. Another observer B is moving with the asteroid and measures its decay time as T_B. Then T_A and T_B are related as below
   a) $T_B < T_A$
   b) $T_B = T_A$
   c) $T_B > T_A$
   d) Either (a) or (c) depending on whether the asteroid is approaching or moving away from A
662. π mesons can be
   a) π^+ or π^- b) π^+ or π^0 c) π^- or π^0 d) π^+, π^- or π^0
663. Radioactive $^{60}_{27}Co$ is transformed into stable $^{60}_{28}Ni$ by emitting two γ-rays of energies
   a) 1.33 MeV and 1.17 MeV in succession b) 1.17 MeV and 1.33 MeV in succession
   c) 1.37 MeV and 1.13 MeV in succession d) 1.13 MeV and 1.37 MeV in succession
664. According to Bohr's theory, the moment of momentum of an electron revolving in second orbit of hydrogen atom will be
   a) $2\pi h$ b) πh c) $\frac{h}{\pi}$ d) $\frac{2h}{\pi}$
665. Which sample contains greater number of nuclei : a $5.00 - \mu Ci$ sample of ^{240}Pu (half-life $6560y$) or a $4.45 - \mu Ci$ sample of ^{243}Am (half-life $7370y$)
   a) ^{240}Pu b) ^{243}Am c) Equal in both d) None of these
666. The ground state energy of hydrogen atom is $-13.6\ eV$. What is the potential energy of the electron in this state
   a) $0\ eV$ b) $-27.2\ eV$ c) $1\ eV$ d) $2\ eV$
667. The kinetic energy of an electron revolving around a nucleus will be
   a) Four times of P.E. b) Double of P.E. c) Equal to P.E. d) Half of its P.E.
668. The mass number of He is 4 and that for sulphur is 32. The radius of sulphur nucleus is larger than that of helium, by times
   a) $\sqrt{8}$ b) 4 c) 2 d) 8
669. Heavy water is used as moderator in a nuclear reactor. The function of the moderator is
   a) To control the energy released in the reactor
   b) To absorb neutrons and stop chain reaction
   c) To cool the reactor faster
   d) To slow down the neutrons to thermal energies
670. The wavelength of the first line of Balmer series is 6563 Å. The Rydberg constant for hydrogen is about
   a) $1.09 \times 10^7 per\ m$ b) $1.09 \times 10^8 per\ m$ c) $1.09 \times 10^9 per\ m$ d) $1.09 \times 10^5 per\ m$
671. The transition from the state $n = 4$ to $n = 3$ in a hydrogen, like atom results in ultraviolet radiation. Infrared radiation will be obtained in the transition
   a) $2 \rightarrow 1$ b) $3 \rightarrow 2$ c) $4 \rightarrow 2$ d) $5 \rightarrow 4$
672. Hydrogen atom is excited from ground state to another state with principal quantum number equal to 4. Then the number of spectral lines in the emission spectra will be
   a) 2 b) 3 c) 5 d) 6
673. The half life period of a radioactive element X is same as the mean life time of another radioactive element Y. Initially both them have the same number of atoms. Then

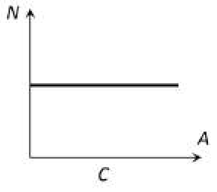
a) X and Y have the same decay rate initially
b) X and Y decay at the same rate always
c) Y will decay at a faster rate than X
d) X will decay at a faster rate than Y

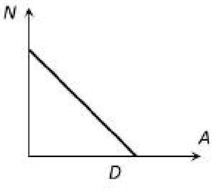
674. In a working nuclear reactor, cadmium rods (control rods) are used to
a) Speed up neutrons
b) Slow down neutrons
c) Absorb some neutrons
d) Absorb all neutrons

675. The plot of the number (N) of decayed atoms versus activity (A) of a radioactive substance is

a) 

b) 

c) 

d) 

676. A sample of an element is 10.38 g. If half-life of element is 3.8 days, then after 19 days, how much quantity of element remains?
a) 0.151 g
b) 0.32 g
c) 1.51 g
d) 0.16 g

677. Radioactive nuclei that are injected into a patient collect at certain sites within its body, undergoing radioactive decay and emitting electromagnetic radiation. These radiations can then be recorded by a detector. This procedure provides an important diagnostic tool called
a) Gamma camera
b) CAT scan
c) Radiotracer technique
d) Gamma ray spectroscopy

678. After five half lives what will be the fraction of initial substance
a) $\left(\frac{1}{2}\right)^{10}$
b) $\left(\frac{1}{2}\right)^{5}$
c) $\left(\frac{1}{2}\right)^{4}$
d) $\left(\frac{1}{2}\right)^{3}$

679. An electron makes a transition from orbit $n = 4$ to the orbit $n = 2$ of a hydrogen atom. The wave number of the emitted radiations (R = Rydberg's constant) will be
a) $\frac{16}{3R}$
b) $\frac{2R}{16}$
c) $\frac{3R}{16}$
d) $\frac{4R}{16}$

680. Whenever a hydrogen atom emits a photon in the Balmer series
a) It may not emit any more photons
b) It may emit another photon in the Paschen series
c) It must emit another photon in the Lyman series
d) It may emit another photon in the Balmer series

681. Half-life of radio-active substance is 140 days. Initially, is 16 g. Calculate the time for this substance when it reduces to 1 g
a) 140 days
b) 280 days
c) 420 days
d) 560 days

682. In a radioactive decay. The half-life of radioactive substance is $T_{1/2} = 69.3$s. The decay constant is
a) 1.5 s^{-1}
b) 2.21 s^{-1}
c) 0.01 s^{-1}
d) 3.01 s^{-1}

683. The mass defect per nucleon is called
a) Binding energy
b) Packing fraction
c) Ionization energy
d) Excitation energy

684. C^{14} has half-life 5700 year. At the end of 11400 years, the actual amount left is
a) 0.5 of original amount
b) 0.25 of original amount
c) 0.125 of original amount
d) 0.0625 of original amount

685. The half-life of a radioactive substance is 40 years. How long will it take to reduce to one fourth of its original amount and what is the value of decay constant
a) 40 year, 0.9173/year
b) 90 year, 9.017/year
c) 80 year, 0.0173/year
d) None of these

686. A heavy nucleus at rest breaks into two fragments which fly off with velocities in the ratio 8:1. The ratio of radii of the fragments is
a) 1 : 2
b) 1 : 4
c) 4 : 1
d) 2 : 1

687. Which of the following transition in Balmer series for hydrogen atom will have longest wavelength

a) $n = 2$ to $n = 1$ b) $n = 6$ to $n = 1$ c) $n = 3$ to $n = 2$ d) $n = 6$ to $n = 2$

688. An α-particle of 5 MeV energy strikes with a nucleus of uranium at stationary at an scattering angle of 180°. The nearest distance upto which α-particle reaches the nucleus will be of the order of

a) 1 Å b) $10^{-10} cm$ c) $10^{-12} cm$ d) $10^{-15} cm$

689. For nuclear forces to be effective, the distance should be

a) 10^{-10} m b) 10^{-11} m c) 10^{-15} m d) 10^{-20} m

690. U^{238} decays into Th^{234} by the emission of an α −particle. There follows a chain of further radioactive decays, either by α −decay or by β −decay. Eventually a stable nuclide is reached and after that, no further radioactive decay is possible. Which of the following stable nuclides is the end product of the U^{238} radioactive decay chain

a) Pb^{206} b) Pb^{207} c) Pb^{208} d) Pb^{209}

691. Pick out the unmatched pair from the following

a) Moderator – Heavy water

b) Nuclear fuel - $_{92}U^{235}$

c) Pressurized water reactor – water as the heat exchange system

d) Safety rods – Carbon

692. Heavy water is

a) Water is 4°C

b) Compound of deuterium and oxygen

c) Compound of heavy oxygen and heavy hydrogen

d) Water, in which soap does not lather

693. The angular momentum of electron in n^{th} orbit is given by

a) nh b) $\frac{h}{2\pi n}$ c) $n\frac{h}{2\pi}$ d) $n^2\frac{h}{2\pi}$

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

a) After 1 *minute*

b) After $\frac{1}{\log_e 2}$ *minute*

c) After $\frac{1}{N}$ *minute*, where N is the number of nuclei present at that moment

d) After any time

695. If the speed of light were 2/3 of its present value, the energy released in a given atomic explosion will be decreased by a fraction

a) 2/3 b) 4/9 c) 3/4 d) 5/9

696. In the given reaction $_{Z}X^{A} \rightarrow {}_{Z+1}Y^{A} \rightarrow {}_{Z-1}K^{A-4} \rightarrow {}_{Z-1}K^{A-4}$ radioactive radiation are emitted in the sequence

a) α, β, γ b) β, α, γ c) γ, α, β d) β, γ, α

697. Half-life of radium is 1600 yr. Its average life is

a) 3200 yr b) 4800 yr c) 2309 yr d) 4217 yr

698. If a star can convert all the He nuclei completely into oxygen nuclei, the energy released per oxygen nuclei is (Mass of the nucleus is 4.0026 amu and mass of oxygen nucleus is 15.9994 amu)

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

699. Which of the following transitions in a hydrogen atom emits photon of the highest frequency

a) $n = 1$ to $n = 2$ b) $n = 2$ to $n = 1$ c) $n = 2$ to $n = 6$ d) $n = 6$ to $n = 2$

700. The half-life of At^{215} is 100μs. If a sample contains 215 mg of At^{215}, the activity of the sample initially is

a) 10^2Bq b) 3×10^{10} Bq c) 4.17×10^{24} Bq d) 1.16×10^5 Bq

701. In the nuclear reaction $_{92}U^{238} \rightarrow {}_{Z}Th^{A} + {}_{2}He^{4}$, the values of A and Z are

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

702. In a fission reaction $_{92}U^{236} = X^{117} + Y^{117} + n + n$, the binding energy per nucleon of X and Y is 8.5 MeV, whereas of $U^{236}$is 7.6 MeV.The total energy liberated will be about

a) 200 keV b) 2 MeV c) 200 MeV d) 2000 MeV

703. The number of electrons, neutrons and protons in a species are equal to 10, 8 and 8 respectively. The proper symbol of the species is

a) $^{16}O_8$ b) $^{18}O_8$ c) $^{18}Ne_{10}$ d) $^{16}O_8^{2-}$

704. If the binding energy of the deutrium is 2.23 MeV. The mass defect given in $a.m.u.$ is

a) −0.0024 b) −0.0012 c) 0.0012 d) 0.0024

705. A count rate metre shows a count of 240 per minute from a given radioactive source later the metre shows a count rate 0f 30 min^{-1} . The half-life of the source is

a) 80 min b) 120 min c) 20 min d) 30 min

706. The distance of closest approach of an α-particle fired towards a nucleus with momentum p, is r. If the momentum of the α-particle is $2p$, the corresponding distance of closest approach is

a) $r/2$ b) $2r$ c) $4r$ d) $r/4$

707. In beta decay

a) The parent and daughter nuclei have same number of protons

b) The daughter nucleus has one proton less than the 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

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

a) $m_3 = m_1 + m_2$ b) $m_3 = |m_1 m_2|$ c) $m_3 < (m_1 + m_2)$ d) $m_3 > (m_1 + m_2)$

709. The ratio between Bohr radii are

a) 1 : 2 : 3 b) 2 : 4 : 6 c) 1 : 4 : 9 d) 1 : 3 : 5

710. A diatomic molecule is made of two masses m_1 and m_2 which are separated by a distance r. If we calculate its rotational energy by applying Bohr's rule of angular momentum quantization, its energy will be given by (n is an integer)

a) $\frac{(m_1+m_2)^2 n^2 h^2}{2m_1^2 m_2^2 r^2}$ b) $\frac{n^2 h^2}{2(m_1+m_2)r^2}$ c) $\frac{2n^2 h^2}{(m_1+m_2)r^2}$ d) $\frac{(m_1+m_2)\, n^2 h^2}{2m_1 m_2 r^2}$

711. The energy of a hydrogen atom in its ground state is $-13.6\ eV$. The energy of the level corresponding to the quantum number $n = 2$ (first excited state) in the hydrogen atom is

a) $-2.72\ eV$ b) $-0.85\ eV$ c) $-0.54\ eV$ d) $-3.4\ eV$

712. Consider an initially pure 3.4 g sample of ^{67}Ga, an isotope that has a half-life of 78 h. What is its initial decay rate?

a) $8.00 \times 10^{16} s^{-1}$ b) $6.27 \times 10^{16} s^{-1}$ c) $7.53 \times 10^{16} s^{-1}$ d) $8.53 \times 10^{15} s^{-1}$

713. When a radioactive isotope $_{88}R^{228}$decay in series by the emission of 3α-particles and β-particle, the isotope finally formed is

a) $_{84}X^{228}$ b) $_{86}X^{222}$ c) $_{83}X^{216}$ d) $_{83}X^{215}$

714. In terms of Rydberg's constant R, the wave number of the first Balmer line is

a) R b) $3R$ c) $\frac{5R}{36}$ d) $\frac{8R}{9}$

715. Which one of the following nuclear reaction is a source of energy in the sun?

a) $_4Be^9 + {_2He^4} \to {_6C^{12}} + {_0n^1}$ b) $_2He^3 + {_2He^3} \to {_2He^4} + {_1H^1} + {_1H^1}$

c) $_{56}Ba^{144} + {_{36}Kr^{92}} \to {_{92}U^{235}} + {_0n^1}$ d) $_{26}Fe^{50} + {_{48}Ca^{112}} \to W^{161} + {_0n^1}$

716. The radius of the first (lowest) orbit of the hydrogen atom is a_0. The radius of the second (next higher) orbit will be

a) $4a_0$ b) $6a_0$ c) $8a_0$ d) $10a_0$

717. What will be the angular momentum of an electron, if energy of this electron in H-atom is $-1.5eV$ (in J-s)

a) 1.05×10^{-34} b) 2.1×10^{-34} c) 3.15×10^{-34} d) -2.1×10^{-34}

718. If scattering particles are 56 for 90° angle, then at an angle 60° it will be

a) 224 b) 256 c) 98 d) 108

719. What was the fissionable material used in bomb dropped at Nagasaki (Japan) in the year 1945

a) Uranium b) Nepturium c) Berkelium d) Plutonium

720. With the increase in principal quantum number, the energy difference between the two successive energy levels

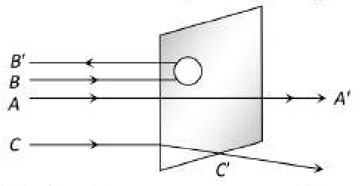
a) Increases b) Decreases

c) Remains constant d) Sometimes increases and sometimes decreases

721. Which of the following phenomena suggests the presence of electron energy levels in atoms

a) Radio active decay b) Isotopes c) Spectral lines d) α-particles scattering

722. A beam of fast moving alpha particles were directed towards a thin film of gold. The parts A', B' and C' of the transmitted and reflected beams corresponding to the incident parts A, B and C of the beam, are shown in the adjoining diagram. The number of alpha particles in



a) B' will be minimum and in C' maximum b) A' will be maximum and in B' minimum

c) A' will be minimum and in B' maximum d) C' will be minimum and in B' maximum

723. In a radioactive reaction

$_{92}X^{232} \rightarrow {}_{82}X^{204}$

the number of α-particles emitted is

a) 7 b) 6 c) 5 d) 4

724. The electric potential between a proton and an electron is given by $V = V_0 \ln \frac{r}{r_0}$, where r_0 is a constant. Assuming Bohr's model to be applicable, write variation of r_n with n, n being the principal quantum number

a) $r_n \propto n$ b) $r_n \propto 1/n$ c) $r_n \propto n^2$ d) $r_n \propto 1/n^2$

725. The minimum energy required to excite a hydrogen atom from its ground state is

a) 13.6 eV b) −13.6 eV c) 3.4 eV d) 10.2 eV

726. What fraction of a radioactive material will get disintegrated in a period of two half-lives

a) Whole b) Half c) One-fourth d) Three-fourth

727. Atom bomb consists of two pieces of $_{92}U^{235}$ and a source of

a) Proton b) Neutron c) Meson d) Electron

728. The kinetic energy of the electron in an orbit of radius r in hydrogen atom is (e = electronic charge)

a) $\frac{e^2}{r^2}$ b) $\frac{e^2}{2r}$ c) $\frac{e^2}{r}$ d) $\frac{e^2}{2r^2}$

729. Which can pass through 20 cm thickness of the steel

a) α −particles b) β −particles c) γ −rays d) Ultraviolet rays

730. Neutrino emission in β − decay was predicted theoretically by

a) Planck b) Heisenberg c) Laue d) Pauli

731. Orbital acceleration of electron is

a) $\frac{n^2h^2}{4\pi^2m^2r^3}$ b) $\frac{n^2h^2}{2n^2r^3}$ c) $\frac{4n^2h^2}{\pi^2m^2n^3}$ d) $\frac{4n^2h^2}{4\pi^2m^2r^3}$

732. A nucleus of an element $_{84}X^{202}$ emits an α-particle first, a β-particle next and then a gamma photon. The final nucleus formed has an atomic number

a) 200 b) 199 c) 83 d) 198

733. The radius of an electron orbit in a hydrogen atom is of the order of

a) $10^{-8}m$ b) $10^{-9}m$ c) $10^{-11}m$ d) $10^{-13}m$

734. Electrons in a certain energy level $n = n_1$, can emit 3 spectral lines. When they are in another energy level, $n = n_2$. They can emit 6 spectral lines. The orbital speed of the electrons in the two orbits are in the ratio

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

735. The number of revolutions per second made by an electron in the first Bohr orbit of hydrogen atom is of the order of

a) 10^{20} b) 10^{19} c) 10^{17} d) 10^{15}

736. Consider a hypothetical annihilation of a stationary electron with a stationary positron. What is the wavelength of resulting radiation

(h = Planck's constant, c = speed of light, m_0 = rest mass)

a) $\frac{h}{2m_0c}$ b) $\frac{h}{m_0c}$ c) $\frac{2h}{m_0c}$ d) $\frac{h}{m_0c^2}$

737. M_n and M_p represent mass of neutron and proton respectively. If an element having atomic mass M has N-neutrons and Z-protons, then the correct relation will be

a) $M < [NM_n + ZM_P]$ b) $M > [NM_n + ZM_P]$ c) $M = [NM_n + ZM_P]$ d) $M = N[M_n + M_P]$

738. The rate of disintegration was observed to be 10^{17} disintegrations per sec when its half life period is 1445 years. The original number of particles are

a) 8.9×10^{27} b) 6.6×10^{27} c) 1.4×10^{16} d) 1.2×10^{17}

739. In the uranium radioactive series, the initial nucleus is $_{92}U^{238}$ and that the final nucleus is $_{82}Pb^{206}$. When uranium nucleus decays to lead, the number of α-particle and β-particles emitted are

a) 8α, 6β b) 6α, 7β c) 6α, 8β d) 4α, 3β

740. Which of the following statements is true

a) $_{78}Pt^{192}$ has 78 neutrons

b) $_{84}Po^{214} \rightarrow {}_{82}Pb^{210} + \beta^-$

c) $_{92}U^{238} \rightarrow {}_{90}Th^{234} + {}_2He^4$

d) $_{90}Th^{234} \rightarrow {}_{91}Pa^{234} + {}_2He^4$

741. A neutron with velocity V strikes a stationary deuterium atom, its kinetic energy changes by a factor of

a) 15/16 b) 1/2 c) 2/1 d) None of these

742. In the Bohr model of a hydrogen atom, the centripetal force is furnished by the coulomb attraction between the proton and the electron. If a_0 is the radius of the ground state orbit, m is the mass, e is the charge on the electron and ε_0 is the vacuum permittivity, the speed of the electron is

a) 0 b) $\frac{e}{\sqrt{\varepsilon_0 a_0 m}}$ c) $\frac{e}{\sqrt{4\pi\varepsilon_0 a_0 m}}$ d) $\frac{\sqrt{4\pi\varepsilon_0 a_0 m}}{e}$

743. After absorbing a slowly moving neutron of mass m_N (momentum ~0) a nucleus of mass M breaks into two nuclei of masses m_1 and $5m_1$ ($6m_1 = M + m_N$), respectively. If the de-Broglie wavelength of the nucleus with mass m_1 is λ, then de- Broglie wavelength of the other nucleus will be

a) 25λ b) 5λ c) $\frac{\lambda}{5}$ d) λ

744. Plutonium decays with half-life of 24000 yr. If plutonium is stored for 7200 yr, the fraction of it that remains is

a) 1/8 b) 1/3 c) 1/4 d) 1/2

745. The ratio of the nuclear radii of elements with mass numbers 216 and 125 is

a) 216:125 b) $\sqrt{216}:\sqrt{125}$ c) 6:5 d) None of these

746. Mass of the nucleons together in a heavy nucleus is

a) Greater than mass of nucleus

b) Equal to mass of nucleus

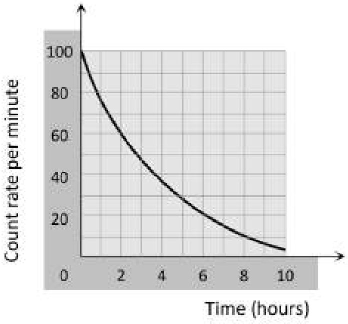
c) Same as mass of nucleus

d) None of the above

747. The half-life of a radioactive substance against α-decay is $1.2 \times 10^7 s$. What is the decay rate for 4×10^{15} atoms of the substance

a) $4.6 \times 10^{12} atoms/s$ b) $2.3 \times 10^{11} atoms/s$ c) $4.6 \times 10^{10} atoms/s$ d) $2.3 \times 10^8 atoms/s$

748. The count rate of $10g$ of radioactive material was measured at different times and this has been shown in the figure. The half life of material and the total counts (approximately) in the first half life period, respectively are



a) $4h, 9000$ b) $3h, 14000$ c) $3h, 235$ d) $3h, 50$

749. Ratio of the wavelengths of first line of Lyman series and first time of Balmer series is

a) 1 : 3 b) 27 : 5 c) 5 : 27 d) 4 : 9

750. If half-life of radium is 77days,its decay constant will be

a) 3×10^{-3}- day^{-1} b) 9×10^{-3}- day^{-1} c) 1×10^{-3}- day^{-1} d) 6×10^{-3}- day^{-1}

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

a) $9 \times 10^{10} J$ b) $9 \times 10^{11} J$ c) $9 \times 10^{12} J$ d) $9 \times 10^{13} J$

752. The radioactivity of a simple is I_1 at a time t_1 and I_2 at a time t_2. If the half-life of the sample is$\tau_{1/2}$,then the number of nuclei that have disintegrated in the time $t_2 - t_1$ is proportional to

a) $I_1 t_2 - I_2 t_1$ b) $I_1 - I_2$ c) $\frac{I_1 - I_2}{\tau_{1/2}}$ d) $(I_1 - I_2)\tau_{1/2}$

753. The operation of a nuclear reactor is said to be critical, if the multiplication factor (k) has a value

a) 1 b) 1.5 c) 2.1 d) 2.5

754. ${}_1H^1 + {}_1H^1 + {}_1H^2 \rightarrow X + {}_{+1}e^0$ + energy. The emitted particle is

a) Neutron b) Proton c) α –particle d) Neutrino

755. Cadmium rods are used in a nuclear reactor for

a) Slowing down fast neutrons b) Speeding up slow neutrons

c) Absorbing neutrons d) Regulating the power level of reactor.

756. Energy of electron in an orbit of H-atom is

a) Positive b) Negative c) Zero d) Nothing can be said

757. A radioactive isotope X with a half-life of 1.37×10^9 years decays to Y which is stable. A sample of rock from the moon was found to contain both the elements X and Y which were in the ratio 1:7. The age of the rock is

a) $1.96 \times 10^8 years$ b) $3.85 \times 10^9 years$ c) $4.11 \times 10^9 years$ d) $9.59 \times 10^9 years$

758. The half-life of a radioactive substance is 48 hours. How much time will it take to disintegrate to its $\frac{1}{16}th$ part

a) 12 h b) 16 h c) 48 h d) 192 h

759. In the following atoms and molecules for the transition from $n = 2$ to $n = 1$, the spectral line of minimum wavelength will be produced by

a) Hydrogen atom b) Deuterium atom c) Uni-ionized helium d) De-ionized lithium

760. The radioactivity of a given sample of whisky due to tritium (half life 12.3 years) was found to be only 3% of that measured in a recently purchased bottle marked "7 years old". The sample must have been prepared about

a) 220 years back b) 300 years back c) 400 years back d) 70 years back

761. The nuclear reaction ${}^2H + {}^2H \rightarrow {}^4He$ (mass of deuteron $= 2.0141\ a.m.u.$ and mass of $He =$ $4.0024\ a.m.u.$) is

a) Fusion reaction releasing 24 MeV energy

b) Fusion reaction absorbing 24 MeV energy

c) Fission reaction releasing 0.0258 MeV energy

d) Fission reaction absorbing 0.0258 MeV energy

762. ^{234}U has 92 protons and 234 nucleons total in the nucleus. It decays by emitting an alpha particle. After the decay it becomes

a) ^{232}U b) ^{232}Pa c) ^{230}Th d) ^{230}Ra

763. The intensity of gamma radiation from a given source is I_o. On passing through 37.5 mm of lead it is reduced to $I_o/8$. The thickness of lead which will reduce it to $I_o/2$ is

a) $(37.7)^{1/3}$mm b) $(37.5)^{1/4}$mm c) 37.5/3 mm d) (37.5/4) mm

764. If R is the Rydberg's constant for hydrogen the wave number of the first line in the Lyman series will be

a) $\frac{R}{4}$ b) $\frac{3R}{4}$ c) $\frac{R}{2}$ d) $2R$

765. The mass of a ^7_3Li nucleus is $0.042u$ less than the sum of the masses of all its nucleons. The binding energy per nucleon of ^7_3Li nucleus is nearly

a) 23 MeV b) 46 MeV c) 5.6 MeV d) 3.9 MeV

766. The mass defect for the nucleus of helium is 0.0303 $a.m.u$. What is the binding energy per nucleon for helium in MeV

a) 28 b) 7 c) 4 d) 1

767. When a neutron is disintegrated to give aβ particle,

a) A neutrino alone is emitted
b) A proton and neutrino are emitted
c) A proton alone is emitted
d) A proton and an antineutrino are emitted

768. The principle of controlled chain reaction is used in

a) Atomic energy reactor
b) Atom bomb
c) In the core of sun
d) Artificial radioactivity

769. Two radioactive substances A and B have decay constants 5λ and λ 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 $\left(\frac{1}{e}\right)^2$ after a time interval

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

770. The size of an atom is of the order of

a) $10^{-8}m$ b) $10^{-10}m$ c) $10^{-12}m$ d) $10^{-14}m$

771. The difference between U^{235} and U^{238} atom is that

a) U^{238} contains 3 more protons
b) U^{238} contains 3 protons and 3 more electrons
c) U^{238} contains 3 more neutrons and 3 more electrons
d) U^{238} contains 3 more neutrons

772. A radioactive substance of half-life 6 min is placed near a Geiger counter which is found to resister 1024 particles per minute. How many particles per minute will it register after 42 min?

a) 4 per min b) 8 per min c) 5 per min d) 7 per min

773. If the decay constant of a radioactive substance is λ, then its half-life is

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

774. 10 g of radioactive material of half-life 15 year is kept in store for 20 years. The disintegrated material is

a) 12.5 g b) 10.5 g c) 6.03 g d) 4.03 g

775. The binding energies per nucleon for a deuteron and an $\alpha -$ particle are x_1 and x_2 respectively. What will be the energy Q released in the reaction $_1H^2 + {_1H^2} \rightarrow _2 He^4 + Q$

a) $4(x_1 + x_2)$ b) $4(x_2 - x_1)$ c) $2(x_1 + x_2)$ d) $2(x_2 - x_1)$

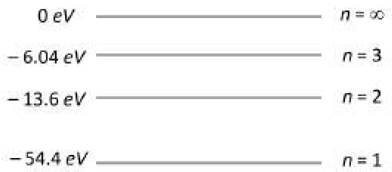
776. A nucleus ^A_ZX has mass represented by $M(A, Z)$. If M_P and M_n denote the mass of proton and neutron respectively and B.E the binding energy in MeV, then

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

777. In helium nucleus, there are

a) 2 protons and 2 electrons
b) 2 neutrons, 2 protons and 2 electrons
c) 2 protons and 2 neutrons
d) 2 positrons and 2 protons

778. The energy level diagram for an hydrogen like atom is shown in the figure. The radius of its first Bohr orbit is



a) 0.265 Å
b) 0.53 Å
c) 0.132 Å
d) None of these

779. Energy released in fusion of 1 kg of deuterium nuclei
a) $8 \times 10^{13} J$
b) $6 \times 10^{27} J$
c) $2 \times 10^{7} kwh$
d) $8 \times 10^{23} MeV$

780. The ionization energy of the electron in the hydrogen atom in its ground state is 13.6 eV. The atoms are excited to higher energy levels to emit radiations of 6 wavelengths. Maximum wavelength of emitted radiation corresponds to the transition between
a) $n = 3$ to $n = 2$ states
b) $n = 3$ to $n = 1$ states
c) $n = 2$ to $n = 1$ states
d) $n = 4$ to $n = 3$ states

781. When the wave of hydrogen atom comes from infinity into the first orbit then the value of wave number is
a) 109700 cm^{-1}
b) 1097 cm^{-1}
c) 109 cm^{-1}
d) None of these

782. The energy of electron in the nth orbit of hydrogen atom is expressed as $E_n = \frac{-13.6}{n^2} eV$. The shortest and longest wavelength of Lyman series will be
a) 910Å, 1213Å
b) 5463Å, 7858Å
c) 1315Å, 1530Å
d) None of these

783. In a hypothetical Bohr hydrogen, the mass of the electron is doubled. The energy E_0 and the radius r_0 of the first orbit will be (a_0 is the Bohr radius)
a) $E_0 = -27.2\ eV; r_0 = a_0/2$
b) $E_0 = -27.2\ eV; r_0 = a_0$
c) $E_0 = -13.6\ eV; r_0 = a_0/2$
d) $E_0 = -13.6\ eV; r_0 = a_0$

784. The ionization energy of hydrogen atom is 13.6 eV. Following Bohr's theory, the energy corresponding to a transition between the 3rd and the 4th orbit is
a) 3.40 eV
b) 1.51 eV
c) 0.85 eV
d) 0.66 eV

785. The energy of a hydrogen atom in the ground state is $-13.6\ eV$. The energy of a He^+ ion in the first excited state will be
a) $-6.8\ eV$
b) $-13.6\ eV$
c) $-27.2\ eV$
d) $-54.4\ eV$

786. Decay constant of radium is λ. By a suitable process its compound radium bromide is obtained. The decay constant of radium bromide will be
a) λ
b) More than λ
c) Less than λ
d) Zero

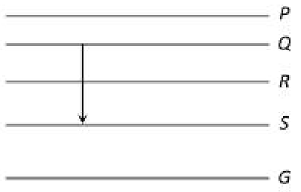
787. In the reaction
$_7N^{14} + \alpha \rightarrow {_8X^{17}} + {_1p^1}$
identify X.
a) O_2
b) N_2
c) He
d) Ar

788. What is the radius of iodine atom (at. no. 53, mass number 126)
a) $2.5 \times 10^{-11} m$
b) $2.5 \times 10^{-9} m$
c) $7 \times 10^{-9} m$
d) $7 \times 10^{-6} m$

789. In the lowest energy level of hydrogen atom, the electron has the angular momentum
a) π/h
b) h/π
c) $h/2\pi$
d) $2\pi/h$

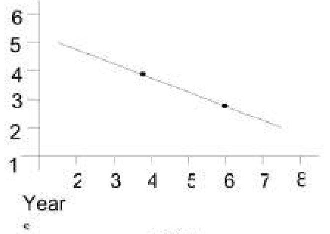
790. Which of these is a fusion reaction
a) ${}_1^3H + {}_1^2H = {}_2^4He + {}_0^1n$
b) ${}_{92}^{238}U \rightarrow {}_{82}^{206}Pb + 8({}_2^4He) + 6({}_{-1}^{0}\beta)$
c) ${}_7^{12}C \rightarrow {}_6^{12}C + \beta^+ + \gamma$
d) None of these

791. Figure shows the energy levels P, Q, R, S and G of an atom where G is the ground state. A red line in the emission spectrum of the atom can be obtained by an energy level change from Q to S. A blue line can be obtained by following energy level change



a) P to Q b) Q to R c) R to S d) R to G

792. To determine the half- life of radioactive element, a student plots graph of $\ln\left|\frac{dN(t)}{dt}\right|$ $versus$ t. Here $\frac{dN(t)}{dt}$ is the rate of radioactive decay at time t. If the number of radioactive nuclei of this element decreases by a factor of p after 4.16 yr, the value of p is



a) 8 b) 7 c) 4 d) 8.5

793. The energy of electron in first excited state of H-atom is $-3.4\ eV$ its kinetic energy is

a) $-3.4\ eV$ b) $+3.4\ eV$ c) $-6.8\ eV$ d) $6.8\ eV$

794. In a nuclear reactor, the fuel is consumed at the rate of 1 mgs^{-1}. The power generated in kilowatt is

a) 9×10^4 b) 9×10^7 c) 9×10^8 d) 9×10^{12}

795. The order of the size of nucleus and Bohr radius of an atom respectively are

a) $10^{-14}m, 10^{-10}m$ b) $10^{-10}m, 10^{-8}m$ c) $10^{-20}m, 10^{-16}m$ d) $10^{-8}m, 10^{-6}m$

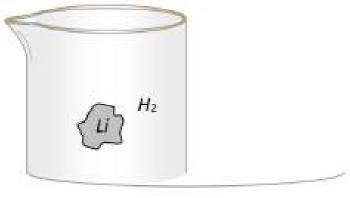
796. Size of nucleus is of the order of

a) $10^{-10}m$ b) $10^{-15}m$ c) $10^{-12}m$ d) $10^{-19}m$

797. When a sample of solid lithium is placed in a flask of hydrogen gas then following reaction happened

$^1_1H + {_3Li^7} \rightarrow {_2He^4} + {_2He^4}$

This statement is



a) True b) False
c) May be true at a particular pressure d) None of these

798. In the nuclear fusion reaction

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

given that the repulsive potential energy between the two nuclei is 7.7×10^{-14} J, the temperature at which the gases must be heated to initiate the reaction is nearly [Boltzmann's constant $k = 1.38 \times 10^{-23}$ JK^{-1}]

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

799. Nuclear fission can be explained based on

a) Millikan's oil drop method b) Liquid drop model
c) Shell model d) Bohr's model

800. A radioactive substance has an average life of 5h. In a time of 5 h

a) Half of the active nuclei decay b) Less than half of the active nuclei decay
c) More than half of the active nuclei decay d) All active nuclei decay

801. The wavelength of the energy emitted when electron comes from fourth orbit to second orbit in hydrogen is $20.397cm$. The wavelength of energy for the same transition in He^+ is

a) $5.099\ cm^{-1}$ b) $20.497\ cm^{-1}$ c) $40.994\ cm^{-1}$ d) $81.988\ cm^{-1}$

802. The half-life of a radioactive substance is 3.6 days. How much of 20 mg of this radioactive substance will remain after 36 days

a) 0.0019 mg b) 1.019 mg c) 1.109 mg d) 0.019 mg

803. The activity of a sample is $64 \times 10^{-5} Ci$. Its half-life is 3 $days$. The activity will become $5 \times 10^{-6} Ci$ after

a) 12 $days$ b) 7 $days$ c) 18 $days$ d) 21 $days$

804. The radioactive nucleus $_7N^{13}$ decays to $_6C^{13}$ through the emission of

a) Neutron b) Proton c) Electron d) Positron

805. The half-life of Bi^{210} is 5 days. What time is taken by $(7/8)^{\text{th}}$ part of the sample to decay

a) 3.4 days b) 10 days c) 15 days d) 64 days

806. If the atom $_{100}Fm^{257}$ follows the Bohr model and the radius of $_{100}Fm^{257}$ is n times the Bohr radius, then find n

a) 100 b) 200 c) 4 d) 1/4

807. If the decay or disintegration constant of a radioactive substance is λ, then its half life and mean life are respectively

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

808. The sodium nucleus $^{23}_{11}Na$ contains

a) 11 electrons b) 12 protons c) 23 protons d) 12 neutrons

809. Atomic reactor is based on

a) Controlled chain reaction b) uncontrolled chain reaction

c) Nuclear fission d) Nuclear fussion

810. The binding energy of deuteron ^2_1H is 1.112 MeV per nucleon and an α-particle ^4_2He has a binding energy of 7.047 MeV per nucleon. Then in the fusion reaction $^2_1H + ^2_1H \rightarrow ^4_2 He + Q$, the energy Q released is

a) 1 MeV b) 11.9 MeV c) 23.8 MeV d) 931 MeV

811. Solar energy is mainly cause due to

a) Fission of uranium present in the sun

b) Fusion of protons during synthesis of heavier elements

c) Gravitational contraction

d) Burning of hydrogen in the oxygen

812. A free neutron decays into a proton, an electron and

a) A neutrino b) An antineutrino c) An alpha particle d) A beta particle

813. The nuclei of which of the following pairs of nuclei are isotones

a) $_{34}Se^{74}$, $_{31}Ca^{71}$ b) $_{42}Mo^{92}$, $_{40}Zr^{92}$ c) $_{38}Sr^{81}$, $_{38}Sr^{86}$ d) $_{20}Ca^{40}$, $_{16}S^{32}$

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

a) 0.78 MeV b) 1.78 MeV c) 1.28 MeV d) 0.28 MeV

815. The binding energy per nucleon of deuterium and helium atom is 1.1 MeV and 7.0 MeV. If two deuterium nuclei fuse to form helium atom, the energy released is

a) 19.2 MeV b) 23.6 MeV c) 26.9 MeV d) 13.9 MeV

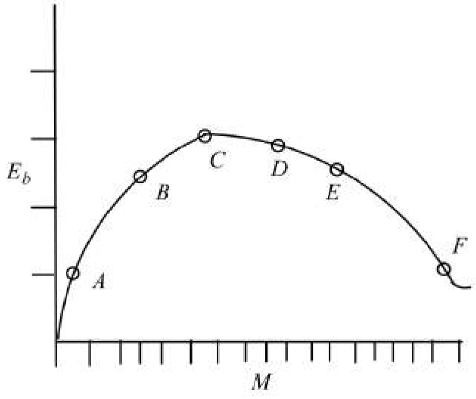
816. The above is a plot of binding energy per nucleon E_b, against the nuclear mass M; A, B, C, D, E, F correspond to different nuclei. Consider four reactions

$A + B \rightarrow C + \varepsilon$

$C \rightarrow A + B + \varepsilon$

$D + E \rightarrow F + \varepsilon$

$F \rightarrow D + E + \varepsilon$



where ε is the energy released? In which reaction is ε positive?

a) (i) and (iv) b) (i) and (iii) c) (ii) and (iv) d) (ii) and (iii)

817. A radioactive sample S_1 having the activity A_1 has twice the number of nuclei as another sample S_2 of activityA_2. If $A_2 = 2A_1$, then the ratio of half-life of S_1 to the half-life of S_2 is

a) 4 b) 2 c) 0.25 d) 0.75

818. Consider the nuclear reaction $X^{200} \to A^{110} + B^{80}$. If the binding energy per nucleon for X, A and B are 7.4 MeV, 8.2 MeV and 8.1MeV respectively, then the energy released in the reaction is

a) 70 MeV b) 200 MeV c) 190 MeV d) 10 MeV

819. The decay constant of a radioactive element is 1.5×10^{-9} per second. Its mean life in seconds will be

a) 1.5×10^9 b) 4.62×10^8 c) 6.67×10^8 d) 10.35×10^8

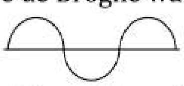
820. How many neutrons are more than protons in $_{92}\mathrm{U}^{235}$nucleus?

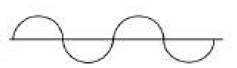
a) 54 b) 49 c) 51 d) 143

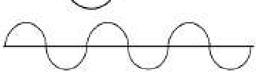
821. The energy released in a typical nuclear fusion reaction is approximately

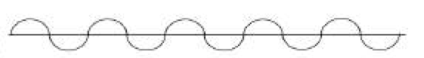
a) 25 MeV b) 200 MeV c) 800 MeV d) 1050 MeV

822. The de Broglie wave present in fifth Bohr orbit is

a) 

b) 

c) 

d) 

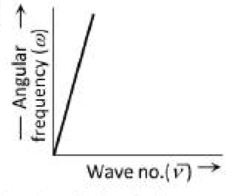
823. An alpha nucleus of energy $\frac{1}{2}mv^2$ bombards a heavy nuclear target of charge Ze. Then the distance of closest approach for the alpha nucleus will be proportional to

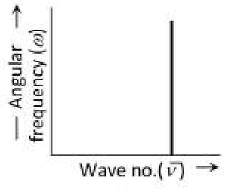
a) $1/m$ b) $1/v^4$ c) $1/Ze$ d) v^2

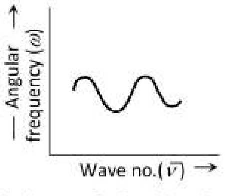
824. In the reaction $^2_1H + {}^3_1H \to {}^4_2He + {}^1_0n$ if the binding energies of ^2_1H, ^3_1H and ^4_2He are respectively a, b and c (in MeV), then the energy (in MeV) released in this reaction is

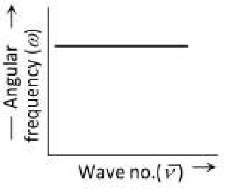
a) $c + a - b$ b) $c - a - b$ c) $a + b + c$ d) $a + b - c$

825. The graph between wave number ($\bar{\nu}$) and angular frequency (ω) is

a) 

b) 

c) 

d) 

826. Which of the following statements are true regarding Bohr's model of hydrogen atom

(I) Orbiting speed of electron decreases as it shifts to discrete orbits away from the nucleus

(II) Radii of allowed orbits of electron are proportional to the principal quantum number

(III) Frequency with which electrons orbit around the nucleus is discrete orbits is inversely proportional to the cube of principal quantum number

(IV) Binding force with which the electron is bound to the nucleus increases as it shifts to outer orbits

Select correct answer using the codes given below

a) I and III b) II and IV c) I, II and III d) II, III and IV

827. A photon creates a pair of electron positron with equal kinetic energy. Let kinetic energy of each particle is 0.29 MeV. Then what should be energy of the photon?

a) 1.60 MeV b) 1.63 MeV c) 2.0 MeV d) 1.90 MeV

828. In the options given below, let E denote the rest mass energy of a nucleus and n a neutron. the correct option is

a) $E({}^{236}_{92}U) > E({}^{137}_{53}I) + E({}^{97}_{39}Y) + 2E(n)$ b) $E({}^{236}_{92}U) < E({}^{137}_{53}I) + E({}^{97}_{39}Y) + 2E(n)$

c) $E({}^{236}_{92}U) > E({}^{140}_{56}\mathrm{Ba}) + E({}^{94}_{36}\mathrm{Kr}) + 2E(n)$ d) $E({}^{236}_{92}U) < E({}^{140}_{56}\mathrm{Ba}) + E({}^{94}_{36}\mathrm{Kr}) + 2E(n)$

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: ANSWER KEY :

1)	a	2)	c	3)	a	4)	b	165)	a	166)	a	167)	c	168)	d
5)	a	6)	b	7)	a	8)	b	169)	d	170)	a	171)	a	172)	b
9)	a	10)	d	11)	c	12)	d	173)	d	174)	b	175)	d	176)	d
13)	b	14)	c	15)	b	16)	a	177)	c	178)	a	179)	d	180)	a
17)	c	18)	a	19)	a	20)	b	181)	b	182)	b	183)	c	184)	d
21)	b	22)	c	23)	a	24)	b	185)	a	186)	a	187)	d	188)	d
25)	b	26)	b	27)	c	28)	a	189)	c	190)	d	191)	b	192)	d
29)	b	30)	a	31)	c	32)	a	193)	b	194)	a	195)	a	196)	b
33)	c	34)	a	35)	c	36)	a	197)	d	198)	d	199)	d	200)	c
37)	a	38)	c	39)	a	40)	a	201)	c	202)	b	203)	c	204)	d
41)	a	42)	a	43)	c	44)	a	205)	c	206)	c	207)	d	208)	c
45)	a	46)	a	47)	b	48)	d	209)	d	210)	b	211)	d	212)	d
49)	c	50)	b	51)	d	52)	b	213)	a	214)	b	215)	c	216)	a
53)	a	54)	a	55)	b	56)	b	217)	d	218)	a	219)	d	220)	b
57)	d	58)	b	59)	c	60)	b	221)	a	222)	b	223)	d	224)	c
61)	d	62)	c	63)	c	64)	a	225)	a	226)	a	227)	c	228)	c
65)	b	66)	a	67)	d	68)	a	229)	a	230)	c	231)	c	232)	d
69)	c	70)	d	71)	b	72)	a	233)	b	234)	a	235)	a	236)	d
73)	c	74)	b	75)	d	76)	c	237)	c	238)	c	239)	a	240)	d
77)	c	78)	b	79)	a	80)	a	241)	b	242)	c	243)	c	244)	d
81)	c	82)	d	83)	b	84)	b	245)	d	246)	b	247)	b	248)	c
85)	d	86)	c	87)	a	88)	c	249)	c	250)	b	251)	d	252)	a
89)	a	90)	c	91)	d	92)	a	253)	a	254)	a	255)	c	256)	c
93)	a	94)	a	95)	d	96)	b	257)	b	258)	a	259)	c	260)	b
97)	a	98)	b	99)	d	100)	a	261)	b	262)	b	263)	a	264)	c
101)	b	102)	d	103)	c	104)	c	265)	b	266)	a	267)	d	268)	a
105)	d	106)	a	107)	b	108)	c	269)	a	270)	b	271)	a	272)	a
109)	d	110)	c	111)	a	112)	d	273)	a	274)	d	275)	a	276)	d
113)	c	114)	c	115)	d	116)	a	277)	d	278)	b	279)	b	280)	d
117)	b	118)	a	119)	d	120)	d	281)	a	282)	b	283)	c	284)	c
121)	a	122)	c	123)	d	124)	b	285)	b	286)	a	287)	a	288)	d
125)	d	126)	b	127)	a	128)	a	289)	d	290)	c	291)	b	292)	c
129)	c	130)	c	131)	b	132)	c	293)	a	294)	c	295)	c	296)	b
133)	b	134)	b	135)	d	136)	d	297)	b	298)	c	299)	b	300)	b
137)	c	138)	b	139)	d	140)	a	301)	b	302)	a	303)	d	304)	d
141)	a	142)	b	143)	c	144)	b	305)	d	306)	b	307)	b	308)	c
145)	a	146)	a	147)	b	148)	b	309)	d	310)	a	311)	c	312)	a
149)	a	150)	c	151)	a	152)	a	313)	b	314)	c	315)	b	316)	c
153)	d	154)	a	155)	b	156)	a	317)	a	318)	d	319)	a	320)	d
157)	a	158)	c	159)	b	160)	b	321)	c	322)	b	323)	b	324)	a
161)	b	162)	b	163)	a	164)	c	325)	a	326)	b	327)	a	328)	d

329)	c	330)	b	331)	a	332)	d	529)	d	530)	c	531)	a	532)	c
333)	b	334)	b	335)	b	336)	d	533)	c	534)	c	535)	c	536)	c
337)	d	338)	a	339)	a	340)	c	537)	b	538)	c	539)	a	540)	c
341)	b	342)	a	343)	c	344)	a	541)	a	542)	c	543)	b	544)	d
345)	c	346)	c	347)	d	348)	b	545)	b	546)	c	547)	d	548)	c
349)	c	350)	b	351)	d	352)	b	549)	d	550)	d	551)	a	552)	a
353)	a	354)	c	355)	a	356)	a	553)	a	554)	b	555)	b	556)	c
357)	a	358)	b	359)	d	360)	a	557)	d	558)	a	559)	a	560)	c
361)	d	362)	c	363)	c	364)	c	561)	c	562)	d	563)	a	564)	a
365)	a	366)	d	367)	a	368)	d	565)	a	566)	a	567)	d	568)	d
369)	a	370)	a	371)	a	372)	d	569)	d	570)	a	571)	c	572)	c
373)	c	374)	b	375)	d	376)	d	573)	c	574)	b	575)	c	576)	a
377)	c	378)	d	379)	a	380)	b	577)	a	578)	b	579)	b	580)	b
381)	b	382)	d	383)	c	384)	c	581)	a	582)	b	583)	c	584)	b
385)	b	386)	c	387)	a	388)	d	585)	d	586)	a	587)	c	588)	a
389)	a	390)	d	391)	c	392)	a	589)	b	590)	d	591)	c	592)	c
393)	b	394)	c	395)	d	396)	d	593)	b	594)	b	595)	d	596)	c
397)	d	398)	d	399)	c	400)	d	597)	d	598)	a	599)	c	600)	b
401)	b	402)	b	403)	b	404)	c	601)	d	602)	b	603)	d	604)	b
405)	c	406)	b	407)	a	408)	a	605)	d	606)	b	607)	d	608)	d
409)	c	410)	a	411)	c	412)	c	609)	b	610)	c	611)	a	612)	b
413)	b	414)	c	415)	a	416)	a	613)	b	614)	c	615)	a	616)	b
417)	a	418)	a	419)	d	420)	d	617)	b	618)	c	619)	a	620)	c
421)	b	422)	b	423)	d	424)	a	621)	c	622)	a	623)	a	624)	b
425)	a	426)	a	427)	d	428)	a	625)	c	626)	a	627)	c	628)	b
429)	d	430)	d	431)	c	432)	d	629)	d	630)	d	631)	d	632)	c
433)	c	434)	b	435)	c	436)	c	633)	a	634)	a	635)	b	636)	c
437)	d	438)	b	439)	c	440)	a	637)	c	638)	d	639)	b	640)	d
441)	a	442)	d	443)	d	444)	a	641)	b	642)	d	643)	d	644)	b
445)	a	446)	b	447)	b	448)	b	645)	b	646)	d	647)	b	648)	b
449)	c	450)	a	451)	c	452)	b	649)	c	650)	a	651)	d	652)	a
453)	b	454)	b	455)	b	456)	c	653)	d	654)	d	655)	b	656)	c
457)	c	458)	d	459)	c	460)	b	657)	a	658)	c	659)	d	660)	a
461)	a	462)	d	463)	d	464)	c	661)	a	662)	d	663)	b	664)	c
465)	a	466)	c	467)	a	468)	b	665)	c	666)	b	667)	d	668)	c
469)	c	470)	b	471)	c	472)	b	669)	d	670)	a	671)	d	672)	d
473)	b	474)	b	475)	c	476)	b	673)	c	674)	c	675)	d	676)	b
477)	a	478)	d	479)	b	480)	b	677)	c	678)	b	679)	c	680)	c
481)	d	482)	c	483)	d	484)	b	681)	d	682)	c	683)	b	684)	b
485)	a	486)	c	487)	c	488)	d	685)	c	686)	a	687)	c	688)	c
489)	b	490)	c	491)	a	492)	d	689)	c	690)	a	691)	d	692)	b
493)	b	494)	a	495)	d	496)	b	693)	c	694)	d	695)	b	696)	b
497)	a	498)	a	499)	d	500)	d	697)	c	698)	c	699)	a	700)	c
501)	d	502)	c	503)	c	504)	a	701)	b	702)	c	703)	d	704)	d
505)	b	506)	d	507)	c	508)	d	705)	c	706)	d	707)	c	708)	c
509)	b	510)	a	511)	d	512)	a	709)	c	710)	d	711)	d	712)	c
513)	d	514)	b	515)	a	516)	c	713)	c	714)	c	715)	b	716)	a
517)	c	518)	d	519)	c	520)	a	717)	c	718)	a	719)	d	720)	b
521)	a	522)	d	523)	d	524)	b	721)	c	722)	b	723)	a	724)	a
525)	a	526)	b	527)	a	528)	b	725)	d	726)	d	727)	b	728)	b

729)	c	730)	d	731)	a	732)	c	785)	b	786)	a	787)	a	788)	a
733)	c	734)	a	735)	d	736)	b	789)	c	790)	a	791)	d	792)	a
737)	a	738)	b	739)	a	740)	c	793)	b	794)	b	795)	a	796)	b
741)	d	742)	c	743)	d	744)	a	797)	b	798)	d	799)	b	800)	c
745)	c	746)	a	747)	d	748)	b	801)	a	802)	d	803)	d	804)	d
749)	c	750)	b	751)	d	752)	d	805)	c	806)	d	807)	b	808)	d
753)	a	754)	c	755)	c	756)	b	809)	a	810)	c	811)	b	812)	b
757)	c	758)	d	759)	d	760)	d	813)	a	814)	b	815)	b	816)	a
761)	a	762)	c	763)	c	764)	b	817)	a	818)	a	819)	c	820)	c
765)	c	766)	b	767)	d	768)	a	821)	a	822)	d	823)	a	824)	b
769)	d	770)	b	771)	d	772)	b	825)	a	826)	a	827)	a	828)	a
773)	a	774)	c	775)	b	776)	b								
777)	c	778)	a	779)	d	780)	d								
781)	a	782)	a	783)	a	784)	d								

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: HINTS AND SOLUTIONS :

1 **(a)**

Remaining amount

$= 16 \times \left(\frac{1}{2}\right)^{32/2} = 16 \times \left(\frac{1}{2}\right)^{16} = \left(\frac{1}{2}\right)^{12} < 1mg$

3 **(a)**

Half-life of a radioactive element

$T = \frac{0.693}{\lambda}$ or $T \propto \frac{1}{\lambda}$

$\therefore \quad \frac{\lambda_A}{\lambda_B} = \frac{T_B}{T_A}$

4 **(b)**

${}_7N^{14} + {}_2He^4 \rightarrow {}_8O^{17} + {}_1H^1$

5 **(a)**

$N_{t_1} = N_0 e^{-\lambda t_1}$

$N_{t_2} = N_0 e^{-\lambda t_2}$

$\therefore N_{t_1} - N_{t_2} = N_0(e^{-\lambda t_2} - e^{-\lambda t_2})$

7 **(a)**

Mass defect

$\Delta m =$ Total mass of $\alpha -$ particles $-$ mass of ^{12}C nucleus

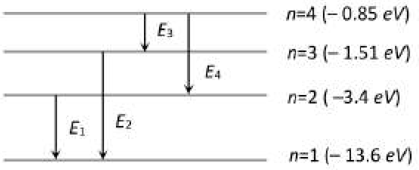
$= 3 \times 4.002603 - 12$

$= 12.007809 - 12$

$= 0.007809$ unit

8 **(b)**

From diagram



$E_1 = -13.6 - (-3.4) = -10.2eV$

$E_2 = -13.6 - (-1.51) = -12.09eV$

$E_3 = -1.51 - (-0.85) = -0.66eV$

$E_4 = -3.4 - (-0.85) = (-2.55)eV$

E_3 is least, *i. e.*, frequency is lowest

9 **(a)**

1amu (or 1 u)=1.6605402 $\times 10^{-27}$ kg

$= 1.6 \times 10^{-24}$ g

Moreover 1 amu is equivalent to 931 MeV

Or 1.6 $\times 10^{-24}$ g is equivalent to 931 MeV

$\therefore$ 1g is equivalent to $\frac{931}{1.6\times10^{-24}}$ MeV

and 10^{-3} g is equivalent to $\frac{931}{1.6\times10^{-24}} \times 10^{-3}$MeV

$= 5.6 \times 10^{23}$ MeV

10 **(d)**

$\Delta m = 0.3g$

$= 0.3 \times 10^{-3}$ kg $= 3 \times 10^{-4}$ kg

Energy liberated , $E = \Delta mc^2$

$= 3 \times 10^{-4} \times (3 \times 10^8)^2$

$= 3 \times 10^{-4} \times 9 \times 10^{16}$

$= 27 \times 10^{12}$ J $= \frac{27 \times 10^{12}}{3.6 \times 10^6}$ kWh

$= 7.5 \times 10^6$ kWh

11 **(c)**

$\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{4^2}\right) = \frac{3R}{16} \Rightarrow \lambda = \frac{16}{3R} = \frac{16}{3} \times 10^{-5}cm$

Frequency $n = \frac{c}{\lambda} = \frac{3\times10^{10}}{\frac{16}{3}\times10^{-5}} = \frac{9}{16} \times 10^{15}Hz$

12 **(d)**

$V = (12.1 - 5.1)volt$

$V_{stopping} = 7V$

13 **(b)**

${}_{88}A^{196} \rightarrow {}_{78}B^{164}$

Number of $\alpha -$ particles $= \frac{196-164}{4} = 8$

${}_{88}A^{196} \xrightarrow{-8\alpha} {}_{72}X^{164} \rightarrow {}_{78}B^{164}$

$\therefore$ Number of $\beta -$ particles $= 78 - 72 = 6$

14 **(c)**

$\frac{hc}{\lambda} = E = eV$

$\Rightarrow \lambda = \frac{hc}{eV} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{1.6 \times 10^{-19} \times 4.9} = 2525$ Å

15 **(b)**

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

Remaining part $= N_0 - \frac{3}{4}N_0$

$= \frac{1}{4}N_0$

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

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

$n=2$

Time = Half year × Number of half year= 3×2 = 6days

16 **(a)**

The total mass of the initial particles

m_i=1.007825 +7.016004

= 8.023829 u

and the total mass of final particles

$m_f = 2 \times 4.002603$ =8.005206 u

Difference between initial and final mass of particles

$\Delta m = m_i - m_f$ = 8.023829 - 8.005206

= 0.018623 u

The Q-value is given by

$Q = (\Delta m)c^2$

= 0.018623 × 931.5 =17.35 MeV

17 **(c)**

1 week = 7 days = 7 × 24hr ≃ 14 half lives

Number of atoms left $= \frac{N_0}{(2)^{14}}$, Activity $= N\lambda$

∴ Activity left is $\frac{1}{(2)^{14}}$ times the initial

$\Rightarrow \frac{1}{(2)^{14}} \times 1 curie = \frac{1}{16384} \times$ 1 curie ≅ 61 × 10^{-6} curie

$\approx 60\mu\ curie$

18 **(a)**

Mean life $= \frac{\text{Half life}}{0.6931} = \frac{10}{0.6931} = 14.4\ hours$

19 **(a)**

If R is activity of radioactive substance after n half lives,

then $R = R_0\left(\frac{1}{2}\right)^n$

$\frac{R_0}{16} = R_0\left(\frac{1}{2}\right)^n \therefore n = 4$

$t = nT = 4 \times 100 = 400$ µs

20 **(b)**

Here $T_{1/2} = 20\ minutes$, we know $\frac{N}{N_0} = \left(\frac{1}{2}\right)^{t/T_{1/2}}$

For 20% decay $\frac{N}{N_0} = \frac{80}{100} = \left(\frac{1}{2}\right)^{t_1/20}$ ...(i)

For 80% decay $\frac{N}{N_0} = \frac{20}{100} = \left(\frac{1}{2}\right)^{t_2/20}$ ...(ii)

Dividing (ii) by (i)

$\frac{1}{4} = \left(\frac{1}{2}\right)^{\frac{(t_2-t_1)}{20}}$

On solving we get $t_2 - t_1 = 40\ min$

21 **(b)**

β −decay from nuclei is based on this process only

22 **(c)**

The binding energy of nucleus may be defined as the energy equivalent to the mass defect of the nucleus.

If Δm is mass defect than according to Einstein's mass energy relation.

Binding Energy

$= \Delta mc^2 = [\{Zm_p + (A-Z)m_n] - M]c^2$

$= (7 \times 1.00783 + 7 \times 1.00867 - 14.00307)c^2$

or BE = 0.1124 × 931.5 MeV

or BE = 104.6

23 **(a)**

Ionisation energy of $Li^{++} = 9hcR$

Ionization energy $= RchZ^2 = Rch(3)^2$ (as $Z = 3$ for Li^{++})

$= 9hcR$

24 **(b)**

$E_b + E_c > E_a$

25 **(b)**

$r = \frac{n^2}{Z}(r_0); \Rightarrow r_{(n=2)} = \frac{(2)^2}{2} \times 0.53 = 1.06$ Å

26 **(b)**

Linear momentum $= mv = 9.1 \times 10^{-31} \times 2.2 \times 10^6$

$= 2.0 \times 10^{-24} kg - m/s$

27 **(c)**

According to the quark model, it is possible to build all hadrons using 3 quarks and 3 antiquarks Mesons and baryons are collectively known as hadrons

28 **(a)**

$N = M - Z$ = Total no. of nucleons – no. of protons

30 **(a)**

Nuclear density is constant hence, mass ∝ volume

Or $m \propto V$

31 **(c)**

$_{92}U^{235}$ is normally fissionable

33 **(c)**

Out side the nucleus, neutron is unstable (life $-932\ s$)

34 **(a)**

The mass of nucleus formed is always less than the sum of the masses of the constituent protons and neutrons $i.e., m < (A-Z)m_n + Zm_p$

35 **(c)**

Binding energy per nucleon increases with atomic number. The greater the binding energy per nucleon the more stable is the nucleus

For $_{26}Fe^{56}$ number of nucleons is 56

This is most stable nucleus, since maximum energy is needed to pull a nucleon away from it

36 **(a)**

$X(n,\alpha)\,^7_3Li \Rightarrow {_Z}X^A + {_0}n^1 \to 3^{Li^7} + {_2}He^4$

$Z = 3 + 2 = 5$ and $A = 7 + 4 - 1 = 10$

$\therefore {_5}X^{10} = {_5}B^{10}$

37 **(a)**

$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n \Rightarrow \frac{1}{8} = \left(\frac{1}{2}\right)^n \Rightarrow n = 3$

Now $t = n \times T_{1/2} = 3 \times 3.8 = 11.4\ days$

38 **(c)**

Experimental measurements show that volume of a nucleus is proportional to its mass number A. If R is the radius of the nucleus assumed to be spherical, then its volume

$$\left(\frac{4}{3}\pi R^3\right) \propto A$$

or $R \propto A^{1/3}$

or $R = R_0 A^{1/3}$

where R_0 is an empirical constant whose value is found to be 1.1×10^{-15} m.

40 **(a)**

Rest energy of an electron $= m_e c^2$

Here $m_e = 9.1 \times 10^{-31} kg$ and $c =$ velocity of light

$\therefore$ Rest energy $= 9.1 \times 10^{-31} \times (3 \times 10^8)^2 joule$

$= \frac{9.1 \times 10^{-31} \times (3 \times 10^8)^2}{1.6 \times 10^{-19}} eV = 510\ keV$

41 **(a)**

In increasing order of penetrating powers, the radiations are,

$$\alpha < \beta < \gamma$$

42 **(a)**

B.E. per nucleon is maximum for Fe^{56}. For futher detail refer theory

43 **(c)**

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

$\Rightarrow \frac{1}{100} N_0 = N_0 \left(\frac{1}{2}\right)^n \Rightarrow \frac{1}{100} = \left(\frac{1}{2}\right)^n \Rightarrow n = \frac{2}{\log 2}$

$\Rightarrow \frac{t}{T} = \frac{2}{\log 2} \Rightarrow t = 6.6T\ year$

44 **(a)**

Mass number decreases by $8 \times 4 = 32$

Atomic number decreases by $8 \times 2 - 5 = 11$

45 **(a)**

Activity of $S_1 = \frac{1}{2}$ (activity of S_2)

Or $\lambda_1 N_1 = \frac{1}{2}(\lambda_2 N_2)$

Or $\frac{\lambda_1}{\lambda_2} = \frac{N_2}{2N_1}$

Or $\frac{T_1}{T_2} = \frac{2N_1}{N_2}$

Given $N_1 = 2N_2$

$\therefore \frac{T_1}{T_2} = 4$

46 **(a)**

Since electron and positron annihilate

$\lambda = \frac{hc}{E_{Total}} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{(0.51 + 0.51) \times 10^6 \times 1.6 \times 10^{-19}}$

$= 1.21 \times 10^{-12} m = 0.012$Å

47 **(b)**

Activity $= -\frac{dN}{dt} = \lambda N = \lambda N_0 e^{-\lambda t}$

$i.e.$, graph between activity and t, is exponential having negative slope

48 **(d)**

Rydberg constant $R = \frac{\varepsilon_0 n^2 h^2}{\pi m Z e^2}$

Velocity $v = \frac{Ze^2}{2\varepsilon_0 nh}$ and energy $E = -\frac{mZ^2e^4}{8\varepsilon_0^2 n^2 h^2}$

Now, it is clear from above expressions $R.v \propto n$

50 **(b)**

Nuclear forces are charge independent so,

$F_1 = F_2 = F_3$.

51 **(d)**

$r = r_0(A)^{1/3}$

$\therefore \frac{r_1}{r_2} = \left(\frac{A_1}{A_2}\right)^{1/3} = \left(\frac{64}{125}\right)^{1/3}$

$= \left[\left(\frac{4}{5}\right)^3\right]^{1/3} = \frac{4}{5}$

52 **(b)**

In a material medium, when a positron meets an electron both the particles annihilate leading to the emission of two γ-ray photons. This process forms the basis of an important diagnostic procedure called PET

53 **(a)**

For Balmer series $\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{n^2}\right)$ where $n =$ 3, 4, 5

For second line $n = 4$

So $\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{4^2}\right) = \frac{3}{16}R \Rightarrow \lambda = \frac{16}{3R}$

54 **(a)**

$m_0c^2 = 0.54\ MeV$ and K.E. $= mc^2 - m_0c^2$

Also $m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{m_0}{\sqrt{1-(0.8)^2}} = \frac{m_0}{0.6}$

$\therefore E = mc^2 = \frac{m_0}{0.6}c^2 = \frac{0.54}{0.6} = 0.9\ MeV$

$\therefore$ K.E. $= (0.9 - 0.54) = 0.36\ MeV$

55 **(b)**

In order to compare the stability of the nuclei of different atoms, binding energy per nucleon is determined. Higher the binding energy per nucleon more stable is the nucleus.

$\therefore$ BE per nucleon of deuteron $= \frac{1.125}{2}$

$= 0.5625$ MeV

BE per nucleon of alpha particle $= \frac{7.2}{4} = 1.8$ MeV

Since, binding energy per nucleon of alpha particle is more, hence it is more stable.

57 **(d)**

Here, $\frac{N_{x_1}(t)}{N_{x_2}(t)} = \frac{1}{e}$

or $\frac{N_0 e^{-10\lambda t}}{N_0 e^{-\lambda t}} = \frac{1}{e}$

(Because initially, both have the same number of nuclei, N_0).

or $e = \frac{e^{-\lambda t}}{e^{-10\lambda t}} = e^{9\lambda t}$

$9\lambda t = 1$

$t = \frac{1}{9\lambda}$

58 **(b)**

$\lambda = \frac{0.693}{T_{1/2}} = \frac{0.693}{77} = 9 \times 10^{-3}/day$

59 **(c)**

Since the ${}^{133}_{55}Cs$ has larger size among the four atoms given, thus the electrons present in the outermost orbit will be away from the nucleus and the electrostatic force experienced by electrons due to nucleus will be minimum. Therefore the energy required to liberate electron from outer will be minimum in the case of ${}^{133}_{55}Cs$

61 **(d)**

Because sound waves require medium to travel through and there is no medium (air) on moon's surface

62 **(c)**

By using $v = Rc\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$\Rightarrow v = 10^7 \times (3 \times 10^8)\left[\frac{1}{4^2} - \frac{1}{5^2}\right]$

$= 6.75 \times 10^{13} Hz$

64 **(a)**

For Bracket series $\frac{1}{\lambda_{max}} = R\left[\frac{1}{4^2} - \frac{1}{5^2}\right] = \frac{9}{25\times16}R$

and $\frac{1}{\lambda_{min}} = R\left[\frac{1}{4^2} - \frac{1}{\infty^2}\right] = \frac{R}{16} \Rightarrow \frac{\lambda_{max}}{\lambda_{min}} = \frac{25}{9}$

65 **(b)**

$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{t/T} \Rightarrow \left(\frac{1}{16}\right) = \left(\frac{1}{2}\right)^{2/T} \Rightarrow \left(\frac{1}{2}\right)^4 = \left(\frac{1}{2}\right)^{2/T}$

$\Rightarrow T = 0.5\ hour = 30\ minutes$

66 **(a)**

${}_8O^{18} + {}_1H^1 \to {}_9F^{18} + {}_0n^1$

67 **(d)**

In time $t = T$, $N = \frac{N_0}{2}$

In another half-life,(ie, after 2 half-lives)

$N = \frac{1}{2}\frac{N_0}{2} = \frac{N_0}{4} = N_0\left(\frac{1}{2}\right)^2$

After yet another half-life ,(*ie*, after 3 half-lives)

$N = \frac{1}{2}\left(\frac{N_0}{4}\right) = \frac{N_0}{8} = N_0\left(\frac{1}{2}\right)^3$ and so on. Hence, after n half-lives

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

$= N_0\left(\frac{1}{2}\right)^{t/T}$

where $t = n \times T$ = total time of n half-lives.

Here, $n = \frac{t}{T} = \frac{19}{3.8}$

$= 5$

$\therefore$ The fraction left

$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n = \left(\frac{1}{2}\right)^5 = \frac{1}{32}$

$= 0.031$

69 **(c)**

$N = N_0 e^{-\lambda t} \Rightarrow \ln\frac{N_0}{N} = \lambda t$

$t = \frac{1}{\lambda}\ln\frac{N_0}{N} \Rightarrow t = \frac{2.303 \times T_{1/2}}{0.693}\log_{10}\frac{N_0}{N}$

$\frac{N_0}{N} = 10, T_{1/2} = 10\ day \Rightarrow t = 33.23\ days$

70 **(d)**

In vector form of Coulomb's law proves that the forces $\mathbf{F}_{12}$ and $\mathbf{F}_{21}$ are equal and opposite.

or $\mathbf{F}_{21} = \mathbf{F}_{12}$

$\mathbf{F}_{pe} = \mathbf{F}_{ep}$

$\mathbf{F}'_{pe} = \mathbf{F}'_{ep}$

And $\mathbf{F}_{pe} + \mathbf{F}_{ep} = -\mathbf{F}'_{ep} + \mathbf{F}'_{pe}$

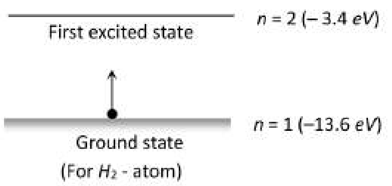
So option (d) is incorrect.

71 **(b)**

$\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] = R\left[\frac{1}{(2)^2} - \frac{1}{(4)^2}\right] \Rightarrow \lambda = \frac{16}{3R}$

73 **(c)**

Energy to excite the e^- from $n = 1$ to $n = 2$



$E = -3.4 - (-13.6) = 10.2 eV$

$= 10.2 \times 1.6 \times 10^{-19}$

$= 1.632 \times 10^{-18} J$

74 **(b)**

The mass excess per nucleon of isotopes of atom is known as packing fraction given by

$$P = \frac{M-A}{A}$$

Where M is the actual mass of isotope and A is its atomic mass.

Packing fraction is positive for isotope having very low or very high mass number and negative for all others.

75 **(d)**

$N_1 = \frac{N_{01}}{(2)^{t/20}}, N_2 = \frac{N_{02}}{(2)^{t/10}}$

$N_1 = N_2$

$\frac{40}{(2)^{t/20}} = \frac{160}{(2)^{t/10}} \Rightarrow 2^{t/20} = 2^{\left(\frac{t}{10}-2\right)}$

$\Rightarrow \frac{t}{20} = \frac{t}{10} - 2 \Rightarrow \frac{t}{20} - \frac{t}{10} = -2$

$\Rightarrow \frac{t}{20} = 2 \Rightarrow t = 40$

78 **(b)**

Conserving the momentum

$0 = \frac{M}{2} v_1 - \frac{M}{2} v_2$

$v_1 = v_2$ ...(i)

$\Delta mc^2 = \frac{1}{2} \cdot \frac{M}{2} v_1^2 + \frac{1}{2} \cdot \frac{M}{2} v_2^2$ ...(ii)

$\Delta mc^2 = \frac{M}{2} v_1^2$

$\frac{2\Delta mc^2}{M} = v_1^2$

$v_1 = c\sqrt{\frac{2\Delta m}{M}}$

79 **(a)**

The proton is the most stable in the Baryon group

80 **(a)**

Activity of substance that has 2000 disintegrations/sec

$= \frac{2000}{3.7 \times 10^{10}} = 0.054 \times 10^{-6} ci = 0.054\ \mu ci$

The number of radioactive nuclei having activity A

$N = \frac{A}{\lambda} = \frac{2000 \times T_{1/2}}{\log_e 2}$

$= \frac{2000 \times 138.6 \times 24 \times 3600}{0.693} = 3.45 \times 10^{10}$

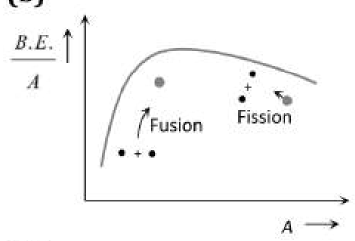
81 **(c)**

$N = N_0 \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}} \Rightarrow \frac{N}{N_0} = \left(\frac{1}{2}\right)^{\frac{30}{10}} = \frac{1}{8} = 0.125$

82 **(d)**

${}_4Be^9 + {}_2He^4 \rightarrow {}_6C^{12} + {}_0n^1$

83 **(b)**



84 **(b)**

Bohr postulated that the angular momentum of the electron is conserved

85 **(d)**

After emitting β-particle $({}_{-1}e^0)$ mass of nucleus doesn't change

86 **(c)**

In nuclear fission, neutrons are released

87 **(a)**

In Lyman series $(\lambda_{\min})_L = \frac{1}{R}$ and $(\lambda_{\min})_B = \frac{4}{R}$

$\Rightarrow (\lambda_{\min})_B = 4 \times (\lambda_{\min})_L = 4 \times 912 = 3648$ Å

88 **(c)**

$\Delta E = mc^2 - m_0c^2 = \frac{m_0c^2}{\sqrt{1-(v^2/c^2)}} - m_0c^2$

$= m_0c^2\left(\frac{1}{\sqrt{1-(v^2/c^2)}} - 1\right) = 0.511\left(\frac{1}{\sqrt{0.75}} - 1\right)$

$= 0.079\ MeV$

89 **(a)**

In fission process, when a parent nucleus breaks into daughter products, then some mass is lost in the form of energy. Thus, mass of fission products < mass of parent nucleus

$\Rightarrow \frac{\text{Mass of fission products}}{\text{Mass of parent nucleus}} < 1$

90 **(c)**

$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}} \Rightarrow \frac{1}{4} = \left(\frac{1}{2}\right)^{\frac{t}{10}}$

$\Rightarrow \frac{t}{10} = 2 \Rightarrow t = 20$

91 **(d)**

Suppose closest distance is r, according to conservation of energy

$400 \times 10^3 \times 1.6 \times 10^{-19} = 9 \times 10^9 \frac{(ze)(2e)}{r}$

$\Rightarrow 6.4 \times 10^{-14}$

$$= \frac{9 \times 10^9 \times (82 \times 1.6 \times 10^{-19}) \times (2 \times 1.6 \times 10^{-19})}{r}$$

$\Rightarrow r = 5.9 \times 10^{-13} m = 0.59\ pm$

93 **(a)**

$$\frac{R_1}{R_2} = \left(\frac{A_1}{A_2}\right)^{1/3} = \left(\frac{27}{125}\right)^{1/3} = \frac{3}{5} = 6:10$$

94 **(a)**

$$N = \frac{N_0}{2^n} = \frac{N_0}{2^{1/2}} = \frac{N_0}{\sqrt{2}}$$

95 **(d)**

$$_{48}Cd^{115} \xrightarrow{2(_{-1}\beta^0)} {}_{50}Sn^{115}$$

96 **(b)**

In positive beta decay a proton is transformed into a neutron and a positron is emitted.

$$p^+ \to n^0 + e^+$$

Number of neutrons initially was $A - Z$.
Number of neutrons after decay $(A - Z) - 3 \times 2$(due to alpha particles) $+ 2 \times 1$(due to positive beta decay).
The number of protons will reduce by 8 [as 3×2 (due to alpha particles) + 2(due to positive beta decay)].
Hence, atomic number reduces by 8.
So, the ratio number of neutrons to that of protons

$$= \frac{A-Z-4}{Z-8}$$

97 **(a)**

The activity or decay rate R of radioactive substance is the number of decays per second.

$\therefore \quad R = \lambda N$

or $\quad R = \lambda N_0 \left(\frac{1}{2}\right)^{t/T_{1/2}}$

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

where $R_0 = \lambda N_0$ is the activity of radioactive substance at time $t = 0$.

According to question,

$$\frac{R}{R_0} = 1 - \frac{75}{100} = 25\%$$

$\therefore \quad \frac{25}{100} = \left(\frac{1}{2}\right)^{t/T_{1/2}}$

or $\quad \left(\frac{1}{2}\right)^2 = \left(\frac{1}{2}\right)^{t/T_{1/2}}$

or $\quad \frac{t}{T_{1/2}} = 2$

$\therefore \quad t = 2T_{1/2} = 2 \times 3.20 = 6.40\ h$

or $\quad t \approx 6.38$ h

98 **(b)**

In the spectral series of the hydrogen atom, Lyman series is in the ultraviolet region, Balmer series is in the visible region, paschen, Brackett and pfund are in the infrared region of the electromagnetic spectrum

99 **(d)**

$${}^9_4Be + {}^4_2He \to {}^{12}_6C + {}^1_0x$$

Clearly, it is a neutron

100 **(a)**

Let initial activity of both substances are same.

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

$$\therefore \quad \frac{R_1}{R_2} = \frac{\left(\frac{1}{2}\right)^{4/1}}{\left(\frac{1}{2}\right)^{4/2}} = \frac{\left(\frac{1}{2}\right)^4}{\left(\frac{1}{2}\right)^2} = \left(\frac{1}{2}\right)^2$$

$$\Rightarrow \quad \frac{R_1}{R_2} = \frac{1}{4}$$

101 **(b)**

By using $R = R_0 A^{1/3} \Rightarrow \frac{R_1}{R_2} = \left(\frac{A_1}{A_2}\right)^{1/3}$

$\Rightarrow \frac{R}{R_{He}} = \left(\frac{A}{4}\right)^{1/3} \Rightarrow (14)^{1/3} = \left(\frac{A}{4}\right)^{1/3}$

$\Rightarrow A = 56$ so $Z = 56 - 30 = 26$

102 **(d)**

Extremely high temperature needed for fusion make KE large enough to overcome repulsion between nuclei.

103 **(c)**

Number of lines in absorption spectrum $= (n - 1)$

$\Rightarrow 5 = n - 1 \Rightarrow n = 6$

$\therefore$ Number of bright lines in the emission spectrum

$$= \frac{n(n-1)}{2} = \frac{6(6-1)}{2} = 15$$

104 **(c)**

From conservation of momentum

$$4v = (A - 4)v_1$$

$$v_1 = \left(\frac{4v}{A-4}\right)$$

105 **(d)**

Number of α –particles emitted $= \frac{238-222}{4} = 4$

This decreases atomic number to $90 - 4 \times 2 = 82$

Since atomic number of $_{83}Y^{222}$ is 83, this is possible of one β –particle is emitted

106 **(a)**

$$_{92}X^{235} \xrightarrow{\alpha} {}_{90}X^{231} \xrightarrow{_{-1}e^0} {}_{91}Y^{231}$$

107 **(b)**

By using $N = N_0 e^{-\lambda t}$ and $t = \tau = \frac{1}{\lambda}$

Substance remains $= N = \frac{N_0}{e} = 0.37N_0 \simeq \frac{N_0}{3}$

$\therefore$ Substance disintegrated $= N_0 - \frac{N_0}{3} = \frac{2N_0}{3}$

108 **(c)**

After t second fractional amount of X left is $\frac{1}{16}$ or $\left(\frac{1}{2}\right)^4$

$\therefore t = 4 \times T_{1/2} = 4 \times 50 = 200\ years$

109 **(d)**

$_{72}A^{100} \xrightarrow{-\alpha} {}_{70}A_1^{176} \xrightarrow{-\beta} {}_{71}A_2^{176} \xrightarrow{-\alpha}$
$_{69}A_3^{172} \xrightarrow{\gamma} {}_{69}A_4^{172}$

110 **(c)**

Charge density is uniform inside and then falls rapidly near the surface of the nucleus

111 **(a)**

Number of protons $= 2 + 2 + 6 + 2 + 6 = 18$

Number of neutrons $= 40 - 18 = 22$

112 **(d)**

By using $N = N_0 e^{-\lambda t}$ and $\frac{dN}{dt} = -\lambda N$

It shows that N decreases exponentially with time

113 **(c)**

In critical condition, k=1. The chain reaction will be steady. The size of the fissionable material used is said to be critical size and its mas the critical mass.

114 **(c)**

Radius of n^{th} orbit for any hydrogen like atom

$r_n = r_0\left(\frac{n^2}{Z}\right)$ (r_0 = radius of first orbit of H_2-atom)

If $r_n = r_0 \Rightarrow n = \sqrt{2}$. For $Be^{+++}, Z = 4 \Rightarrow n = 2$

116 **(a)**

For $n = 1$, maximum number of states $= 2n^2 = 2$ and for $n = 2, 3, 4$, maximum number of states would be 8, 18, 32 respectively, Hence number of possible elements

$= 2 + 8 + 18 + 32 = 60$

117 **(b)**

After one α- emission, the daughter Nucleus reduces in mass number by 4 unit and in atomic number by 2 unit. In β- emission the atomic number of daughter nucleus increases by 1 unit. The reaction can be written as

$_{92}\text{U}^{238} \xrightarrow{-8\alpha} {}_{76}X^{206} \xrightarrow{-6\beta} {}_{82}Y^{206}$

Thus, the resulting nucleus is $_{82}Y^{206}$ie, $_{82}\text{Pb}^{206}$.

119 **(d)**

In the given case, 12 days = 3 half lives Number of atoms left after 3 half live

$= 6.4 \times 10^{10} \times \frac{1}{2^3} = 0.8 \times 10^{10}$

120 **(d)**

Radioactive decay does not depend upon the time of creation.

121 **(a)**

$$\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] \Rightarrow \frac{\lambda_{\min}}{\lambda_{\max}} = \frac{\left[\frac{1}{2^2} - \frac{1}{3^2}\right]}{\left[\frac{1}{2^2} - \frac{1}{\infty}\right]} = \frac{5}{9}$$

122 **(c)**

Average life $\frac{1}{\lambda} = \frac{1600}{0.693} = 2308 \approx 2319\ years$

123 **(d)**

$\lambda_{IR} > \lambda_{UV}$ also wavelength of emitted radiation

$\lambda \propto \frac{1}{\Delta E}$

124 **(b)**

$$A = A_0\left(\frac{1}{2}\right)^{t/T_{1/2}} \Rightarrow 5 = A_0\left(\frac{1}{2}\right)^{\frac{2\times 60}{30}} = \frac{A_0}{16} \Rightarrow A_0 = 80s^{-1}$$

125 **(d)**

In Raman effect, Stoke's lines are spectral lines having lower frequency or wavelength greater than that of the original line

126 **(b)**

Number of atoms undecayed $N = N_0 e^{-\lambda t}$

Number of atoms decayed $= N_0 - N = N_0(1 - e^{-\lambda t})$

$\Rightarrow$ Decyaed fraction $f = \frac{N_0 - N}{N_0} = 1 - e^{-\lambda t}$

i.e., fraction will rise up to 1, following exponential path as shown in graph (B)

128 **(a)**

For Lyman series

$$v_{\text{Lyman}} = \frac{c}{\lambda_{\max}} = RO\left[\frac{1}{(1)^2} - \frac{1}{(2)^2}\right] = \frac{3RC}{4}$$

For Balmer series

$$v_{\text{Balmer}} = \frac{c}{\lambda_{\max}} = RO\left[\frac{1}{(2)^2} - \frac{1}{(3)^2}\right] = \frac{5RC}{36}$$

$$\therefore \frac{v_{\text{Lyman}}}{v_{\text{Balmer}}} = \frac{27}{5}$$

129 **(c)**

$$E = \frac{(\text{momentum})^2}{2M} = \frac{\left(\frac{hv}{c}\right)^2}{2M}$$

130 **(c)**

As the γ –particle has no charge and mass

131 **(b)**

Nuclear fusion takes place in stars which results in joining of nuclei accompanied by release of tremendous amount of energy

132 **(c)**

When there is an excess of protons in the nucleus and it is not energetically possible to emit an α – particle, β^+ decay occurs.

Resulting in reducing atomic numbers by 1. New atomic number = $Z - 1$, mass number= A.

Gamma ray emission occurs with β^+ emission. Since, gamma rays have no charge or mass their emission does not change the chemical composition of the atom.

Hence atomic number= $Z-1$,

mass number $= A$

133 **(b)**

In negative β-decay a neutron in the nucleus is transformed into a proton, an electron and an antineutrino. Hence, in radioactivity decay process, the negatively charged emitted β-particles are the electrons produced as a result of the decay of neutrons present inside the nucleus.

134 **(b)**

According to Kepler's 3rd law.

$T^2 \propto r^3$

$\therefore \frac{T_1}{T_2} = \left(\frac{r_1}{r_2}\right)^{3/2} = 8$

$\frac{r_1}{r_2} = 8^{2/3} = 4$

According to Bohr atom model, $r \propto n^2$

$\therefore \frac{n_1^2}{n_2^2} = \frac{r_1}{r_2} = 4; \frac{n_1}{n_2} = 2$

If $n_1 = 2$, then $n_2 = 1$

135 **(d)**

Speed of electron in n^{th} orbit (in CGS) $v_n = \frac{2\pi Ze^2}{nh}(k=1)$

For first orbit of $H_1; n = 1$ and $Z = 1$

So $v = \frac{2\pi e^2}{h} \Rightarrow \frac{v}{c} = \frac{2\pi e^2}{hc}$

136 **(d)**

Impact parameter $b \propto \cot\frac{\theta}{2}$

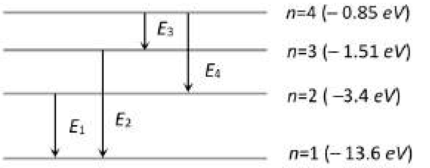
Here $b = 0$, hence $\theta = 180°$

137 **(c)**

When uranium is bombarded by neutrons, each uranium nucleus is broken into nearly equal fragments and along with it huge energy and two or three fresh neutrons are liberated. Under favourable conditions these neutrons fission other uranium nuclei in the same way. Thus, a chain of nuclear fission is established which continues till the whole of uranium is consumed.

138 **(b)**

From diagram



$E_1 = -13.6 - (-3.4) = -10.2eV$

$E_2 = -13.6 - (-1.51) = -12.09eV$

$E_3 = -1.51 - (-0.85) = -0.66eV$

$E_4 = -3.4 - (-0.85) = (-2.55)eV$

E_3 is least, *i.e.*, frequency is lowest

139 **(d)**

Lyman series lies in the UV region

140 **(a)**

Mass of Uranium nucleus = mass of proton + mass of neutron.

$= 92 \times 1.6725 \times 10^{-27} + 143 \times 1.6747 \times 10^{-27})$

$= (153.87 \times 10^{-27} + 239.48 \times 10^{-27})$

$= 3.93.35 \times 10^{-27}$ Kg

since, radius of nucleus is of the order of 10^{-15} m, hence, volume is

$V \propto (10^{-15})^3 \text{ m}^3 \propto 10^{-45} \text{ m}^3$

$\therefore \text{Density} = \frac{\text{mass}}{\text{volume}} = \frac{393.35 \times 10^{-27}}{10^{-45}} = 10^{20} \text{ kgm}^{-3}$

141 **(a)**

From Rutherford-Soddy law

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

$n = \frac{38}{3.8} = 10$

The initial quantity of radon $N_0 = 1024\, mg$.

Therefore, the mass of radon left after 10 half-lives is

$N = 1024 \times \left(\frac{1}{2}\right)^{10} = \frac{1024}{1024} = 1\text{mg}.$

142 **(b)**

$N = N_0 e^{-\lambda t}$

$N = ne^{-\lambda t}$

The number of decay between 0 and t $N_0 - N$

$= n - ne^{-\lambda t} = n(1 - e^{-\lambda t}) = n(1 - e^{-t/T})$

143 **(c)**

The nuclear reactions is as follows

${}_7N^{14} + {}_2He^4 \rightarrow {}_8O^{17} + {}_qX^p$

Conservation of mass number gives

$P = 14 + 4 - 17 = 1$

Conservation of atomic number gives

$a = 7 + 2 - 8 = 1$

Hence, particle is a proton ${}_1H^1$.

144 **(b)**

${}_1H^2 + {}_1H^2 \rightarrow {}_2He^4 + Q$

145 **(a)**

For isotopes Z is same and A is different.
Therefore the number of neutrons $A - Z$ will also be different

148 **(b)**

Power $= \frac{\text{energy}}{\text{time}} = 300 \times 10^6$ watt

$= 3 \times 10^8$ J/s

170 MeV $= 170 \times 10^6 \times 1.6 \times 10^{-19}$

$= 27.2 \times 10^{-12}$ J

Number of atoms fissioned per second

$= \frac{3 \times 10^8}{27.2 \times 10^{-12}}$

$= \frac{3 \times 10^{20}}{27.2}$

Number of atoms fissioned per hour

$= \frac{3 \times 10^{20} \times 3600}{27.2}$

$= \frac{3 \times 36}{27.2} \times 10^{22} = 4 \times 10^{22}$ m

149 **(a)**

K.E. = − (T.E.)

150 **(c)**

'Rad' is used to measure biological effect of radiation.

152 **(a)**

$$\frac{1}{\lambda_{\text{Balmer}}} = R\left[\frac{1}{2^2} - \frac{1}{3^2}\right] = \frac{5R}{36}, \frac{1}{\lambda_{\text{Lyman}}} = R\left[\frac{1}{1^2} - \frac{1}{2^2}\right] = \frac{3R}{4}$$

$$\therefore \lambda_{\text{Lyman}} = \lambda_{\text{Balmer}} \times \frac{5}{27} = 1215.4 \text{ Å}$$

154 **(a)**

$$N = N_0 \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}} = N_0 \left(\frac{1}{2}\right)^{\frac{15}{5}} = \frac{N_0}{8}$$

155 **(b)**

Half life of neutron $T_{1/2} = 12$ min

Mean life $= T_{1/2} + 44\%\ of\ T_{1/2}$

≈ 17 min ≈ 1000sec

156 **(a)**

A and C are isotopes as their charge number is same

158 **(c)**

Energy in excited state $= -13.6 + 12.1 = -1.5$ eV

$$\therefore \frac{-13.6}{n^2} = -1.5$$

$$\therefore n = \sqrt{\frac{13.6}{1.5}} = 3$$

Number of spectral lines

$$= \frac{n(n-1)}{2} = \frac{3(3-1)}{2} = 3$$

159 **(b)**

Heavy water is used in certain type of nuclear where it acts as a neutron moderator to slow down neutrons so that they can react with uranium in the reactor.

160 **(b)**

$N = N_0 e^{-\lambda t}$

Variation of N is exponential

161 **(b)**

Here $\frac{N}{N_0} = \left(\frac{1}{2}\right)^n = \left(\frac{1}{2}\right)^{1/3}$

Where n = Number of half lives $= \frac{1}{3}$

$$\Rightarrow \frac{N}{N_0} = \frac{1}{1.26} \Rightarrow \frac{N_U}{N_{Pb} + N_U} = \frac{1}{1.26}$$

$$\Rightarrow N_{Pb} = 0.26\, N_U \Rightarrow \frac{N_{Pb}}{N_U} = 0.26$$

163 **(a)**

According to Rydberg's formula

$$\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

Here, $n_f = 1, n_i = n$

$$\therefore \frac{1}{\lambda} = R\left(\frac{1}{1^2} - \frac{1}{n^2}\right) \Rightarrow \frac{1}{\lambda} = R\left(1 - \frac{1}{n^2}\right) \quad \text{... (i)}$$

Multiplying equation (i) by λ on both sides,

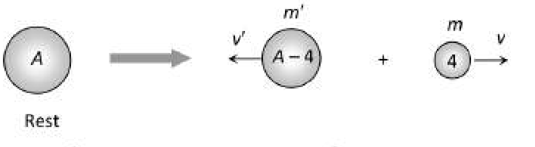
$$1 = \lambda R\left(1 - \frac{1}{n^2}\right) \Rightarrow \frac{1}{\lambda R} = 1 - \frac{1}{n^2}$$

$$\Rightarrow \frac{1}{n^2} = 1 - \frac{1}{\lambda R} \Rightarrow \frac{1}{n^2} = \frac{\lambda R - 1}{\lambda R} \Rightarrow n = \sqrt{\frac{\lambda R}{\lambda R - 1}}$$

164 **(c)**

Energy of stars is due to the fusion of light hydrogen nuclei into He. In this process much energy is released

165 **(a)**



According to conservation of momentum $4v = (A-4)v'$

$$\Rightarrow v' = \frac{4v}{A-4}$$

167 **(c)**

For third line of Balmer series $n_1 = 2, n_2 = 5$

$\therefore \frac{1}{\lambda} = RZ^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$ gives $Z^2 = \frac{n_1^2 n_2^2}{(n_2^2 - n_1^2)\lambda R}$

On putting values $Z = 2$

From $E = -\frac{13.6Z^2}{n^2} = \frac{-13.6(2)^2}{(1)^2} = -54.4eV$

168 **(d)**

Using conservation of momentum $P_{daughter} = P_\alpha$

$$\Rightarrow \frac{E_d}{E_\alpha} = \frac{m_\alpha}{m_d} \Rightarrow E_d = \frac{E_\alpha \times m_\alpha}{m_d} = \frac{6.7 \times 4}{214}$$

$$= 0.125 MeV$$

169 **(d)**

$B.E.$ per nucleon $\propto$ stability

170 **(a)**

According to Bohr theory, $mvr = n\frac{h}{2\pi} \Rightarrow v = \frac{nh}{2\pi mr}$

and $\frac{mv^2}{r} \propto \frac{k}{r} \Rightarrow \frac{m}{r}\left(\frac{n^2h^2}{4\pi^2m^2r^2}\right) \propto \frac{k}{r} \Rightarrow r_n \propto n$

Kinetic energy $T = \frac{1}{2}mv^2 = \frac{1}{2}m\left(\frac{n^2h^2}{4\pi^2m^2r^2}\right) \Rightarrow T_n \propto \frac{n^2}{r^2}$

But as $r \propto n$ therefore $T \propto n^0$

171 **(a)**

For Lyman series $v = RC\left[\frac{1}{1^2} - \frac{1}{n^2}\right]$

Where $n = 2, 3, 4, \dots \dots$

For the series limit of Lyman series $n = \infty$

$\therefore v_1 = RC\left[\frac{1}{1^2} - \frac{1}{\infty^2}\right] = RC$ ...(i)

For the first line of Lyman series, $n = 2$

$\therefore v_2 = RC\left[\frac{1}{1^2} - \frac{1}{2^2}\right] = \frac{3}{4}RC$ ...(ii)

For Balmer series $v = RC\left(\frac{1}{2^2} - \frac{1}{n^2}\right)$

Where $n = 3, 4, 5 \dots$

For the series limit of Balmer series $n = \infty$

$\therefore v_3 = RC\left[\frac{1}{2^2} - \frac{1}{\infty^2}\right] = \frac{RC}{4}$ ...(iii)

From equations (i), (ii) and (iii), we get

$v_1 = v_2 + v_3 \Rightarrow v_1 - v_2 = v_3$

172 **(b)**

Positron is the antiparticle of electron

173 **(d)**

Nuclides with same atomic number Z but different mass number A are known as isotopes

Nuclides with same mass number A but different atomic number Z are known as isobars

Nuclides with same neutron number $N = (A - Z)$ but different atomic number Z are known as isotones

${}_1H^2$ and ${}_1H^3$ are isotopes

${}_2He^3$ and ${}_1H^3$ are isobars

${}_{79}Au^{197}$ and ${}_{80}Hg^{198}$ are isotones

174 **(b)**

$${}_6C^{12} + {}_0n^1 \rightarrow {}_7N^{13} + {}_{-1}e^0 + \bar{v}$$

(Neutron) (Beta particle) (Anti neutrino)

On equating atomic numbers and atomic masses, the atomic number and atomic mass for resulting nucleus is 7 and 13, which is for nitrogen nucleus.

175 **(d)**

$$E = \Delta mc^2 \Rightarrow E = \frac{0.3}{1000} \times (3 \times 10^8)^2$$

$$= 2.7 \times 10^{13} J$$

$$= \frac{2.7 \times 10^{13}}{3.6 \times 10^6} = 7.5 \times 10^6 kWh$$

176 **(d)**

The number force is charge independent

No. of nucleons = No. of protons + no. of neutrons = Mass number

All nuclei have masses that are less than the sum of the masses of its constituents. The difference in mass of a nucleus and its constituents is known as mass defect.

Nucleons belong to the family of hadrons while electrons belong to family of leptons

178 **(a)**

Given $N_0\lambda = 5000, N\lambda = 1250$

$$N = N_0 e^{-\lambda t} = N_0 e^{-5\lambda}$$

Where λ is decay constant per min.

$$N\lambda = N_0 \lambda e^{-5\lambda}$$

$$1250 = N_0 \lambda e^{-5\lambda}$$

$$\therefore \quad e^{-5\lambda} = \frac{5000}{1250} = 4$$

$$e^{5\lambda} = 4$$

$$5\lambda = 2 \log_e 2$$

$$\lambda = 0.4 \ln 2$$

179 **(d)**

β-emission takes place from a radioactive nucleus as

$${}^{32}_{15}P \xrightarrow{-\beta} {}^{32}_{16}S + {}_{-1}e^0 + \bar{v}_1$$

Where $\bar{v}$ is the anti-neutrino.

In β^+ decay a positron is emitted as

$${}^{22}_{11}Na \rightarrow {}^{22}_{10}Ne + {}_{-1}e^0 + v$$

180 **(a)**

Excitation energy $\Delta E = E_2 - E_1 = 13.6\, Z^2 \left[\frac{1}{1^2} - \frac{1}{2^2}\right]$

$$\Rightarrow 40.8 = 13.6 \times \frac{3}{4} \times Z^2 \Rightarrow Z = 2$$

Now required energy to remove the electron from ground state $= \frac{+13.6Z^2}{(1)^2} = 13.6(Z)^2 = 54.4\, eV$

181 **(b)**

$F = kq_1\, q_2/r^2, i.e.,$

$$F = \frac{9 \times 10^9 \times 1.6 \times 10^{-19} \times 1.6 \times 10^{-19}}{(2.5 \times 10^{-11})^2}$$
$$= 3.7 \times 10^{-7} N$$

184 **(d)**

Helium atom has 2 electrons. When one electron is removed, the remaining atom is hydrogen like atom, whose energy in first orbit is

$$E_1 = -(2)^2(13.6 \text{ eV}) = -54.4 \text{ eV}$$

Therefore, to remove the second electron from the atom, the additional energy of 54.4 eV is required. Hence, total energy required to remove both the electrons = 24.6 + 54.4 = 79.0 eV

185 **(a)**

This is due to mass defect because a part of mass is used in keeping the neutrons and protons bound as α −particle

186 **(a)**

From Rutherford-Soddy law

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

$$n = \frac{t}{T}$$

$$\therefore 10^6 = 1.414 \times 10^6 \left(\frac{1}{2}\right)^{t/T}$$

$$\Rightarrow \frac{1000}{1414} = \left(\frac{1}{2}\right)^{t/T}$$

$$\Rightarrow \left(\frac{1}{2}\right)^2 = \left(\frac{10}{12}\right)^2 \quad \text{(Approximately)}$$

$$\Rightarrow n = 2$$

$$\Rightarrow n = \frac{t}{T} = 2$$

$$\Rightarrow T = \frac{10}{2} = 5 \text{ min}$$

187 **(d)**

$$E = \Delta mc^2 = 1 \times (3 \times 10^8)^2 = 9 \times 10^{16} J$$

$$\Rightarrow E = \frac{9 \times 10^{16}}{1.6 \times 10^{-19}} = 5.625 \times 10^{35} eV$$
$$= 5.625 \times 10^{29} MeV$$

189 **(c)**

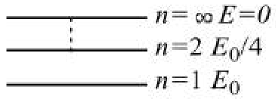
$${}_{85}X^{297} \rightarrow {}_{77}Y^{281} + 4({}_2He^4)$$

190 **(d)**

Minimum wavelength is for highest energy

$n = 1 \rightarrow n = \infty$, energy $= E_0$

$n = 2 \rightarrow n = \infty$, energy $= E_0/4$



∴ Balmer line has 4 times the wavelength

∴ Ratio of minimum wavelength is 1/4 = 0.25

192 **(d)**

Activity reduces from 6000dps to 3000dps in 140 days. It implies that half-life of the radioactive sample is 140 days. In 280 days (or two half-lives)activity will remain $\frac{1}{4}$ th of the initial activity . Hence the initial activity of the sample is

4×6000 dps = 24000 dps

193 **(b)**

The working of hydrogen bomb is based upon nuclear fusion.

195 **(a)**

(i) ${}_{16}S^{32} + {}_0n^1 \rightarrow {}_{15}p^{32} + {}_1H^1$

(ii) ${}_9F^{19} + {}_1H^1 \rightarrow {}_2He^4 + {}_8O^{16}$

(iii) ${}_7N^{14} + {}_0n^1 \rightarrow {}_6C^{14} + {}_1H^1$

196 **(b)**

Number of atoms remains undecayed $N = N_0 e^{-\lambda t}$

Number of atoms decayed $= N_0(1 - e^{-\lambda t})$

$= N_0\left(1 - e^{-\lambda \times \frac{1}{\lambda}}\right) = N_0\left(1 - \frac{1}{e}\right) = 0.63\, N_0 = 63\%$ of N_0

197 **(d)**

By using $A = A_0\left(\frac{1}{2}\right)^{\frac{1}{T_{1/2}}} \Rightarrow \frac{A}{A_0} = \left(\frac{1}{2}\right)^{9/3} = \frac{1}{8}$

199 **(d)**

Decrease in mass number = 4

Decreases in charge number = 2 − 1 = 1

200 **(c)**

$T \propto n^3$

201 **(c)**

$$N = N_0 e^{-\lambda t} \Rightarrow \frac{dN}{dt} = -N_0 \lambda e^{-\lambda t}$$

i.e., Rate of decay $\left(\frac{dN}{dt}\right)$ varies exponentially with time (t)

202 **(b)**

$${}_ZX^A \xrightarrow{\alpha} {}_{Z-2}X^{A-4}$$

203 **(c)**

New mass number $A' = A - 4n_\alpha = 232 - 4 \times 6 = 208$

Atomic number $Z' = Z + n_\beta - 2n_\alpha = 90 + 4 - 2 \times 6 = 82$

204 **(d)**

$$E_{n_1 \rightarrow n_2} = -13.6\left[\frac{1}{n_2^2} - \frac{1}{n_1^2}\right]; n_1 = 2\ \&\ n_2 = 1$$

$$\Rightarrow E_{II} \rightarrow E_I = -13.6 \times \frac{3}{4} = -10.2\ eV$$

205 **(c)**

James Chadwick discovered the neutron

206 **(c)**

Let number of α particles decayed be x and number of β particles decayed be$y$.

Then equation for the decay is given by

${}_{92}U^{235} \rightarrow x\alpha_2^4 + y\beta_{-1}^0 + Pb_{82}^{203}$

Equating the mass number on both sides

$$235 = 4x + 203 \quad ...(i)$$

Equating atomic number on both sides

$$92 = 2x - y + 82 \quad ...(ii)$$

Solving Equ.(i) and(ii), we get

$$x = 8, y = 6$$

∴ 8α particles and 6β particles are emitted in disintegration.

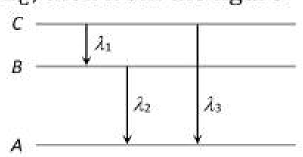
209 **(d)**

$E = -Z^2 \times 13.6\, eV = -9 \times 13.6\, eV = -122.4\, eV$

So ionization energy $= +122.4\, eV$

210 **(b)**

Let the energy in A, B and C states be $E_A . E_B$ and E_C, then from the figure



$(E_C - E_B) + (E_B - E_A) = (E_C - E_A)$ or $\frac{hc}{\lambda_1} + \frac{hc}{\lambda_2} = \frac{hc}{\lambda_3}$

$\Rightarrow \lambda_3 = \dfrac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$

211 **(d)**

$E_n = -13.6 \frac{Z^2}{n^2} eV$. Required energy for said transition

$\Delta E = E_3 - E_1 = 13.6\, Z^2 \left[\dfrac{1}{1^2} - \dfrac{1}{3^2}\right]$

$\Rightarrow \Delta E = 13.6 \times 3^2 \left[\dfrac{8}{9}\right] = 108.8\, eV$

$\Rightarrow \Delta E = 108.8 \times 1.6 \times 10^{-19} J$

Now $\Delta E = \frac{hc}{\lambda} = 108.8 \times 1.6 \times 10^{-19}$

$\Rightarrow \lambda = \dfrac{6.6 \times 10^{-34} \times 3 \times 10^8}{108.8 \times 1.6 \times 10^{-19}}$

$= 0.11374 \times 10^{-7} m = 113.74$Å

212 **(d)**

For Lyman series $\frac{1}{\lambda_{max}} = R\left[\frac{1}{1^2} - \frac{1}{2^2}\right] = \frac{3}{4} R$ and

$\dfrac{1}{\lambda_{min}} = R\left[\dfrac{1}{1^2} - \dfrac{1}{\infty^2}\right] = \dfrac{R}{1} \Rightarrow \dfrac{\lambda_{max}}{\lambda_{min}} = \dfrac{4}{3}$

213 **(a)**

R_0 = Initial activity = 1 micro curie = $3.7 \times 10^4 d\,ps$

r = Activity in 1 cm^3 of blood at $t = 5\, hr$

$= \dfrac{296}{60} dps = 4.93 dps$

R = Activity of whole blood at time $t = 5\, hr$

Total volume should be $V = \frac{R}{r} = \frac{R_0 e^{-\lambda t}}{r}$

$= \dfrac{3.7 \times 10^4 \times 0.7927}{4.93} = 5.94 \times 10^3 cm^3$

$= 5.94\, litre$

214 **(b)**

${}_Z^AX + {}_0^1n \rightarrow {}_3^7Li + {}_2^4He$

It implies that $A + 1 = 7 + 4$

$\Rightarrow \quad A = 10$

and $\quad Z + 0 = 3 + 2$

$\Rightarrow \quad Z = 5$

Thus, it is boron ${}_5^{10}B$.

215 **(c)**

The equation is $O^{17} \rightarrow_0 n^1 + O^{16}$

∴ Energy required = B.E. of O^{17} − B.E. of O^{16}

$= 17 \times 7.75 - 16 \times 7.97 = 4.23\, MeV$

216 **(a)**

Let α-particles emitted are x and β − particles emitted are y

${}_{90}Th^{232} \rightarrow {}_{82}Pb^{208} + x\, {}_2He^4 + y\, {}_{-1}e^0$

On comparing atomic number

$$90 = 82 + 2x - y$$

or $\quad 2x - y = 8 \quad$ ...(i)

On comparing mass number

$$232 = 208 + 4x$$

or $\quad x = 6$

Putting the value of x in Eq.(i), we get

$$y = 4$$

217 **(d)**

Half life of a substance doesn't depends upon amount, temperature and pressure. It depends upon the nature of the substance

218 **(a)**

By using $n_\alpha = \frac{A - A'}{4}$ and $n_\beta = 2n_\alpha - Z + Z'$

220 **(b)**

Let there be xα-particles and yβ- particles

${}_ZX^4 \rightarrow x He_2^4 + y\beta_{-1}^0 + Y_{Z-3}^{A-8}$

Then equating the mass numbers

$$A = 4x + A - 8 \quad ...(i)$$

and Equating atomic number

$$Z = 2x - y + Z - 3 \quad ...(ii)$$

Solving Eqs.(i) and (ii),we get

x=2 and y=1

∴The number of α and β particles emitted are 2 and 1 respectively.

221 **(a)**

${}_{92}U^{239} \longrightarrow {}_{94}Pu^{239} + 2({}_{-1}e^{0})$

222 **(b)**

$A = A_0 e^{-\lambda t} \Rightarrow 975 = 9750\, e^{-\lambda \times 5} \Rightarrow e^{5\lambda} = 10$

$\Rightarrow 5\lambda = \log_e 10 = 2.3026 \log_{10} 10 = 2.3026$

$\Rightarrow \lambda = 0.461$

223 **(d)**

Let radius of $^9_4$Be nucleus be r. Then radius of germanium (Ge) nucleus will be $2r$.

Radius of nucleus is given by

$$R = R_0 A^{1/3}$$

$$\therefore \quad \frac{R_1}{R_2} = \left(\frac{A_1}{A_2}\right)^{1/3}$$

$$\Rightarrow \quad \frac{r}{2r} = \left(\frac{9}{A^2}\right)^{1/3} \qquad (\because A_1 = 9)$$

$$\Rightarrow \left(\frac{1}{2}\right)^3 = \frac{9}{A^2}$$

Hence, $A_2 = 9 \times (2)^3 = 9 \times 8 = 72$

Thus, in germanium (Ge) nucleus number of nucleons is 72.

224 **(c)**

$A = A_0 e^{-\lambda t} = A_0 e^{-t/\tau}$; where τ = mean life

So $A_1 = A_0 e^{-t_1/T}$

$$\Rightarrow A_0 = \frac{A_1}{e^{-t_1/T}} = A_1 e^{t_1/T}$$

$$\therefore A_2 = A_0 e^{-t/T} = \left(A_1 e^{t_1/T}\right) e^{-t_2/T}$$

$$\Rightarrow A_2 = A_1 e^{(t_1 - t_2)/T}$$

225 **(a)**

According to kinetic interpretation of temperature

$$K.E. = \left(\frac{1}{2}mv^2\right) = \frac{3}{2}kT$$

$$\Rightarrow 10.2 \times 1.6 \times 10^{-19} = \frac{3}{2} \times (1.38 \times 10^{-23})T$$

$$\Rightarrow T = 7.9 \times 10^4 K$$

226 **(a)**

Electron after absorbing 10.2 eV energy goes to its first excited state ($n = 2$) from ground state ($n = 1$)

$\therefore$ Increase in momentum $= \frac{h}{2\pi}$

$$= \frac{6.6 \times 10^{-34}}{6.28} = 1.05 \times 10^{-34} J - s$$

227 **(c)**

Nuclear force between two particles is independent of charges of particle.

$$\Rightarrow \quad F_{pp} = F_{nn} = F_{np}$$

228 **(c)**

Transition A ($n = \infty$ to 1) : Series limit of Lyman series

Transition B ($n = 5$ to $n = 2$) : Third spectral line of Balmer series

Transition C ($n = 5$ to $n = 3$) : Second spectral line of Paschen series

229 **(a)**

$$E = mc^2 = (1 \times 10^{-3})(3 \times 10^8)^2 = 9 \times 10^{13} J$$

230 **(c)**

$$E_1 = -\frac{13.6(3)^2}{(1)^2}$$

$$E_3 = -\frac{13.6(3)^2}{(3)^2}$$

$$\therefore \Delta E = E_3 - E_1 = 13.6(3)^2\left[1 - \frac{1}{9}\right]$$

$$= \frac{13.6 \times 9 \times 8}{9}$$

$$\Rightarrow \Delta E = 108.8 eV$$

231 **(c)**

From Rutherford-Soddy's law

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

Given, $N = 1 - \frac{3}{4} = \frac{1}{4} N_0$, $n = \frac{t}{T} = \frac{t}{4}$

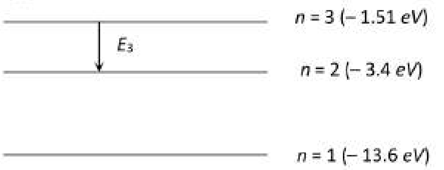
$$\therefore \quad \frac{1}{4} = \left(\frac{1}{2}\right)^{t/4}$$

$$\Rightarrow \quad \left(\frac{1}{2}\right)^2 = \left(\frac{1}{2}\right)^{t/4}$$

$$\Rightarrow \quad 2 = \frac{t}{4}$$

$\Rightarrow \quad t = 8$ months

232 **(d)**



$$E_{3\to2} = -1.51 - (-3.4) = 1.89 eV$$

$$\Rightarrow |E_{3\to2}| = 1.9 eV$$

234 **(a)**

B.E. $= \Delta mc^2 = \Delta \times 931\ MeV$

$= [2(1.0087 + 1.0073) - 4.0015] \times 931$

$= 28.4\ MeV$

235 **(a)**

The splitting of $_{92}U^{234}$ is as follows

$$_{92}U^{234} \to {}_{46}X^{116} + {}_{46}X^{116} + 2\,{}_0n^1 + \text{energy}$$

$\therefore {}_{46}X^{116}$ *is* ${}_{46}Pd^{116}$

236 **(d)**

Average BE/nucleon increase first, and then decreases, as is clear from BE curve.

237 **(c)**

Energy is released in a process when total binding energy (B.E.) of the nucleus is increased or we can say when total $B.E.$ of products is more than the reactants. By calculation we can see that only in case of option (c), this happens

Given $W \to 2Y$

$B.E.$ of reactants $= 120 \times 7.5 = 900\ MeV$
and $B.E.$ of products $= 2 \times (60 \times 8.5) =$
$1020\ MeV$
$i.e.$, $B.E.$ of products $>$ $B.E.$ of reactants

238 **(c)**

$N = N_0 e^{-\lambda t} \Rightarrow \left|\frac{dN}{dt}\right| = N_0 \lambda e^{-\lambda t}$

Initially at $t = 0$, $\left|\frac{dN}{dt}\right|_{t=0} = N_0 \lambda$

Where N_0 = Initial number of undecayed atoms

$= \frac{\text{Mass of the sample}}{\text{Mass of a single atom of } X} = \frac{M}{A/N_A} = \frac{MN_A}{A}$

$\therefore \left|\frac{dN}{dt}\right|_{t=0} = \frac{MN_A \lambda}{A} = \frac{0.693 MN_A}{AT}$

239 **(a)**

$R = R_0 A^{1/3}$

Here, $R = 7.2 \times 10^{-15}\ m, R_0 = 1.2 \times 10^{-15}\ m$

$\therefore A = \left(\frac{R}{R_0}\right)^3 = \left(\frac{7.2 \times 10^{-15}}{1.2 \times 10^{-15}}\right)^3 = (6)^3 = 216$

Also, atomic number $Z = \frac{q}{e} = \frac{1.28 \times 10^{-17}}{1.6 \times 10^{-19}} = 80$

Therefore, number of neutrons

$N = A - Z = 216 - 80 = 136$

240 **(d)**

Applying principle of energy conservation.

Energy of proton=total BE of 2 α −energy of Li^7

$= 8 \times 7.06 \times 7 \times 5.6$

$= 56.48 - 39.2 = 17.28$ MeV

241 **(b)**

Energy of proton $+7 \times 5.60 = 2 \times [4 \times 7.06]$

$\therefore$ Energy of proton $=$ 17.28 MeV

242 **(c)**

Fast neutrons can escape from the reaction. So as to proceed the chain reaction slow neutrons are best

243 **(c)**

An electron is accompanied by an antineutrino.

244 **(d)**

Undisintegrated part

$\frac{N}{N_0} = (100 - 18)\% = 82\%$

Using relation $N = N_0(e^{-\lambda t})$

$\frac{82}{100} = e^{-(24 \times 60 \times 60 \lambda)}$

$\therefore 24 \times 60 \times 60 \times \lambda = \log\left(\frac{100}{82}\right)$

or $\lambda = 2.1 \times 10^{-6}\ s^{-1}$

245 **(d)**

One curie $= 3.71 \times 10^{10}$ disintegrations S^{-1}

Mass of 6.023×10^{23}atoms of $U^{234} = 234$ g

Mass of 3.71×10^{10}atoms

$= \frac{234 \times 3.71 \times 10^{10}}{6.023 \times 10^{23}} = 1.438 \times 10^{11}$g

246 **(b)**

$\lambda = \frac{0.693}{T_{1/2}} = \frac{0.693}{20} = 0.03465$

Now time of decay $t = \frac{2.303}{\lambda} \log \frac{N_0}{N}$

$\Rightarrow t_1 = \frac{2.303}{0.03465} \log \frac{100}{67} = 11.6$ min min

and $t_2 = \frac{2.303}{0.03465} \log \frac{100}{33} = 32 min$

Thus time difference between points of time

$= t_1 - t_2 = 32 - 11.6 = 20.4\ min = 20\ min$

248 **(c)**

$\therefore$ Orbital quantum number has values : 0 to $(n - 1)$

For $n = 3$, orbital quantum number $l = 0, 1, 2$

249 **(c)**

$N = N_0 \left(\frac{1}{2}\right)^{t/T_{1/2}} \Rightarrow 1 = 16 \left(\frac{1}{2}\right)^{\frac{2}{T_{1/2}}} \Rightarrow T_{1/2}$

$= \frac{1}{2} hour$

250 **(b)**

20 g substance reduces to 10 g ($i.e.$, becomes half in 4 min. So $T_{1/2} = 4$ min. Again $M = M_0 = \left(\frac{1}{2}\right)^{t/T_{1/2}}$

$\Rightarrow 10 = 80 \left(\frac{1}{2}\right)^{t/4} \Rightarrow \frac{1}{8} = \left(\frac{1}{2}\right)^3 = \left(\frac{1}{2}\right)^{t/4} \Rightarrow t$

$= 12\ min$

252 **(a)**

Mass number of an element is the total number of protons and neutrons present inside the atomic nucleus of the element .It is represented by A. A is different for different elements. Mass number of a nucleus is sometimes equal to its atomic number, for example in case of hydrogen, number of neutrons=0. So, mass number = atomic number.

254 **(a)**

$N = N_0 \left(\frac{1}{2}\right)^{t/T_{1/2}}$

$\Rightarrow \quad N_A = 10 \left(\frac{1}{2}\right)^{t/1}$ and $N_B = 1 \left(\frac{1}{2}\right)^{t/2}$

Given $N_A = N_B$

$\Rightarrow \quad 10 \left(\frac{1}{2}\right)^t = \left(\frac{1}{2}\right)^{t/2} \Rightarrow 10 = \left(\frac{1}{2}\right)^{-t/2}$

$\Rightarrow \quad 10 = 2^{t/2}$

Taking log on both the sides

$$\log_{10} 10 = \frac{t}{2}\log_{10} 2 \Rightarrow 1 = \frac{t}{2} \times 0.3010$$

$\Rightarrow \quad t = 6.62$ yr

256 **(c)**

Let the initial number of atoms at time $t = 0$ be N_0.

Let N be the number of atoms at any instant t.

Mean life$\tau = \frac{1}{\lambda}$, where λ is disintegration constant.

Given , $t = \tau$

According to radioactive disintegration law,

$$N = N_0 e^{-\lambda t}$$

or $\quad N = N_0 e^{-\lambda \times \frac{1}{\lambda}} = \frac{N_0}{e}$

or $\quad \frac{N_0}{N} = e$

257 **(b)**

Paschen series lies in the infrared region

258 **(a)**

Nuclear force is charge independent, it also acts between two neutrons

259 **(c)**

$$N = N_0\left(\frac{1}{2}\right)^{t/T} \Rightarrow \frac{N_0}{64} = N_0\left(\frac{1}{2}\right)^{30/T} \Rightarrow T = \frac{30}{6} = 5s$$

260 **(b)**

Binding energy

$BE = (M_{\text{nucleus}} - M_{\text{nucleons}})c^2 = (M_o - 8M_p - 9M_n)c^2$

261 **(b)**

By using $\frac{1}{\lambda} = RZ^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

For Hydrogen atom $\frac{1}{(\lambda_{\min})_H} = R\left[\frac{1}{1^2} - \frac{1}{\infty}\right] = R$

$\Rightarrow (\lambda_{\min})_H = \frac{1}{R}$ ...(i)

For hydrogen like atom $\left(\frac{1}{\lambda_{\min}}\right)_{\text{atom}} = RZ^2\left(\frac{1}{2^2} - \frac{1}{\infty}\right)$

$\Rightarrow (\lambda_{\min})\text{atom} = \frac{4}{RZ^2}$ ...(i)

From equation (i) and (ii), $\frac{1}{R} = \frac{4}{RZ^2} \Rightarrow Z = 2$

262 **(b)**

By using $r_n = r_0\frac{n^2}{Z}$; where r_0 = Radius of the Bohr orbit in the ground state atom. So for He^+ third excited state $n = 4, Z = 2, r_0 = 0.5\text{Å} \Rightarrow r_4 = 0.5 \times \frac{4^2}{2} = 4\text{Å}$

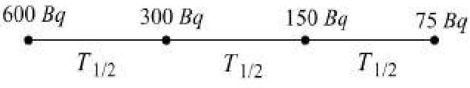
263 **(a)**

When an electron jumps from the orbit of lower energy ($n = 1$) to the orbit of higher energy ($n = 3$), energy is absorbed

264 **(c)**

Number of days from January 1st to January 24th = 23 days

Number of half lives $n = \frac{23}{8.04} = 2.86(< 3)$



In three half lives activity becomes 75 Bq, but the given number of half lives are lesser than 3 so activity becomes greater than 75 Bq

265 **(b)**

They move in opposite direction to conserve linear momentum

266 **(a)**

Einstein's mass energy relation , the energy released is

$$\Delta E = \Delta mc^2$$

Where, c is speed of light and Δm is mass.

Given,

$\Delta m = 1.67 \times 10^{-27}$ kg , $c = 3 \times 10^8$ ms^{-1}

$\therefore \quad \Delta E = 1.67 \times 10^{-27} \times (3 \times 10^8)^2$

$\Delta E \approx 1.5 \times 10^{-10}$ J

267 **(d)**

The complete reaction is

$${}^{235}_{93}X \rightarrow {}^{231}_{91}Y + {}_2\text{He}^4 + {}_{-1}e^0$$

(α − particle) (electron)

268 **(a)**

The average time that the atom spends in this excited sate is equal to Δt, so by using $\Delta E.\Delta t = \frac{h}{2\pi}$

$\Rightarrow$ Uncertainty in energy $= \frac{h/2\pi}{\Delta t}$

$$= \frac{6.6 \times 10^{-34}}{2 \times 3.14 \times 10^{-8}} = 1.05 \times 10^{-26} J$$

$$= 6.56 \times 10^{-8} eV$$

269 **(a)**

Carbon dating

270 **(b)**

Energy $E = K\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$ (K = constant)

$n_1 = 2$ and $n_2 = 3$, so $E = \left[\frac{1}{2^2} - \frac{1}{3^2}\right] = K\left[\frac{5}{36}\right]$

For removing an electron, $n_1 = 1$ to $n_2 = \infty$

Energy $E_1 = K[1] = \frac{36}{5}E = 7.2E$

$\therefore$ Ionization energy = 7.2 E

272 **(a)**

$$\frac{dN}{dt} = \lambda N; \lambda = \frac{0.6931}{t_{12}}$$
$$= \frac{0.6931}{1620 \times 365 \times 24 \times 60 \times 60}$$
$$N = \frac{6.023 \times 10^{23}}{226}$$
$$\therefore \frac{dN}{dt} = \frac{0.6931 \times 6.023 \times 10^{23}}{1620 \times 365 \times 24 \times 60 \times 60 \times 226}$$
$$= 3.61 \times 10^{10}$$

273 **(a)**

$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$ *or* $\frac{N}{N_0} = \left(\frac{1}{2}\right)^{t/t_{1/2}}$ or $\frac{N}{N_0} = \left(\frac{1}{2}\right)^{t/1}$

For $t = 3$ months

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^3 = \frac{1}{8}$$

Therefore , disintegrated part of substance in 3 months

$$= 1 - \frac{1}{8} = \frac{7}{8}$$

274 **(d)**

$\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$. For first wavelength $n_1 = 2, n_2 = 3 \Rightarrow \lambda_1 = 6563$ Å. For second wavelength $n_1 = 2, n_2 = 4 \Rightarrow \lambda_2 = 4861$ Å

275 **(a)**

$${}_0n^1 \rightarrow {}_1H^1 + {}_{-1}e^0 + \overline{v} + Q$$
$$\Delta m = m_n - m_\alpha - m_e$$
$$= (1.6725 \times 10^{-27} - 1.6725 \times 10^{-27} - 9 \times 10^{-31})kg$$
$$= -9 \times 10^{-31} kg$$

Energy $= 9 \times 10^{-31} \times (3 \times 10^8)^2$

$= 0.511 MeV$

Which is nearly equal to $0.73 MeV$

276 **(d)**

For an atom of atomic number Z, radius of nth orbit is given by

$r_n = \frac{kn^2}{Z}$ ... (i) where k =constant

For ground state of hydrogen, $Z = 1, n = 1$, so that

$$r_1 = \frac{k1^2}{1} = k$$

Let n be the energy state of Be $^{+++}$ for which orbital radius is r_1. Put

$Z = 4$ and $r_n = r_1 = k$ in Eq.(i)

$r_1 = \frac{r_1 n^2}{4}$ or $n^2 = 4; n = 2$

277 **(d)**

$$N = N_0\left(\frac{1}{2}\right)^2 \Rightarrow \frac{N}{N_0} = \frac{1}{4}$$

Probability $= 1 - \frac{N}{N_0} = 1 - \frac{1}{4} = \frac{3}{4}$

279 **(b)**

Recoil momentum = momentum of photon $= \frac{h}{\lambda}$

$$= hR\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) = \frac{hR \times 15}{16} = 6.8 \times 10^{-27} N \times s$$

280 **(d)**

$$n_\alpha = \frac{A - A'}{4} = \frac{200 - 168}{4} = 8$$
$$n_\beta = 2n_\alpha - Z + Z' = 2 \times 8 - 90 + 80 = 6$$

281 **(a)**

For hydrogen and hydrogen like atoms $E_n = -13.6\frac{z^2}{n^2} eV$

$U_n = 2E_n = -27.2\frac{z^2}{n^2} eV$ and $K_n = |E_n| = 13.6\frac{z^2}{n^2} eV$

From these three relations we can see that as n decreases, K_n will increase but E_n and U_n will decrease

282 **(b)**

Maximum number of spectral lines are observed in Lyman series

283 **(c)**

Let $\lambda_A = \lambda \therefore \lambda_B = 2\lambda$

If N_0 is total number of atoms in A and B at $t = 0$, then initial rate of disintegration of $A = \lambda N_0$, and initial rate of disintegration of $B = 2\lambda\, N_0$

As $\lambda_B = 2\lambda_A$

$$\therefore T_B = \frac{1}{2} T_A$$

ie, half-life of B is half the half-life of A.

After one half-life of A

$$\left(-\frac{dN}{dt}\right)_A = \frac{\lambda N_0}{2}$$

Equivalently, after two half lives of B

$$\left(-\frac{dN}{dt}\right)_B = \frac{2\lambda N_0}{4} = \frac{\lambda N_0}{2}$$

Clearly, $\left(-\frac{dN}{dt}\right)_A = -\left(\frac{dN}{dt}\right)_B$

after $n = 1$ *ie*, one half-life of A

284 **(c)**

Energy released from 1 kg of uranium

$= \frac{200 \times 10^6 \times 1.6 \times 10^{-19} \times 6.023 \times 10^{26}}{235}$

$= 8.2 \times 10^{13}$ J

285 **(b)**

Because the neutron has no electric charge, it experience no electric repulsion from a U^{235} nucleus. Hence a slow moving neutron can approach and enter a U^{235} nucleus, thereby providing the excitation needed to trigger fission. By contrast a slow moving proton feels a strong repulsion from a U^{235} nucleus. It never get's close to the nucleus, so it cannot trigger fission

286 **(a)**

$$m = \frac{E}{c^2} = \frac{931 \times 1.6 \times 10^{-13}}{(3 \times 10^8)^2} = 1.66 \times 10^{-27} kg$$

287 **(a)**

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n \Rightarrow \frac{1}{16} = \left(\frac{1}{2}\right)^4 = \left(\frac{1}{2}\right)^n \Rightarrow n = 4$$

Also $n = \frac{t}{T_{1/2}} \Rightarrow T_{1/2} = \frac{40}{4} = 10 days$

288 **(d)**

Initially $P \to 4 N_0; Q \to N_0$

Half life $T_p = 1$ min; $T_Q = 2$ min

Let after time t number of nuclei of P and Q are equal

That is $\frac{4N_0}{2^{t/1}} = \frac{N_0}{2^{t/2}}$

Or $\frac{4}{2^{t/2}} = 1$ or $t = 4$ min

So at $t = 4$ min

$$N_P = \frac{(4N_0)}{2^{4/1}} = \frac{N_0}{4}$$

At $t = 4$ min. $N_Q = \frac{N_0}{2^{4/2}} = \frac{N_0}{4}$

Or no. of nuclei of R $= \left(4N_0 - \frac{N_0}{4}\right) + \left(N_0 - \frac{N_0}{4}\right)$

$$= \frac{9N_0}{2}$$

289 **(d)**

Shortest wavelength comes from $n_1 = \infty$ to $n_2 = 1$ and longest wavelength comes from $n_1 = 6$ to $n_2 = 5$ in the given case. Hence $\frac{1}{\lambda_{\min}} = R\left(\frac{1}{1^2} - \frac{1}{\infty^2}\right) = R$

$$\frac{1}{\lambda_{\max}} = R\left(\frac{1}{5^2} - \frac{1}{6^2}\right) = R\left(\frac{36-25}{25 \times 36}\right) = \frac{11}{900}R$$

$$\therefore \frac{\lambda_{\max}}{\lambda_{\min}} = \frac{900}{11}$$

290 **(c)**

Nuclear force of attraction between any two nucleons $(n-n, p-p;\ p-n)$ is same. The difference comes up only due to electrostatic force of repulsion between two protons.

$\therefore F_1 = F_3 \neq F_2$. As $F_2 < F_3 > F_1$

$\therefore F_1 = F_3 > F_2$

291 **(b)**

In atom bomb nuclear fission takes place with huge temperature.

292 **(c)**

Nuclear density for all nuclei is same and equal to 10^{17} kgm^{-3}

Radius of nucleus and mass number are related as

$$R = R_0(A)^{1/3}$$

or $\quad R \propto (A)^{1/3}$

Thus, (A) is true but (B) is false.

293 **(a)**

$${}_{92}U^{238} \xrightarrow{\alpha} {}_{90}Th^{234} \xrightarrow{\beta} {}_{91}Pa^{234} \xrightarrow{e(-_1\beta^0)} {}_{92}U^{234}$$

294 **(c)**

Excitation potential $= \frac{\text{Excitation energy}}{e}$

Minimum excitation energy corresponds to excitation from $n = 1$ to $n = 2$

$\therefore$ Minimum excitation energy in hydrogen atom $= -3.4 - (-13.6) = +10.2eV$

So minimum excitation potential $= 10.2V$

295 **(c)**

$$\frac{r_1}{r_2} = \left(\frac{A_1}{A_2}\right)^{1/3} = \left(\frac{64}{27}\right)^{1/3} = \frac{4}{3}$$

296 **(b)**

Given, $R = 1250, R_0 = 5000$ and $t = 5\ min$

$$R = R_0 e^{-\lambda t}$$

$$1250 = 5000\, e^{-\lambda \times 5}$$

$$\lambda = 0.4 \log_e 2$$

297 **(b)**

Energy released on bombarding U^{235} by neutron=200 MeV

Power output of atomic reactor = 1.6 MW

$\therefore$ Rate of fission$= \frac{1.6 \times 10^6}{200 \times 10^6 \times 1.6 \times 10^{-19}}$

$= 5 \times 10^{16}\ s^{-1}$

298 **(c)**

The electron is in the second orbit $(n = 2)$

Hence $L = \frac{nh}{2\pi} = \frac{2h}{2\pi} = \frac{6.6 \times 10^{-34}}{\pi} = 2.11 \times 10^{-34} J - s$

299 **(b)**

$$\frac{\lambda}{\lambda_0} = \frac{\left[\frac{1}{2^2} - \frac{1}{3^2}\right]}{\left[\frac{1}{2^2} - \frac{1}{4^2}\right]} = \frac{5}{36} \times \frac{16}{3} = \frac{20}{27}$$

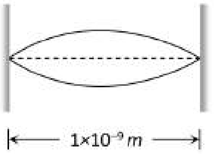
$$\lambda = \frac{20}{27}\lambda_0$$

300 **(b)**

It will form a stationary wave

$\lambda = 2l = 2 \times 10^{-9} m$

$$\Rightarrow \lambda = \frac{h}{\sqrt{2mE}}$$



$$\Rightarrow E = \frac{h^2}{2m\lambda^2} = 6 \times 10^{-20} J$$

301 **(b)**

Moderator is used to slow down neutrons. Heavy water, graphite or beryllium oxide are used for this purpose. Heavy water is the best moderator.

302 **(a)**

$$\frac{N_0}{32} = N_0 \left(\frac{1}{2}\right)^{60/T} \Rightarrow 5 = \frac{60}{T} \Rightarrow T = 12\text{days}$$

303 **(d)**

$n = \frac{24}{24 \times 138.6} = \frac{1}{138.6}$; Now $\frac{N}{N_0} = \left(\frac{1}{2}\right)^n = \left(\frac{1}{2}\right)^{1/138.6}$

$$\Rightarrow N = 10{,}00000 \left(\frac{1}{2}\right)^{1/138.6} = 995011$$

So number of disintegration

$= 1000000 - 995011 = 4989 = 5000$

305 **(d)**

$$\frac{R_1}{R_2} = \left(\frac{A_1}{A_2}\right)^{1/3} = \left(\frac{27}{125}\right)^{1/3} = \frac{3}{5}$$

306 **(b)**

$$N = N_0 \left(\frac{1}{2}\right) n = 4 \times \frac{1}{2} = 2$$

307 **(b)**

In Paschen series $\frac{1}{\lambda_{\max}} = R\left[\frac{1}{(3)^2} - \frac{1}{(4)^2}\right]$

$$\Rightarrow \lambda_{\max} = \frac{144}{7R} = \frac{144}{7 \times 1.1 \times 10^7} = 1.89 \times 10^{-6} m$$

$= 1.89 \mu m$

Similarly $\lambda_{\min} = \frac{9}{R} = \frac{9}{1.1 \times 10^7} = 0.818 \mu m$

308 **(c)**

Speed of electron in n^{th} orbit of hydrogen atom

$v = \frac{e^2}{2\varepsilon_0 nh}$

In ground state $n = 1 \Rightarrow v = \frac{e^2}{2\varepsilon_0 h}$

$$\Rightarrow \frac{v}{c} = \frac{e^2}{2\varepsilon_0 ch}$$

$$= \frac{(1.6 \times 10^{-19})^2}{2 \times 8.85 \times 10^{-12} \times 3 \times 10^8 \times 6.6 \times 10^{-34}}$$

$$= \frac{1}{137}$$

309 **(d)**

By using $N_E = \frac{n(n-1)}{2} \Rightarrow N_E = \frac{4(4-1)}{2} = 6$

310 **(a)**

$$E = E_4 - E_1 = -\frac{13.6}{4^2} - \left(-\frac{13.6}{1^2}\right)$$

$= -0.85 + 13.6 = 12.75$ eV

$= 12.75 \times 1.6 = 10^{-14}$ J

$$P = \frac{E}{c} = \frac{12.75 \times 1.6 \times 10^{-19}}{3 \times 10^8}$$

$= 6.8 \times 10^{-27}$ kg ms^{-1}

This must be the momentum of recoiled hydrogen atom (in opposite direction)

311 **(c)**

Half-life $T_{1/2} = \frac{0.693}{\lambda} = \frac{0.693}{1.07 \times 10^{-4}} = 6476\ years$

312 **(a)**

Using $\Delta E \propto Z^2$ [$\therefore n_1$ and n_2 are same]

$\Rightarrow \frac{hc}{\lambda} \propto Z^2 \Rightarrow \lambda Z^2 =$ constant

$\Rightarrow \lambda_1 Z_1^2 = \lambda_2 Z_2^2 = \lambda_3 Z_3^2 = \lambda_4 Z_4^2$

$\Rightarrow \lambda_1 \times 1 = \lambda_2 \times 1^2 = \lambda_3 \times 2^2 = \lambda_4 \times 3^3$

$\Rightarrow \lambda_1 = \lambda_2 = 4\lambda_3 = 9\lambda_4$

313 **(b)**

Hydrogen bomb is based on nuclear fusion

314 **(c)**

After n half-lives(ie, at $t = nT$) the number of nuclides left undecayed,

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

Given, $\frac{N}{N_0} = \frac{1}{16}$

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

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

Equating the powers, we obtain

$n = 4$

ie, $\frac{t}{T} = 4$

or $t = 4T$

Or $t = 4 \times 5730 = 22929$ yr $(\because T = 5730$ yr)

315 **(b)**

$T_h = \frac{\log_e^2}{\lambda}, \tau_m = \frac{1}{\lambda}$

316 **(c)**

As given

${}_1H^2 + {}_1H^2 \rightarrow {}_2He^4$ + energy

The binding energy per nucleon of a deuteron(${}_1H^2$)

$= 1.1$MeV

∴ Total binding energy of one deuteron nucleus

$= 2 \times 1.1 = 2.2$MeV

∴ The binding energy per nucleon of Helium(${}_2He^4$)

$=7$MeV

∴ Total binding energy

$= 4 \times 7 = 28$MeV

Hence, energy released in the above process

$= 28 - 2 \times 2.2$

$= 28 - 4.4 = 23.6$ MeV

317 **(a)**

As $\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$; where, Number of half lives, $n = \frac{t}{T}$

T is the half life period

For X sample,

$\frac{1}{16} = \left(\frac{1}{2}\right)^{8/T_X}$ or $\left(\frac{1}{2}\right)^4 = \left(\frac{1}{2}\right)^{8/T_X} \Rightarrow 4 = \frac{8}{T_X}$ ...(i)

For Y sample,

$\left(\frac{1}{256}\right) = \left(\frac{1}{2}\right)^{8/T_Y}$ or $\left(\frac{1}{2}\right)^8 = \left(\frac{1}{2}\right)^{8/T_Y} \Rightarrow 8 = \frac{8}{T_Y}$ ...(ii)

Divide (i) by (ii) we get

$\frac{4}{8} = \frac{8}{T_X} \times \frac{T_Y}{8} \Rightarrow \frac{1}{2} = \frac{T_Y}{T_X}$ or $\frac{T_X}{T_Y} = \frac{2}{1}$

320 **(d)**

Half-life $T/2 = \frac{T}{1.44} = \frac{100}{1.44}$ s $= 69.44$ s

$= \frac{69.44}{60} \approx 1.155$ min

321 **(c)**

A and B can be isotopes if number of β-decays is two times the number of α − decays.

322 **(b)**

$v \propto Z^2 \Rightarrow \frac{v_{H_2}}{v_{He}} = \left(\frac{1}{2}\right)^2 = \frac{1}{4} \Rightarrow v_{He} = 4v_{H_2} = 4v_0$

323 **(b)**

$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n \Rightarrow \frac{1}{64} = \left(\frac{1}{2}\right)^6 = \left(\frac{1}{2}\right)^n \Rightarrow n = 6$

After 6 half lives intensity emitted will be safe

∴ Total time taken $= 6 \times 2 = 12hrs$

325 **(a)**

Speed of electron in n^{th} orbit (in CGS) $v_n = \frac{2\pi Ze^2}{nh} (k = 1)$

For first orbit of H_1; $n = 1$ and $Z = 1$

So $v = \frac{2\pi e^2}{h} \Rightarrow \frac{v}{c} = \frac{2\pi e^2}{hc}$

326 **(b)**

$N = N_0 \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$

No of atoms at $t = 2hr, N_1 = 8 \times 10^{10} \left(\frac{1}{2}\right)^{\frac{2}{1}} = 2 \times 10^{10}$

No. of atoms at $t = 4hr, N_2 = 8 \times 10^{10} \left(\frac{1}{2}\right)^{\frac{4}{1}} = \frac{1}{2} \times 10^{10}$

∴ No. of atoms decayed in given duration

$= \left(2 - \frac{1}{2}\right) \times 10^{10} = 1.5 \times 10^{10}$

327 **(a)**

$r_n \propto n^2$ in Bohr atom model

Potential energy $= \frac{-1}{4\pi\varepsilon_0} \cdot \frac{e^2}{r_n}$

For the 10^{th} orbit, it is $= \frac{-1}{4\pi\varepsilon_0} \cdot \frac{e^2}{r_1(100)}$

$\frac{1}{100}$ times less than the potential energy in the first orbit

Potential energy will decrease but with negative sign. Therefore when an electron in hydrogen atom jumps from $n = 1$ to $n = 10$ orbit, the potential energy of the system will increase

329 **(c)**

After decay, the daughter nuclei will be more stable hence, binding energy per nucleon will be more than that of their parent nucleus.

330 **(b)**

Balmer series lies in the visible region

332 **(d)**

Energy released in the fission of one nucleus = $200\ MeV$

$= 200 \times 10^6 \times 1.6 \times 10^{-19} J = 3.2 \times 10^{-11} J$

$P = 16kW = 16 \times 10^3 watt$

Now, number of nuclei required per *second*

$n = \frac{P}{E} = \frac{16 \times 10^3}{3.2 \times 10^{-11}} = 5 \times 10^{14}$

333 **(b)**

At any instant the rate of decay of radioactive atoms is proportional to the number of atoms present at that instant *ie*,

$$-\frac{dN}{dt} \propto N$$

Or $-\frac{dN}{dt} = R = \lambda N$

where λ is decay constant.

334 **(b)**

Experimentally it is found that the volume of a nucleus is directly proportional to its mass number. From this it is concluded that the density of each nucleus is uniform, it does not depend on the size of the nucleus.

It the nucleus is assumed to be a sphere of radius R and its mass number is A, then volume of nucleus $V = \frac{4}{3}\pi R^3$.

Thus, $\frac{4}{3}\pi R^3 \propto A$ or $R^3 \propto A$

Or $R \propto A^{1/3}$

ie, the radius of nucleus is directly proportional to the cube root(or $\frac{1}{3}$ power) of its mass number A.

Aliter

Nuclear radius

$$R = R_0 A^{1/3}$$

$$\therefore \quad R \propto A^{1/3}$$

335 **(b)**

$${}_{Z}X^{A} \longrightarrow {}_{Z-2}X^{A-4} + {}_{2}\text{He}^{4}$$

$${}_{Z-2}X^{A-4} \rightarrow {}_{Z-2}X^{A-4} + -1e^{0}$$

337 **(d)**

Rate $R = -\frac{dN}{dt} = \lambda N_0 e^{-\lambda t} = \lambda N \Rightarrow \frac{R}{N} = \lambda$ (constant) $i.e.$, graph between $\frac{R}{N}$ and t, is a straight line parallel to the time axis

338 **(a)**

$${}_{92}U^{235} + {}_{0}n^{1} \rightarrow {}_{38}Sr^{90} + {}_{54}Xe^{143} + 3\,{}_{0}n^{1}$$

341 **(b)**

Here $A_0 = 8$ counts, $A = 1$ counts $t = 3$h.

$$\frac{A}{A_0} = \left(\frac{1}{2}\right)^n$$

$$\Rightarrow \quad \frac{1}{8} = \left(\frac{1}{2}\right)^n$$

or $\left(\frac{1}{2}\right)^3 = \left(\frac{1}{2}\right)^n \Rightarrow n = 3$

So, $T_{1/2} = \frac{t}{n} = \frac{3}{3} = 1h$

342 **(a)**

Energy constant $E = 10.2eV = 10.2 \times 1.6 \times 10^{-19} J$

$$\Rightarrow E = \frac{hc}{\lambda} \Rightarrow \lambda = 1.215 \times 10^{-7} m$$

343 **(c)**

The nuclear reaction can be represented as

$${}_{3}\text{Li}^{7} + {}_{1}\text{H}^{1} \rightarrow {}_{4}\text{Be}^{8} + {}_{Z}X^{A}$$

Applying conservation of atomic number (charge)

$$3 + 1 = 4 + Z \Rightarrow Z = 0$$

Applying conservation of atomic mass

$$7 + 1 = 8 + A \Rightarrow A = 0$$

Thus, the emitted particles are γ-photons (${}_{0}X^{0}$).

344 **(a)**

$$P = n\left(\frac{E}{t}\right) \Rightarrow 1000 = \frac{n \times 200 \times 10^6 \times 1.6 \times 10^{-19}}{t}$$

$$\Rightarrow \frac{n}{t} = 3.125 \times 10^{13}$$

345 **(c)**

For ${}_{6}C^{12}, p = 6, e = 6, n = 6$

For ${}_{6}C^{14}, p = 6, e = 6, n = 8$

346 **(c)**

$$B = [Z\,M_p + N\,M_n - M(N,Z)c^2$$

$$\Rightarrow M(M,Z) = ZM_p + NM_n - B/c^2$$

347 **(d)**

The given equation is ${}_{2}He^{4} + {}_{Z}X^{A} \rightarrow {}_{Z+2}Y^{A+3} + A$

Applying charge and mass conservation

$$4 + A = A + 3 + x \Rightarrow x = 1 \Rightarrow 2 + z = z + 2 + n$$

$$\Rightarrow n = 0$$

Hence A is a neutron

349 **(c)**

$$E = E_3 - E_1 = -\frac{13.6}{3^2} - \left(-\frac{13.6}{1^2}\right)$$

$$E = -1.51 + 13.6 = 12.09 \text{ eV}$$

350 **(b)**

The nuclear reaction can be put as

$${}_{6}\text{C}^{1} \longrightarrow {}_{5}\text{B}^{11} + {}_{+1}e^{0} + {}_{Z}X^{A}$$

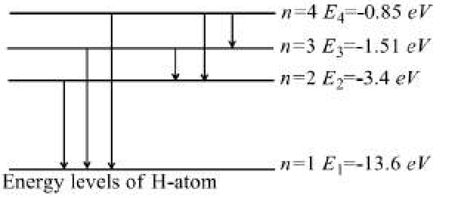
Applying conservation of mass number and charge number, we find that

$A = 0$ and $Z = 0$

Therefore, X stands for a neutrino

351 **(d)**

$$E = E_1/n^2$$



Energy levels of H-atom

Energy used for excitation is 12.75 eV

$i.e.$, $(-13.6 + 12.75)eV = -0.85\ eV$

The photons of energy 12.75 eV can excite the fourth level of H-atom. Therefore six lines will be emitted $\left(n\frac{(n-1)}{2}\text{ lines}\right)$

352 **(b)**

$\left(\frac{1}{2}\right)^n = \frac{N}{N_0} = \frac{1}{20}$ given $n = 4.32$

$t = n \times T = 4.32 \times 3.8$

$= 16.4$ days

354 **(c)**

$R = R_0(A)^{1/3}$

$\frac{R_2}{R_1} = \left(\frac{A_2}{A_1}\right)^{1/3} = \left(\frac{64}{27}\right)^{1/3} = \frac{4}{3}$

$R_2 = 3.6 \times \frac{4}{3} = 4.8$

356 **(a)**

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

359 **(d)**

${}_{92}U^{238} \rightarrow {}_{90}Th^{234} + {}_2He^4$

360 **(a)**

Ratio of n/p will decrease

$2\,{}_1H^2 \rightarrow {}_2He^4 + Q$

Energy released

$Q = 4 \times 7 - 4 \times 1.1 = 23.6$ MeV

361 **(d)**

From Rutherford-Soddy law, the number of atoms left after n half-lives is given by

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

Where, N_0 is original number of atoms.

The number of half-life

$n = \frac{\text{time of decay}}{\text{effective half} - \text{life}}$

Relation between effective disintegration constant (λ) and half-life (T) is

$\lambda = \frac{\ln 2}{T}$

$\therefore \lambda_1 + \lambda_2 = \frac{\ln 2}{T_1} + \frac{\ln 2}{T_2}$

Effective half –life

$\frac{1}{T} = \frac{1}{T_1} + \frac{1}{T_2} = \frac{1}{1620} + \frac{1}{810}$

$\frac{1}{T} = \frac{1+2}{1620} \Rightarrow T \Rightarrow 540$ yr

$\therefore \quad n = \frac{t}{540}$

$\therefore \quad N = N_0\left(\frac{1}{2}\right)^{t/540}$

$\Rightarrow \quad \frac{N}{N_0} = \left(\frac{1}{2}\right)^2 = \left(\frac{1}{2}\right)^{t/540}$

$\Rightarrow \quad \frac{t}{540} = 2$

$\Rightarrow \quad t = 2 \times 540 = 1080$ yr

362 **(c)**

In β-decay, mass number is unaffected. Atomic number increase by one.

364 **(c)**

During γ-decay, neither charge number Z nor mass number A changes. So the only correct option is (c).

365 **(a)**

$n \rightarrow p + \bar{e} + v$ (anti –neutrino)

366 **(d)**

$r \propto n^2$. For ground state $n = 1$ and for first excited state $n = 2$

367 **(a)**

As disintegration by two different processes is simultaneous, therefore, effective decay constant $\lambda = (\lambda_1 + \lambda_2)$

368 **(d)**

In the second orbit, $n = 2$

Ionisation energy, $E = \frac{13.6}{2^2} = 3.4$ eV

369 **(a)**

As $T = \frac{2\pi r}{v}$ or $V = \frac{nh}{2\pi mr}$

$\therefore T = \frac{2\pi r}{nh/2\pi mr} = \frac{mr^2}{nh} \propto \frac{r^2}{n}$

But $r \propto n^2 \therefore T \propto n^3$

or $\frac{T_1}{T_2} = \left(\frac{n_1}{n_2}\right)^3$, As $T_1 = 8T_2$

$\therefore \left(\frac{n_1}{n_2}\right)^3 = 8, \frac{n_1}{n_2} = 2$

Therefore, in given values $n_1 = 6, n_2 = 3$

370 **(a)**

$\frac{1}{\lambda_{H_2}} = RZ_H^2\left[\frac{1}{4} - \frac{1}{9}\right] = R(1)^2\left[\frac{5}{36}\right]$

$\frac{1}{\lambda_{He}} = RZ_{He}^2\left[\frac{1}{4} - \frac{1}{16}\right] = R(4)\left[\frac{3}{16}\right]$

$\frac{\lambda_{He}}{\lambda_{H_2}} = \frac{1}{4}\left[\frac{16}{3} \times \frac{5}{36}\right] = \frac{5}{27}$

$\lambda_{He} = \frac{5}{27} \times 6561 = 1215$ Å

371 **(a)**

Fraction of material decayed $= 1 - \frac{N}{N_0}$

$$= 1 - \left(\frac{1}{2}\right)^{t/T_{1/2}} = 1 - \left(\frac{1}{2}\right)^{20/5} = 1 - \frac{1}{16} = \frac{15}{16}$$

$$= 93.75\%$$

372 **(d)**

$$A = A_0\left(\frac{1}{2}\right)^n \Rightarrow 30 = 240\left(\frac{1}{2}\right)^n \Rightarrow \left(\frac{1}{2}\right)^3 = \left(\frac{1}{2}\right)^n$$

$$\Rightarrow n = 3$$

$$\therefore \frac{t}{T_{1/2}} = 3 \Rightarrow T_{1/2} = \frac{t}{3} = \frac{1}{3} hr = 20\ min$$

373 **(c)**

For 80 minutes, number of half lives of sample $A = n_A = \frac{80}{20} = 4$ and number of half lives of sample $B = n_B = \frac{80}{40} = 2$. Also by using $N = N_0\left(\frac{1}{2}\right)^n$

$$\Rightarrow N \propto \frac{1}{2^n} \Rightarrow \frac{N_A}{N_B} = \frac{2^{n_B}}{2^{n_A}} = \frac{2^2}{2^4} = \frac{1}{4}$$

374 **(b)**

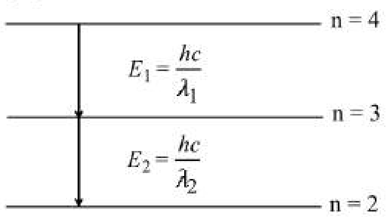
Energy is given by

$$E = mc^2 = 1 \times (3 \times 10^8)^2$$

$$= 9 \times 10^{16} = 10^{17} \text{ joule}$$

approximately

375 **(d)**



$$E_1 = \frac{hc}{\lambda_1} = 13.6\left[\frac{1}{(3)^2} - \frac{1}{(4)^2}\right] \quad ...(i)$$

$$E_2 = \frac{hc}{\lambda_2} = 13.6\left[\frac{1}{(2)^2} - \frac{1}{(3)^2}\right] \quad ...(ii)$$

Dividing eq. (ii) by eq. (i)

$$\frac{\lambda_1}{\lambda_2} = \frac{\frac{1}{4} - \frac{1}{9}}{\frac{1}{9} - \frac{1}{16}} = \frac{20}{7}$$

376 **(d)**

Elementary particles are mainly classified into two parts viz. Bosons & Fermions. Photons and mesons belong to Bosons. Fermions and further divided into leptons and conservation of charge principle. Baryons which are lighter and heavier particles respectively. Electrons belong to leptons. Neutrons and protons belong to Baryons. Baryons and mesons are together known as Hadrons

377 **(c)**

The wavelength of spectral line in Balmer series is given by

$$\frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{n^2}\right]$$

For first line of Balmer series, $n = 3$

$\Rightarrow \frac{1}{\lambda_1} = R\left[\frac{1}{2^2} - \frac{1}{3^2}\right] = \frac{5R}{36}$; For second line $n = 4$

$$\Rightarrow \frac{1}{\lambda_2} = R\left[\frac{1}{2^2} - \frac{1}{4^2}\right] = \frac{3R}{16}$$

$$\therefore \frac{\lambda_2}{\lambda_1} = \frac{20}{27} \Rightarrow \lambda_2 = \frac{20}{27} \times 6561 = 4860\text{Å}$$

379 **(a)**

(i) When ${}_{92}U^{235}$ undergoes fission, 0.1 % of its original mass is changed into energy.

(ii) Most of energy released appears in the form of kinetic energy of fission fragments.

(iii) The energy released in U^{235} fission in about 200 MeV.

(iv) By fission of ${}_{92}U^{235}$, on the average 2.5 neutrons are liberated.

381 **(b)**

Mass of proton = mass of antiproton

$= 1.67 \times 10^{-27} kg = 1 amu$

Energy equivalent to 1 $amu = 931\ MeV$

So energy equivalent to 2 $amu = 2 \times 931\ MeV$

$= 1862 \times 10^6 \times 1.6 \times 10^{-19}$

$= 2.97 \times 10^{-10} J = 3 \times 10^{-10} J$

382 **(d)**

Upto $n = 1$ it gives Lyman series

Upto $n = 2$ it gives Balmer series

Upto $n = 3$ it gives Paschen series

Upto $n = 4$ it gives Brackett series

Upto $n = 5$ it gives Pfund series

383 **(c)**

After n half-lives the quantity of a radioactive substance left intact (undecayed) is given by

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

$$= N_0\left(\frac{1}{2}\right)^{t/T_{1/2}}$$

Here, $N = \frac{1}{16}N_0, t = 2h$

$$\frac{1}{16}N_0 = N_0\left(\frac{1}{2}\right)^{\frac{2}{T_{\frac{1}{2}}}}$$

$$\left(\frac{1}{2}\right)^4 = \left(\frac{1}{2}\right)^{2/T_{1/2}}$$

Equating the powers on both sides

$$4 = \frac{2}{T_{1/2}}$$

$$T_{1/2} = \frac{1}{2}\text{h} = 30 \text{ min}$$

384 **(c)**

If N_0 potassium atoms were present at the time the rock was formed by solidification from a molten form, the number of potassium atoms remaining at the time of analysis is,

$$N_K = N_0 e^{-\lambda t} \quad ....(i)$$

In which t is the age of the rock.

For every potassium atom that decays, an argon atom is produced. Thus, the number of argon atoms present at the line of the analysis is

$$N_{Ar} = N_0 - N_K \quad ...(ii)$$

We cannot measure N_0, so let's eliminate it from Eqs.(i) and (ii). We find , after some algebra, that

$\lambda t = \ln\left(1 + \frac{N_{Ar}}{N_K}\right)$

in which N_{Ar}/N_K can be measured. Solving for t

$$t = \frac{T_{1/2} \ln(1 + N_{Ar}/N_K)}{\ln 2}$$

$$= \frac{(1.25 \times 10^9 y))[\ln(1+10.3)]}{\ln 2} = 4.37 \times 10^9 \text{ yr.}$$

385 **(b)**

Ionizing property depends upon the charge and mass

386 **(c)**

Due to the production of neutrons, a chain of nuclear fission is established which continues until the whole of the source substance is consumed

387 **(a)**

Applying principle of conservation of linear momentum,

$$m_\alpha v_\alpha + {}^m N^v N = 0$$

$$4v + (210 - 4)^v N = 0$$

$$^v N = \frac{-4v}{206}$$

Negative sigh for recoil speed

388 **(d)**

$r \propto \frac{1}{Z}$, for double ionized lithium $Z(= 3)$ will be maximum. So r will be minimum

389 **(a)**

We know that 1 kW = 1×10^3 Js^{-1}

Also, 1.6×10^{-9} J = 1 eV

$\therefore$ MeV = $200 \times 1.6 \times 10^{-19} \times 10^6$ J

Number of fissions $= \frac{\text{Power}}{\text{Energy released}}$

$$= \frac{10^3}{200 \times 1.6 \times 10^{-13}} = 3.125 \times 10^{13}$$

391 **(c)**

$A_1 = \lambda N_1$

$A_2 = \lambda N_2$

$$N_1 - N_2 = \left[\frac{A_1 - A_2}{\lambda}\right]$$

394 **(c)**

$$N = N_0(1 - e^{-\lambda t})$$

$$\Rightarrow \frac{N_0 - N}{N_0} = e^{-\lambda t}$$

$$\therefore \quad \frac{1}{8} = e^{-\lambda t}$$

$$\Rightarrow \quad 8 = e^{\lambda t}$$

$$\Rightarrow \quad 3 \ln 2 = \lambda t$$

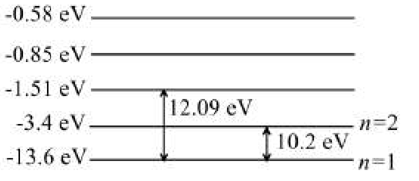
$$\Rightarrow \quad \lambda = \frac{3 \times 0.693}{15}$$

Half-life period

$$t_{1/2} = \frac{0.693}{3 \times 0.693} \times 15$$

$$t_{1/2} = 5 \text{ min}$$

395 **(d)**



Obviously, difference of 11.1 eV is not possible

396 **(d)**

Energy required for ionizing an excited hydrogen atom = ionization energy – excitation energy

= 13.6 – 10.2 = 3.4eV

397 **(d)**

$R = R_0 A^{1/3} \Rightarrow R \propto A^{1/3}$

398 **(d)**

As n increases P.E. also increases

399 **(c)**

$${}_1H^2 + {}_1H^2 \rightarrow {}_2He^3 + {}_0n^1 + Q(\text{energy})$$

$\because$ 2 molecules of deuterium are fused, then released energy = Q

Hence, energy released per molecule $= \frac{Q}{2}$

Now, we know that number of molecules in one mole

$$= 6.02 \times 10^{23}$$

Hence number of molecules in two moles = $2 \times 6.02 \times 10^{23}$

Hence, energy released when two mole of deuterium are fused $= \frac{Q}{2} \times 2 \times 6.02 \times 10^{23} = Q \times 6.02 \times 10^{23}$

400 **(d)**

Activity $A = \lambda N_0 e^{-\lambda t}$

$\Rightarrow \log_e A = \log_e \lambda N_0 + \log_e e^{-\lambda t}$

$\Rightarrow \log_e A = \log_e C - \lambda t$ [Take $\lambda N_0 = C$]

$\Rightarrow \log_e A = -\lambda t + \log_e C$

This is the equation of a straight line having negative slope $(= -\lambda)$ and positive intercept on $\log_e A$ axis

401 **(b)**

${}_eX^A = {}_{88}Ra^{226}$

Number of protons $= Z = 88$

Number of neutrons $= A - Z = 226 - 88 = 138$

402 **(b)**

As n increases P.E. increases and K.E. decreases

403 **(b)**

$$E_n = -\frac{13.6z^2}{n^2}eV \Rightarrow E_1 = -\frac{13.6 \times (2)^2}{(1)^2}$$
$$= -54.4\ eV$$

404 **(c)**

For Paschen series $\overline{v} = \frac{1}{\lambda} = R\left[\frac{1}{3^2} - \frac{1}{n^2}\right]; n =$ 4, 5, 6 ...

For first member of Paschen series $n = 4$

$$\frac{1}{\lambda_1} = R\left[\frac{1}{3^2} - \frac{1}{4^2}\right] \Rightarrow \frac{1}{\lambda_1} = \frac{7R}{144}$$
$$\Rightarrow R = \frac{144}{7\lambda_1} = \frac{144}{7 \times 18800 \times 10^{-10}} = 1.1 \times 10^7$$

For shortest wave length $n = \infty$

So, $\frac{1}{\lambda} = R\left[\frac{1}{3^2} - \frac{1}{\infty^2}\right] = \frac{R}{9}$

$$\Rightarrow \lambda = \frac{9}{R} = \frac{9}{1.1 \times 10^7} = 8.225 \times 10^7 m = 8225\ \text{Å}$$

405 **(c)**

$$\lambda = \frac{0.693}{T_{1/2}} = \frac{0.693}{2.3} = 0.3$$

406 **(b)**

Mass defect per nucleon is called packing fraction. Packing fraction

$(f) = \frac{\Delta m}{A} = \frac{m - A}{A}$, where m=mass of nucleus, A=mass number. Packing fraction measures the stability of a nucleus. Smaller the value of packing fraction, larger is the stability of nucleus. Packing fraction may be positive, negative or zero.

407 **(a)**

For the stability of the nucleus it should have high binding energy per nucleon

408 **(a)**

Fraction of material that remains undecayed

$$\frac{10}{80} = \left(\frac{1}{2}\right)^{\frac{1h}{T_{1/2}}}$$
$$3 = \frac{1h}{T_{1/2}}$$

or $T_{1/2} = \frac{60}{3} min = 20\ min = 1200s$

Now, $\lambda = \frac{0.693}{T_{1/2}} = \frac{0.693}{1200} = 5.8 \times 10^{-4}\ s^{-1}$

409 **(c)**

Change in the angular momentum

$$\Delta L = L_2 - L_1 = \frac{n_2 h}{2\pi} - \frac{n_1 h}{2\pi} \Rightarrow \Delta L = \frac{h}{2\pi}(n_2 - n_1)$$
$$= \frac{6.6 \times 10^{-34}}{2 \times 3.14}(5 - 4) = 1.05 \times 10^{-34} J - s$$

410 **(a)**

Moderator slows down neutrons

411 **(c)**

When a slow neutron strikes a U^{235} nucleus it is absorbed by the nucleus and the following reaction occurs.

$${}_{92}U^{235} + {}_0n^1 \rightarrow {}_{36}Kr^{94} + {}_{56}Ba^{139} + 3{}_0n^1 + \text{energy}$$

Hence, ${}_{56}Ba^{139}$ is another product.

412 **(c)**

Activity $R = R_0 e^{-\lambda t}$

$\frac{R_0}{3} = R_0 e^{-\lambda \times 9} \Rightarrow e^{-9\lambda} = \frac{1}{3}$ ...(i)

After further 9 years $R' = Re^{-\lambda t} = \frac{R_0}{3} \times e^{-\lambda \times 9}$ ...(ii)

From equation (i) and (ii), $R' = \frac{R_0}{9}$

413 **(b)**

To form its own isotope atomic number(Z) should remain same.

So, the emission of one $\alpha -$ particle and two $\beta -$ particles will maintain the Z same.

Where $\alpha -$ particle $= {}_2He^4$; $\beta -$ particle $= {}_{-1}\beta^0$

414 **(c)**

$K.E = \frac{kZe^2}{2r}$ and $P.E. = -\frac{kZe^2}{r}$; $\therefore \frac{K.E.}{P.E.} = -\frac{1}{2}$

416 **(a)**

No radioactive substance emits both α and β particles simultaneously. Some substances emit α –particles and some other emits β –particles, γ –rays are emitted along with both α and β –particles

417 **(a)**

Proton cannot be emitted by radioactive substances during their decay.

418 **(a)**

Energy required to ionize helium atom = $24.6\ eV$

419 **(d)**

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

420 **(d)**

For first line in Lyman series $\lambda_{L_1} = \frac{4}{3R}$ ...(i)

For first line in Balmer series $\lambda_{B_1} = \frac{36}{5R}$ ...(ii)

From equations (i) and (ii)

$$\frac{\lambda_{B_1}}{\lambda_{L_1}} = \frac{27}{5} \Rightarrow \lambda_{B_1} = \frac{27}{5}\lambda_{L_1} \Rightarrow \lambda_{B_1} = \frac{27}{5}\lambda$$

421 **(b)**

After two half-lives $\frac{1}{4}$ th fraction of nuclei will remain undecayed or $\frac{3}{4}$ th fraction will decay.

Hence , the probability that a nucleus decays in two half-lives is $\frac{3}{4}$.

422 **(b)**

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{t/T} = \left(\frac{1}{2}\right)^{\frac{10}{5}} = \left(\frac{1}{2}\right)^2 = \frac{1}{4} 25\%$$

This is probability of remaining portion of radium.

So, probability of decay

= (100-25)%= 75%

423 **(d)**

For stability in case of lighter nuclei $\frac{N}{Z} = 1$ and for heavier nuclei $\frac{N}{Z} > 1$

425 **(a)**

The radius of the Bohr atom model, which is valued only for hydrogen or other ionized atoms with a single electron is given by $r_n = \left(\frac{n^2}{m}\right)\left(\frac{h}{2\pi}\right)^2\left(\frac{4\pi\varepsilon_0}{Ze^2}\right)$

$\therefore$ For a given $Z = 82, r \propto n^2$

$\therefore$ If the radius of the first orbit is R, the radius of the third orbit is n^2R $i.e.$, $9R$

427 **(d)**

No energy and mass enters or goes out of the system of the reaction and no external force is assumed to act

428 **(a)**

$$E_n \propto Z^2 \Rightarrow \frac{(E_n)_{He}}{(E_n)_H} = \frac{Z_{He}^2}{Z_H^2} = 4 \Rightarrow (E_n)_{He} = 4 \times (E_n)_H$$

429 **(d)**

The wavelength of different spectral lines of Lyman series is given by

$\frac{1}{\lambda} = R_H\left[\frac{1}{1^2} - \frac{1}{n^2}\right]$; where $n = 2, 3, 4, \ldots$..

For shortest wavelength, $n = \infty$

$$\therefore \frac{1}{\lambda} = \frac{R_H}{1}$$

Or $\lambda = \frac{1}{R_H} = \frac{1}{109678 cm^{-1}}$

$= 9.117 \times 10^{-6} cm = 9.117 \times 10^{-8} m$

$= 911.7 \times 10^{-10} m = 911.7$Å

430 **(d)**

$B.E. = \Delta m\ amu = \Delta m \times 931\ MeV$

431 **(c)**

Lithium nucleus and carbon nucleus are positively charge. According to coulomb law same charge repal each other. So, nuclei do not come very close.

432 **(d)**

$$v_n \propto \frac{1}{n} \Rightarrow \frac{v_5}{v_2} = \frac{2}{5} \Rightarrow v_5 = \frac{2}{5}v_2 = \frac{2}{5}v$$

433 **(c)**

Energy of an electron in ground state of an atom (Bohr's hydrogen like atom) is given as

$E = -13.6Z^2 eV$ [Z = atomic number of the atom]

$\Rightarrow E_{\text{ionisation}} = 13.6\, Z^2$

$$\Rightarrow \frac{(E_{ion})_H}{(E_{ion})_{Li}} = \left(\frac{Z_H}{Z_{Li}}\right)^2 = \left(\frac{1}{3}\right)^2 = \frac{1}{9}$$

434 **(b)**

$N = N_0 e^{-\lambda t}$

$\therefore 0.9N_0 = N_0 e^{-\lambda \times 5} \Rightarrow 5\lambda = \log_e \frac{1}{0.9}$ ...(i)

and $xN_0 = N_0 e^{-\lambda \times 20} \Rightarrow 20\lambda = \log_e\left(\frac{1}{x}\right)$ ...(ii)

Dividing (i) by (ii), we get

$$\frac{1}{4} = \frac{\log_e(1/0.9)}{\log_e(1/x)} = \frac{\log_{10}(1/0.9)}{\log_{10}(1/x)} = \frac{\log_{10} 0.9}{\log_{10} x}$$

$\Rightarrow \log_{10} x = 4 \log_{10} 0.9 \Rightarrow x = 0.658 = 65.8\%$

435 **(c)**

Neutrons are unstable and having mean life time of 32 sec, decay by emitting an electron and antineutrino to become proton

437 **(d)**

$$r = \frac{\varepsilon_0 n^2 h^2}{\pi Z m e^2}; \therefore r \propto \frac{n^2}{Z}$$

438 **(b)**

Acceleration $a \propto \frac{v^2}{r}$

Where $v \propto \frac{Z}{n}$ and $r \propto \frac{n^2}{Z} \Rightarrow a \propto \frac{Z^3}{n^4}$

Since both are in ground state $i.e.$, $n = 1$

So $a \propto Z^3 \Rightarrow \frac{a_{He^+}}{a_H} = \left(\frac{Z_{He^+}}{Z_H}\right)^3 = \left(\frac{2}{1}\right)^3 = \frac{8}{1}$

439 **(c)**

$${}_5B^{10} + {}_0n^1 \rightarrow {}_3Li^7 + {}_2He^4$$

441 **(a)**

Radius of nucleus $R = R_0 A^{1/3}$

Where $R_0 = 1.2 \times 10^{-15}$ m

Volume of nucleus $(V) = \frac{4}{3}\pi R^3$

$= \frac{4}{3}\pi\left[R_0 A^{1/3}\right]^3$

$= \frac{4}{4}\pi R_0^3 A$

$\therefore$ $V \propto A$

443 **(d)**

The half-life of source $= \frac{8}{4} = 2s$

Now, $R = R_0 \left(\frac{1}{2}\right)^n$

$R = 1600 \left(\frac{1}{2}\right)^{\frac{6}{2}}$

$= 1600 \left(\frac{1}{2}\right)^3 = 200$

444 **(a)**

From radioactive decay law.

$$-\frac{dN}{dt} \propto N \text{ or } -\frac{dN}{dt} = \lambda N$$

Thus, $R = -\frac{dN}{dt}$

Or $R = \lambda N$ or $R = \lambda N_0 e^{-\lambda t}$ ... (i)

Where $R_0 = \lambda N_0$ is the activity of the radioactive materialat time $t = 0$.

At time t_1, $R_1 = R_0 e^{-\lambda t}$ ... (ii)

At time t_2, $R_2 = R_0 e^{-\lambda t}$ ... (iii)

Dividing Eq. (ii) by (iii), we have

$$\frac{R_1}{R_2} = \frac{e^{-\lambda t_1}}{e^{-\lambda t_2}} = e^{-\lambda(t_1 - t_2)}$$

or $R_1 = R_2 e^{-\lambda(t_1 - t_2)}$

445 **(a)**

Ionization energy = Binding energy

446 **(b)**

Fission rate $= \frac{\text{total power}}{\text{energy/fission}}$

$$= \frac{5}{200 \times 1.6 \times 10^{-13}} = 1.56 \times 10^{11} s^{-1}$$

447 **(b)**

The electron in a hydrogen atom, moves with constant acceleration, called centripetal acceleration, round the nucleus. Acceleration of electron $a = \frac{v^2}{r}$

Given, $v = 2.18 \times 10^6 m/s$

$r = 0.528$ Å $= 0.528 \times 10^{-10} m$

$$\therefore a = \frac{(2.18 \times 10^6)^2}{0.528 \times 10^{-10}} = 9 \times 10^{22}\ m/s^2$$

448 **(b)**

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{t/T_{1/2}} \Rightarrow \left(\frac{1}{16}\right) = \left(\frac{1}{2}\right)^{120/T_{1/2}}$$

$$\left(\frac{1}{2}\right)^4 = \left(\frac{1}{2}\right)^{120/T_{1/2}} \Rightarrow 4 = \frac{120}{T_{1/2}} \Rightarrow T_{1/2} = 30$$

449 **(c)**

$$\frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \Rightarrow \lambda \propto \frac{1}{Z^2}$$

$\lambda_{Li^{++}} : \lambda_{He^+} : \lambda_H = 4:9:36$

450 **(a)**

β^- emission from the nucleus is always accompanied with a antineutrino

The β^- decays is $n \to p + e^- + \overline{\nu}$

electron antineutrino

451 **(c)**

Number of atoms decayed $N' = N_0(1 - e^{-\lambda t})$

N' will increase with time (t) exponentially

452 **(b)**

In gamma ray emission the energy is released from nucleus, so that nucleus get stabilised.

453 **(b)**

Let the daughter nucleus be ${}^A_Z X$. So, reaction can be shown as

$${}^{238}_{92}\text{U} \to {}^A_Z X + {}^4_2\text{He}$$

From conservation of atomic mass

$238 = A + 4$

$\Rightarrow A = 234$

From conservation of atomic number

$92 = Z + 2$

$\Rightarrow Z = 90$

So, the resultant nucleus is ${}^{234}_{90}X$, *ie*, ${}^{234}_{90}$Th.

455 **(b)**

Since, 8α – particles 4β–particles are emitted, and 2β⁺ particles are emitted so new atomic number.

$Z' = Z - 8 \times 2 + 4 \times 1 - 2 \times 1$

$= 92 - 16 + 4 - 2$

$= 92 - 14$

$= 78$

456 **(c)**

F_n is stronger than F_e. F_n operates at very short range inside the nucleus as little as 10^{-15} m. As in the given case two protons are kept at a separation of 40Å. $F_n << F_e$.

457 **(c)**

$$\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] \Rightarrow \frac{1}{n_1^2} - \frac{1}{n_2^2} = \frac{1}{R\lambda}$$

$= \frac{1}{1.097 \times 10^7 \times 18752 \times 10^{-10}} = 0.0486 = \frac{7}{144}$. But $\frac{1}{3^2} - \frac{1}{4^2} = \frac{7}{144} \Rightarrow n_1 = 3$ and $n_2 = 4$ [Paschen series]

458 **(d)**

$(E_{ion})_{Na} = Z^2 (E_{ion})_H = (11)^2 13.6\ eV$

459 **(c)**

Number of protons in each =92

Number of neutrons = 235 – 92 = 143in ${}_{92}U^{235}$

= 238 – 92 = 146 in ${}_{92}U^{238}$

460 **(b)**

$x + 1 = 24 + 4 \Rightarrow x = 27$

461 **(a)**
Maximum energy is liberated for transition $E_n \to 1$ and minimum energy for $E_n \to E_{n-1}$
Hence $\frac{E_1}{n^2} - E_1 = 52.224eV$ ...(i)
and $\frac{E_1}{n^2} - \frac{E_1}{(n-1)^2} = 1.224eV$ ...(ii)
Solving equations (i) and (ii), we get
$E_1 = -54.4\ eV$ and $n = 5$
Now $E_1 = -\frac{13.6Z^2}{1^2} = -54.4\ eV$. Hence $Z = 2$

462 **(d)**
Energy released by γ −rays for pair production must be greater than 1.02 MeV

463 **(d)**
Using
$N = N_0 e^{-\lambda t} \Rightarrow \frac{N_1}{N_2} = \frac{1}{e^2}$

464 **(c)**
$r \propto A^{1/3} \Rightarrow \frac{r_1}{r_2} = \left(\frac{A_1}{A_2}\right)^{1/3}$
$\Rightarrow \frac{3.6}{r_2} = \left(\frac{27}{125}\right)^{1/3} = \frac{3}{5} \Rightarrow r_2 = 6\ fermi$

465 **(a)**
$\frac{1}{\lambda} = R_H\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$. For Lyman series $n_1 = 1$ and $n_2 = 2,3,4 ...$
When $n_2 = 2$, we get $\lambda = \frac{4}{3R_H} = \frac{4}{3 \times 10967} cm$

466 **(c)**
The absorption lines are obtained when the electron jumps from ground state ($n = 1$) to the higher energy states. Thus only 1, 2 and 3 lines will be obtained

467 **(a)**
By formula $N = N_0\left(\frac{1}{2}\right)^{t/T}$ or $10^4 = 8 \times 10^4 \left(\frac{1}{2}\right)^{t/3}$
Or $\left(\frac{1}{8}\right) = \left(\frac{1}{2}\right)^{t/3}$ or $\left(\frac{1}{2}\right)^3 = \left(\frac{1}{2}\right)^{t/3} \Rightarrow 3 = \frac{t}{3}$
Hence $t = 9\ years$

468 **(b)**
$_{(Z=92)}U^{(A=238)} \xrightarrow{(8\alpha, 6\beta)} {}_{Z'}X^{A'}$
So $A' = A - 4n_\alpha = 238 - 4 \times 8 = 206$
and $Z' = n_\beta - 2n_\sigma + z = 6 - 2 \times 8 + 92 = 82$

469 **(c)**
$U = 2E, K = -E$ and $E = -\frac{13.6}{n^2} = eV$

470 **(b)**
$\frac{1}{122nm} = R\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = \frac{3R}{4}$
$\Rightarrow \frac{1}{\lambda} = R\left(\frac{1}{3^2} - \frac{1}{\infty^2}\right) = \frac{R}{9} \Rightarrow \frac{\lambda}{122} = \frac{3}{4} \times 9 = \frac{27}{4}$
$\Rightarrow \lambda = 823\ nm$

471 **(c)**
Nucleus does not contain electron

472 **(b)**
Because of large mass and large velocity, α-particles have large ionising power. Each α-particle produces thousands of ions before being absorbed. The β-particles ionise the gas through which they pass, but their ionising power is only $\frac{1}{100}$th that of α-particles. γ-rays have got small ionising power.
Because of large mass, the penetrating power of α-particles is very small, it being 1/100 times that toβ-rays and 1/10000 times that of γ-rays. α-particles can be easily stopped by an Aluminium sheet, only 0.02 mm thick. β-particles have very small mass, so their penetrating power is large. γ-rays have very large penetrating power.

474 **(b)**
Activity, $A = \frac{-N}{dt} = \lambda N$
As the number of nuclei (N) per mole are equal for both the substances, irrespective of their molecular mass, therefore, $A \propto \lambda$
$\frac{A_1}{A_2} = \frac{\lambda_1}{\lambda_2} = \frac{4}{3}$

475 **(c)**
In any nuclear reaction mass number and atomic number should remain conserved. Reaction (c) satisfies this condition. Also for ${}^{239}_{93}$Np, neutron to proton ratio is greater than 1.52 which makes it unstable.

476 **(b)**
$r_n \propto n^2 \Rightarrow \frac{r_3}{r_1} = \frac{3^2}{1} \Rightarrow r_3 = 9r_1 = 9 \times 0.53 = 4.77$Å

477 **(a)**
$(3{}^4_2\text{He} + 1{}_{-1}e^0)$ result in decrease in mass number
$= 3 \times 4$ and
Decrease in charge number $= 3 \times 2 + 1(-1) = 5$
∴ Isotope (X) has mass number $= 236 - 12 = 224$
and charge number $= 88 - 5 = 83$

478 **(d)**
Energy radiated $= 1.4\ kW/m^2$

$= 1.4\, kJ/s\, m^2 = \frac{1.4\, kJ}{\frac{1}{86400}day\, m^2} = \frac{1.4 \times 86400\, kJ}{day\, m^2}$

Total energy radiated/day

$= \frac{4\pi \times (1.5 \times 10^{11})^2 \times 1.4 \times 86400}{1} \frac{kJ}{day} = E$

$\therefore E = mc^2 \Rightarrow m = \frac{E}{c^2}$

$= \frac{4\pi \times (1.5 \times 10^{11})^2 \times 1.4 \times 86400}{(3 \times 10^8)^2} \times 10^3$

$= 3.8 \times 10^{14} kg$

480 **(b)**

$T = \frac{2\pi r}{v}$; r = radius of n^{th} orbit $= \frac{n^2h^2}{\pi M Z e^2}$

v = speed of e^- in n^{th} orbit $= \frac{ze^2}{2\varepsilon_0 nh}$

$\therefore T = \frac{4\varepsilon_0^2 n^3 h^3}{mZ^2e^4} \Rightarrow T \propto \frac{n^3}{Z^2}$

481 **(d)**

According to conservation of momentum

$4v = 234v'$

$\frac{v}{v'} = \frac{234}{4} = \frac{58}{1}$

483 **(d)**

${}_7X^{15} + {}_2He^4 \rightarrow {}_1p^1 + {}_8Y^{18}$

484 **(b)**

$\Delta m = 1 - 0.993 = 0.007\, gm$

$\therefore E = (\Delta m)c^2 = (0.007 \times 10^{-3})(3 \times 10^8)^2$

$= 63 \times 10^{10} J$

485 **(a)**

$R = R_0 A^{1/3} = 1.2 \times 10^{-13} \times (216)^{1/3}$

$= 7.2 \times 10^{-13}$cm

486 **(c)**

$\therefore \frac{N}{N_0} = \left(\frac{1}{2}\right)^{t/T_{1/2}} = \left(\frac{1}{2}\right)^{1/2} = \frac{1}{\sqrt{2}}$

488 **(d)**

$r_n \propto n^2 \Rightarrow \frac{r_4}{r_1} = \left(\frac{4}{1}\right)^2 = \frac{16}{1} \Rightarrow r_4 = 16\, r_1 \Rightarrow r_4$

$= 16\, r_0$

490 **(c)**

The energy released in sun and hydrogen bomb are due to nuclear fusion

491 **(a)**

$N \propto \left[\frac{1}{\sin^4 \theta/2}\right] \Rightarrow N_1 = 7 \times \frac{1}{(\sin 30°)^4} = 112$

and $N_2 = 7 \times \frac{1}{(\sin 60°)^4} = 12.5$

492 **(d)**

According to Bohr's theory $mvr = n\frac{h}{2\pi}$

$\Rightarrow$ Circumference $2\pi r = n\left(\frac{h}{mv}\right) = n\lambda$

494 **(a)**

C-14 is the element used in radioactive carbon dating

495 **(d)**

1 amu = 931 MeV

496 **(b)**

$T_{1/2}(X) = \tau(Y)$

$\Rightarrow \quad \frac{0.693}{\lambda_x} = \frac{1}{\lambda_Y}$

$\Rightarrow \quad \lambda_Y = \frac{\lambda_x}{0.693}$

$\Rightarrow \quad \lambda_Y > \lambda_x$

(So, Y will decay faster than X)

497 **(a)**

Here, $T = 4.47 \times 10^9$yr

$\frac{N}{N_0} = \frac{60}{100} = \left(\frac{1}{2}\right)^n$ or $2^n = \frac{10}{6}$

$n \log 2 = \log 10 - \log 6 = 1 - 0.778 = 0.222$

$n = \frac{0.222}{\log 2} = \frac{0.222}{0.3} = 0.74$

$t = nT = 0.74 \times 4.47 \times 10^9$yr

$= 3.3 \times 10^9$yr

498 **(a)**

For working safely, the activity must reduce to $\frac{1}{64}$

$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n = \frac{1}{64}$

$\therefore \quad n = 6$

Thus, $t = nT = 6 \times 2 = 12$h

499 **(d)**

Density of nuclear material=mass/volume.

$\frac{10^{-27}}{\frac{4}{3}\pi r^3} = \frac{3 \times 10^{-27}}{4\pi(2 \times 10^{-15})^3} = 10^{17}\text{kgm}^{-3}$

500 **(d)**

In the transition from orbit 5 → 2, more energy is liberated as compared to transition from 4 → 2

501 **(d)**

The half-life of source $= \frac{8}{4} = 2$s

Now, $R = R_0\left(\frac{1}{2}\right)^n$

$R = 1600\left(\frac{1}{2}\right)^{\frac{6}{2}}$

$= 1600\left(\frac{1}{2}\right)^3$

$= 200$

502 **(c)**

In hydrogen atom, the lowest orbit ($n = 1$) corresponds to minimum energy ($-13.6\ eV$)

504 **(a)**

Nuclei of different elements having the same mass number are called isotones $e.g.,\ _4Be^9$ and $_5B^{10}$

505 **(b)**

Let nucleus be $_ZX^A$. Nuclear radius, $R = R_0A^{1/3}$ where R_0 is a constant whose value is found to be $1.2 \times 10^{-15} m$ and A is the mass number

$$\therefore \frac{R_X}{R_{Cs}} = \left(\frac{A}{189}\right)^{1/3}, \therefore \frac{1}{3} = \left(\frac{A}{189}\right)^{1/3}$$

$$A = \frac{189}{3^3} = \frac{189}{27} = 7$$

The given nucleus is Li^7

506 **(d)**

Number of possible emission lines $= \frac{n(n-1)}{2}$

Where $n = 4$; Number $= \frac{4(4-1)}{2} = 6$

507 **(c)**

$\lambda_\alpha = \frac{1}{1620} per\ year$ and $\lambda_\beta = \frac{1}{405} per\ year$ and it is given that the fraction of the remained activity $\frac{A}{A_0} = \frac{1}{4}$

Total decay constant

$$\lambda = \lambda_\alpha + \lambda_\beta = \frac{1}{1620} + \frac{1}{405} = \frac{1}{324} per\ year$$

We know that $A = A_0e^{-\lambda t} \Rightarrow t = \frac{1}{\lambda}\log_e\frac{A_0}{A}$

$$\Rightarrow t = \frac{1}{\lambda}\log_e 4 = \frac{2}{\lambda}\log_e 2 = 324 \times 2 \times 0.693$$

$$= 449\ years$$

508 **(d)**

Bohr radius $r = \frac{\varepsilon_0 n^2h^2}{\pi Zme^2}; \therefore r \propto n^2$

509 **(b)**

Energy is released in the sun due to fusion

511 **(d)**

Let

$$_ZX^A \xrightarrow{3\alpha}\ _{(Z-6)}Y^{(A-12)} \xrightarrow{5\beta}\ _{Z-1}Y'^{(A-12)}$$

$$\therefore \frac{\text{No. of neutrons}}{\text{No. of protons}} = \frac{A-12-(Z-1)}{Z-1}$$

$$= \frac{A-Z-11}{Z-1}$$

512 **(a)**

In hydrogen atom $E_2 - E_1 = 10.2eV$

Since, $5eV < 10.2eV$

The electron excites the hydrogen atom. The collision must be therefore elastic

513 **(d)**

$R = R_0A^{1/3}$

$$\therefore \quad \frac{R_1}{R_2} = \left(\frac{A_1}{A_2}\right)^{1/3}$$

$$\frac{2}{R_2} = \left(\frac{7}{189}\right)^{1/3}$$

$\Rightarrow \quad R_2 = 6$ Fermi

514 **(b)**

The electrostatic $P.E.$ is zero when the electron and proton are far apart from each other. Work done in pulling electron and proton far away from each other

$$W = E_f - E_i = 0 - E_i = -\left(-\frac{13.6}{n^2}eV\right)$$

$$\Rightarrow W = \frac{13.6}{(2)^2} \times 1.6 \times 10^{-19}J = 3.4 \times 1.6 \times 10^{-19}J$$

515 **(a)**

$P.E. \propto -\frac{1}{r}$ and $K.E. \propto \frac{1}{r}$

As r increases $K.E.$ decreases but $P.E.$ increases

516 **(c)**

Given $_{90}\mathrm{Th}^{232} \rightarrow\ _{82}\mathrm{Pb}^{208}$ ...(i)

Change in mass number

$= 232 - 208 = 24$

No. of α-particles emitted $= \frac{24}{4} = 6$

Now. Eq. (i) becomes

$$_{90}\mathrm{Th}^{232} \xrightarrow{-6\alpha}\ _{78}\mathrm{A}^{208} \xrightarrow{-n\beta}\ _{82}\mathrm{Pb}^{208}$$

Further change in atomic number is $82 - 78 = 4$

It means atomic no. 78 is increased by 4 to make the atomic no 82.

Therefore 6α-particles and 4β − particles will be emitted.

517 **(c)**

The Hydrogen atom before the transition was at rest. Therefore from conservation of momentum

$$p_{H-\text{atom}} = p_{\text{photon}} = \frac{E_{\text{radiated}}}{c} = \frac{13.6\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)eV}{c}$$

$$1.6 \times 10^{-27} \times v = \frac{13.6\left(\frac{1}{1^2} - \frac{1}{5^2}\right) \times 1.6 \times 10^{-19}}{3 \times 10^8}$$

$$\Rightarrow v = 4.352\ m/s = 4m/sec$$

518 **(d)**

Energy of photon emitted,

$$E = 13.6\left(\frac{1}{1^2} - \frac{1}{5^2}\right)\text{eV} = 13.6 \times \frac{24}{25}\text{eV}$$

Momentum of photon $= \frac{E}{c}$

The momentum of hydrogen atom is equal and opposite to the momentum of photon. If m is the mass of hydrogen atom ($= 1.67 \times 10^{-27}$kg)and v is recoil speed of hydrogen atom , then

$$mv = \frac{E}{c}$$

$$v = \frac{E}{mc} = \frac{13.01 \times 1.6 \times 10^{-19}}{1.67 \times 10^{-27} \times 3 \times 10^{8}}$$

$$v = 4.15 \text{ ms}^{-1}$$

520 **(a)**

The reaction is ${}_3\text{Li}^7 + {}_1P^1 \rightarrow 2({}_2\text{He}^4)$

$$\therefore \; E_p = 2E({}_2\text{He}^4)E_{(\text{Li})}$$

$$= 2(4 \times 7.06) - 7 \times 5.6$$

$$= 56.48 - 39.2 = 17.28 \text{ MeV}$$

521 **(a)**

$$\left(1 - \frac{1}{4}\right) = Z^2 \left[\frac{1}{4} - \frac{1}{16}\right]$$

$$\therefore Z = 2$$

522 **(d)**

3 - 1 transition has higher energy so it has higher frequency $\left(v - \frac{E}{h}\right)$

523 **(d)**

In β-decay a neutron is transformed into a proton and an electron and an antineutrino is emitted.

$$n^0 \rightarrow p + e^- + \bar{v}$$

524 **(b)**

$$N_1 = N_0 - \frac{1}{3}N_0 = \frac{2}{3}N_0$$

$$N_2 = N_0 - \frac{2}{3}N_0 = \frac{1}{3}N_0$$

$$\therefore \quad \frac{N_1}{N_2} = \left(\frac{1}{2}\right)^n$$

$$n = 1$$

$$\therefore \quad t_2 - t_1 = \text{one half - life} = 20 \text{ min}$$

525 **(a)**

Number of half lives $n = \frac{5}{1} = 5$

Now $\frac{N}{N_0} = \left(\frac{1}{2}\right)^n \Rightarrow \frac{N}{N_0} = \left(\frac{1}{2}\right)^5 = \frac{1}{32}$

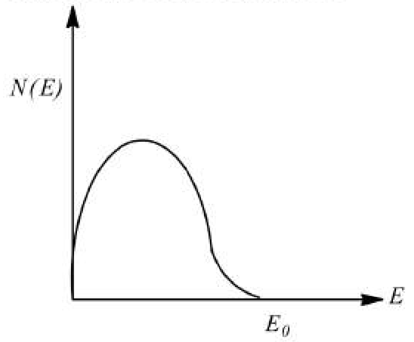
526 **(b)**

$$r \propto n^2, i.e., \frac{r_f}{r_i} = \left(\frac{n_f}{n_i}\right)^2$$

$$\Rightarrow \frac{21.2 \times 10^{-11}}{5.3 \times 10^{-11}} = \left(\frac{n}{1}\right)^2 \Rightarrow n^2 = 4 \Rightarrow n = 2$$

527 **(a)**

Energy spectrum of emitted β − particles from a radioactive source drawn as



528 **(b)**

We can relate an absorbed energy Q and the resulting temperature increase ΔT with relation$Q = cm\Delta T$. In this equation, m is the mass of the material absorbing the energy and c is the specific heat of that material. An absorbed does of 3 Gy corresponds to an absorbed energy per unit mass of 3 JKg^{-1}. Let us assume that c the specific heat of human body, is the same as that of water, 4180 JKg^{-1}K. Then we find that

$$\Delta T = \frac{Q/m}{c} = \frac{3}{4180} = 7.2 \times 10^{-4}\text{K} \approx 700 \text{ μK}$$

Obviously the damage done by ionizing radiation has nothing to do with thermal heating. The harmful effects arise because the radiation damages DNA and thus interferes with the normal functioning of tissues in which it is absorbed.

529 **(d)**

$${}_0n^1 + {}_{92}\text{U}^{235} \longrightarrow {}_{51}\text{Sb}^{133} + {}_{41}\text{Nb}^{99} + \text{Neutrons}$$

Charge number is conserved (92=51+41)

Applying principle of conservation of mass number

$$133 + 99 + x = 235 + 1$$

$$x = 236 - 232 = 4$$

$\therefore$ Number of neutrons $({}_1n^1) = 4$

530 **(c)**

$$\frac{N_1}{N_2} = \frac{(1/2)^{4/1}}{(1/2)^{4/2}} = \frac{(1/16)}{(1/4)} = \frac{1}{4}$$

531 **(a)**

We Know, $\frac{N}{N_0} = \left(\frac{1}{2}\right)^{t/T}$

$$\frac{N}{10000} = \left(\frac{1}{2}\right)^{10/20}$$

$$N = \frac{10000}{\sqrt{2}} = \frac{10000}{1.414} = 7070$$

532 **(c)**

Protium ($^1_1$H), deuterium($^2_1$H) and tritium($^3_1$H) are the isotopes of hydrogen. Out of the three, protium is most stable, deuterium is again stable but tritium is radioactive and eventually decays into an isotope of helium.

533 **(c)**

$$\frac{A_0}{3} = A_0\left(\frac{1}{2}\right)^{9/T_{1/2}}$$

$$A' = \frac{A_0}{3}\left(\frac{1}{2}\right)^{9/T_{1/2}}$$

$$\therefore \frac{A'}{A_0/3} = \frac{1}{3}$$

or $A' = \frac{A_0}{9}$

534 **(c)**

Curie is a unit of radioactivity.

535 **(c)**

When atoms of an element are bombarded by neutrons, the atomic nuclei are (artificially) disintegrated and emit lighter particle ($eg. \alpha -$ particle, $\beta -$ particle,proton etc.). Sometimes a neutron is observed by the nucleus which is converted into its heavier isotope and energy is emitted in the form of γ-photons. This process in which heavy nucleus is broken into two nearly equal fragments is called nuclear fission.

536 **(c)**

Both coulomb and nuclear force act inside the nucleus

537 **(b)**

When two nuclei of mass number lying in the range of $51<A<100$ combined, then a nucleus is formed in the range $100<A<150$ which has high value of specific binding energy. Thus, the fusion of two nuclei of mass number lying in range of $51<A<100$ will release energy.

538 **(c)**

K.E. $= -$ (Total energy) $= -(-13.6\, eV) = +13.6\, eV$

539 **(a)**

Let the percentage of B^{10} atoms be x, then average atomic weight

$$= \frac{10x + 11(100-x)}{100} = 10.81$$

$$x = 19$$

$$\therefore \frac{N_{B^{10}}}{N_{B^{11}}} = \frac{19}{81}$$

540 **(c)**

Fraction remains after n half lives $\frac{N}{N_0} = \left(\frac{1}{2}\right)^n = \left(\frac{1}{2}\right)^{t/T}$

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

541 **(a)**

$$A_n = \pi r_n^2 \Rightarrow \frac{A_n}{A_1} = \left(\frac{r_n}{r_1}\right)^2 = \left(\frac{n}{1}\right)^4 \quad [\because r_n \propto n^2]$$

Taking $\log_e$ on both the sides $\log_e \frac{A_n}{A_1} = 4\log_e(n)$

Comparing it with $y = mx + c$, graph (4) is correct

542 **(c)**

$r \propto n^2 \Rightarrow r_n = n^2 a_0\ [\because r_1 = a_0]$

543 **(b)**

$$E = -Rch \Rightarrow R = -\frac{E}{ch} = \frac{13.6 \times 1.6 \times 10^{-19}}{3 \times 10^8 \times 6.6 \times 10^{-34}}$$

$$= 1.098 \times 10^7 per\ m$$

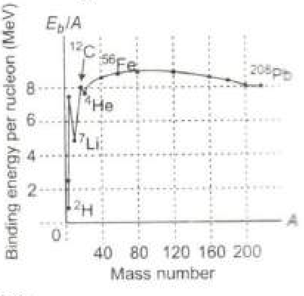
544 **(d)**

$$T = \frac{0.6931 \times 1}{\lambda} = \frac{0.6931}{4.28 \times 10^{-4}} year$$

$$= 1620\ years$$

545 **(b)**

In order to compare the stability of the nuclei of different atoms we determine the binding energy per nucleon. Higher the binding energy per nucleon. More stable is the nucleus. A graph between energy per nucleon and the mass number of nuclei is called the binding energy curve. It gives the following information that of two or more very light nuclei (nucleus of heavy hydrogen $_1H^2$ fuse into a relatively heavier nucleus ($_2He^4$), then binding energy will increase showing that helium is stable.



546 **(c)**

In 9 years, activity becomes $I = \frac{I_0}{3}$

In further 9 years, activity would becomes

$$I' = \frac{I}{3} = \frac{I_0}{3 \times 3} = \frac{I_0}{9}$$

547 **(d)**

An electron is a lepton

548 **(c)**

In hydrogen atom $E_n = -\frac{Rhc}{n^2}$

Also $E_n \propto m$; where m is the mass of the electron. Here the electron has been replaced by a particle whose mass is double of an electron. Therefore, for this hypothetical atom energy in n^{th} orbit will be given by $E_n = -\frac{2Rhc}{n^2}$

The longest wavelength $\lambda_{\max}$ (or minimum energy) photon will correspond to the transition of particle from $n = 3$ to $n = 2 \Rightarrow \frac{hc}{\lambda_{\max}} = E_3 - E_2 = 2Rhc\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$

This gives $\lambda_{\max} = \frac{18}{5R}$

549 **(d)**

Number of half lives in 150 years $n = \frac{150}{75} = 2$

Fraction of the atoms decayed $= 1 - \left(\frac{1}{2}\right)^n$

$= 1 - \left(\frac{1}{2}\right)^2 = \frac{3}{4} = 0.75 \Rightarrow$ Percentage decay $=$ 75%

550 **(d)**

$$T_{1/2} = \frac{\log_e 2}{\lambda} = \frac{2.303 \log_{10} 2}{\lambda}$$

552 **(a)**

Given that $\lambda_1 N_1 = 5\mu Ci$; $\lambda_2 N_2 = 10\mu Ci$; $\lambda_2 N_2 = 2\lambda_1 N_1$

Also $N_1 = 2N_2$; Then $\lambda_2 N_2 = 2\lambda_1(2N_2) \Rightarrow \lambda_2 = 4\lambda_1$

553 **(a)**

For emission

$$\frac{1}{\lambda} = Rz^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$= R\left(\frac{1}{1^2} - \frac{1}{5^2}\right)$$

$$\frac{1}{\lambda} = R\frac{24}{25}$$

Linear momentum

$$P = \frac{h}{\lambda} = h \times R \times \frac{24}{25}$$

$$= mv = \frac{24hR}{25}$$

$$\Rightarrow v = \frac{24hR}{25m}$$

554 **(b)**

$$r \propto n^2 \Rightarrow \frac{r_{(n=2)}}{r_{(n=3)}} = \frac{4}{9} \Rightarrow r_{(n=3)} = \frac{9}{4}R = 2.25\,R$$

555 **(b)**

Let ground state energy (in eV) be E_1

Then from the given condition

$E_{2n} - E_1 = 204eV$

Or $\frac{E_1}{4n^2} - E_1 = 204eV$

$\Rightarrow E_1\left(\frac{1}{4n^2} - 1\right) = 204eV$ ...(i)

and $E_{2n} - E_n = 40.8eV$

$\Rightarrow \frac{E_1}{4n^2} - \frac{E_1}{n^2} = E_1\left(-\frac{3}{4n^2}\right) = 40.8eV$ ...(ii)

From equation (i) and (ii)

$$\frac{1 - \frac{1}{4n^2}}{\frac{3}{4n^2}} = 5 \Rightarrow n = 2$$

556 **(c)**

Emitted enegy $\Delta E = \frac{hc}{\lambda}\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

557 **(d)**

$$t = \frac{\text{nuclear distance}}{\text{velocity}} = \frac{10^{-14}}{3 \times 10^6} \approx 10^{-20}\text{s}$$

558 **(a)**

Each atom of ${}_6C^{14}$ contains $6p, 6e$ and $8n$

$\therefore$ In 14 g of ${}_6\text{C}^{14}$

$p = 6 \times 6 \times 10^{23} = 36 \times 10^{23}$

$n = 8 \times 6 \times 10^{23} = 48 \times 10^{23}$

$e = p = 36 \times 10^{23}$

560 **(c)**

Rate of disintegration $\propto$ Number of atoms left

In case of source A, $\frac{N}{N_0} = \left(\frac{1}{2}\right)^2 = \frac{1}{4}$

In case of source B, $\frac{N}{N_0} = \left(\frac{1}{2}\right)^1 = \frac{1}{2}$

$$\therefore \frac{R_A}{R_B} = \frac{N_0/4}{N_0/2} = \frac{1}{2}$$

561 **(c)**

When a nucleus is formed, then the mass of nucleus is slightly less than the sum of the mass of Z protons and N neutrons.

ie, $M < (Zm_p + Nm_n)$

562 **(d)**

α-particles cannot be attracted by the nucleus

564 **(a)**

D is excitation of electron from 2^{nd} orbit corresponding to absorption line in Balmer series and E is the energy released to bring the electron from ∞ to ground state *i.e.*, ionization energy

565 **(a)**

Applying conservation of mass number and charge number, only (a) is correct.

566 **(a)**

Penetration power of γ is 100 times of β, while that of β is 100 times of α

567 **(d)**

In fusion, two lighter nuclei combine to give a heavier nucleus and possibly other products.

568 **(d)**

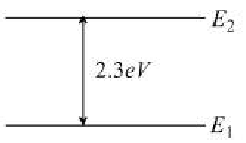
${}_8O^{16} + {}_1H^2 \rightarrow {}_7N^{14} + {}_2He^4$

570 **(a)**

$N = N_0 e^{-\lambda t} \Rightarrow \frac{N_0}{e} = N_0 e^{-\lambda(5)} \Rightarrow \lambda = \frac{1}{5}$

Now $\frac{N_0}{2} = N_0 e^{-\lambda(t)} \Rightarrow t = \frac{1}{\lambda} \ln 2 = 5 \ln 2$

572 **(c)**



$E_2 - E_1 = h\nu$ or $\nu = \frac{E_2 - E_1}{h} = \frac{2.3 \times 1.6 \times 10^{-19} J}{6.6 \times 10^{-34} Js}$

$= 0.56 \times 10^{15} s^{-1} = 5.6 \times 10^{14} Hz$

573 **(c)**

$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{15/5} = \frac{1}{8} \Rightarrow$ Decayed fraction $= 1 - \frac{1}{8} = \frac{7}{8}$

574 **(b)**

Mass of H_2 nucleus = mass of proton = 1 *amu* energy equivalent to 1 *amu* is 931 *MeV* so correct option is (*b*)

575 **(c)**

Here, $N_0 = 4 \times 10^{10}$

Number of half lives, $n = 4$, As $\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$

$\therefore N = N_0 \left(\frac{1}{2}\right)^4 = \frac{N_0}{16} = \frac{4 \times 10^{10}}{16}$

$= 0.25 \times 10^{10} = 25 \times 10^8$

576 **(a)**

Nuclides for which $\frac{N}{Z}$ is too small for stability can emit a positron, the electron's antiparticle which is identical to the electron, but with positive charge. The basic process called β^+ decay.

${}_Z^AX \rightarrow {}_{Z-1}^{A}Y + e^+ + \gamma$ (γ =neutrino)

578 **(b)**

Wave number $\bar{\nu} = \frac{1}{\lambda} = \frac{1}{5896 \times 10^{-8}} = 16961$ per *cm*

579 **(b)**

Penetrating power varies inversely as mass of penetrating radiation. Therefore, γ radiations have maximum penetrating power and α-particles have minimum penetrating power.

580 **(b)**

No. of lines $N_E = \frac{n(n-1)}{2} = \frac{3(3-1)}{2} = 3$

582 **(b)**

In the second excited state, $n = 3$

$\therefore l_H = l_{Li} = 3\left(\frac{h}{2\pi}\right)$

As $E \propto Z^2$ and $Z_H = 1$, and $Z_{Li} = 3$

$\therefore |E_{Li}| = 9|E_H|$ or $|E_H| < |E_{Li}|$

584 **(b)**

Energy released

=initial BE−final BE $= 2x - y$

585 **(d)**

$mvr_n = \frac{nh}{2\pi} \Rightarrow pr_n = \frac{nh}{2\pi} \Rightarrow \frac{h}{\lambda} \times r_n = \frac{nh}{2\pi}$

$\Rightarrow \lambda = \frac{2\pi r_n}{n}$, for first orbit $n = 1$ so $\lambda = 2\pi r_1$

= circumference of first orbit

586 **(a)**

One Becquerel is equal to one disintegration per second.

587 **(c)**

${}_6C^{12} + {}_0n^1 \longrightarrow {}_ZX^A + {}_{-1}e^0$

$\therefore A = 12 + 1 = 13$

$Z = 6 + 1 = 7$

588 **(a)**

The pion, in the laboratory frame can travel

$= 2.5 \times 10^{-8} \times 0.9 \times 3 \times 10^8 \text{m} = 6.75\text{m}$

589 **(b)**

$E_n = \frac{13.6}{n^2} \times Z^2$. For first excited state $n = 2$ and for $Li^{++}, z = 3 \Rightarrow E = \frac{13.6}{4} \times 9 = 30.6\ eV$

590 **(d)**

(With emission of an α particle (${}_2He^4$) mass number decreases by 4 unit and atomic number decrease by 2 units and with emission of $2\beta^{-1}$ particles atomic number increases by 2 units. So Z will remain same and *N* will become $N - 4$)

592 **(c)**

$\frac{3}{4}th$ active decay takes place to time

$t = 2(T_{1/2}) \Rightarrow \frac{3}{4} = 2(T_{1/2}) \Rightarrow T_{1/2} = \frac{3}{8} s$

594 **(b)**

Let x be the mass number of A and y the atomic number. Then , since atomic number and mass number remain conserved, we have

$_yA^x \to \ _{y-2}B^{x-4} + \ _2He^4$

$_{y-2}B^{x-4} \to \ _yC^{x-4} + 2\ _{-1}e^0$

Hence, we observe that A and C are isotopes as their atomic numbers are same but mass numbers are different.

596 **(c)**

$T \propto n^3 \Rightarrow \frac{T_2}{T_1} = \frac{2^3}{1^3} = \frac{8}{1}$

598 **(a)**

To becomes $\frac{1}{4}th$, it requires time of two half lives

$i.e., t = 2(T_{1/2}) = 2 \times 5800 = 2 \times 58\ centuries$

599 **(c)**

By using $N = N_0 e^{-\lambda t}$ and average life time $t = \frac{1}{\lambda}$

So $N = N_0 e^{-\lambda \times 1/\lambda} = N_0 e^{-1} \Rightarrow \frac{N}{N_0} = e^{-1} = \frac{1}{e}$

Now disintegrated fraction $= 1 - \frac{N}{N_0} = 1 - \frac{1}{e} = \frac{e-1}{e}$

602 **(b)**

Mass defect $= \frac{2 \times 1.115}{931} = 0.0024$ unit

604 **(b)**

By using $N = N_0 e^{-\lambda t} \Rightarrow \frac{N_0}{2} = N_0 e^{-\lambda T_{1/2}} \Rightarrow 2 = e^{\lambda T_{1/2}}$

By using $\log_e$ both the side

$\log_e 2 = \lambda T_{1/2} \Rightarrow \lambda T_{1/2} = 0.693$

605 **(d)**

$\frac{A}{A_0} = \left(\frac{1}{2}\right)^{t/T_{1/2}} \Rightarrow \frac{1}{8} = \left(\frac{1}{2}\right)^{t/8} \Rightarrow t = 24\ years$

606 **(b)**

By using $\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

607 **(d)**

Fraction $= \frac{N}{N_0} = \left(\frac{1}{2}\right)^{\frac{6400}{1600}} = \left(\frac{1}{2}\right)^4 = \frac{1}{16}$

608 **(d)**

$R = \frac{2\pi^2 k^2 e^4 m}{ch^3} = \left(\frac{1}{4\pi\varepsilon_0}\right)^2 \frac{2\pi^2 m e^4}{ch^3}$

609 **(b)**

Taking average count per minute in the first half value period as (100+50)/2 ie, 75

Total number of counts during this period $= 75 \times 3 \times 60 = 13500$ which is closest to the given result (14100)

611 **(a)**

$N = N_0\left(\frac{1}{2}\right)^n \Rightarrow \frac{N}{N_0} = \left(\frac{1}{2}\right)^n \Rightarrow \frac{1}{100} - \left(\frac{1}{2}\right)^n$

$\Rightarrow 2^n - 100$

n comes out in between 6 and 7

613 **(b)**

Transition from $4E$ to E

$(4E - E) = \frac{hc}{\lambda_1} \Rightarrow \lambda_1 = \frac{hc}{3E}$ ...(i)

Transition from $\frac{7}{3}E$ to E

$\left(\frac{7}{3}E - E\right) = \frac{hc}{\lambda_2} \Rightarrow \lambda_2 = \frac{3hc}{4E}$ ...(ii)

From equation (i) and (ii), $\frac{\lambda_1}{\lambda_2} = \frac{4}{9}$

614 **(c)**

$\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$\Rightarrow \frac{1}{970.6 \times 10^{-10}} = 1.097 \times 10^7 \left[\frac{1}{1^2} - \frac{1}{n_2^2}\right] \Rightarrow n_2 = 4$

$\therefore$ Number of emission lines $N = \frac{n(n-1)}{2} = \frac{4\times3}{2} = 6$

616 **(b)**

$\left|\frac{dN}{dt}\right| = \lambda N \Rightarrow \left|\frac{dN}{dt}\right| \propto N$

617 **(b)**

In two half lives, the activity becomes one fourth

618 **(c)**

The sun is continuously emitting light and heat at a very high rate. The source of the huge solar energy is the fusion of lighter nuclei. About 90 % of the mass is composed of hydrogen and helium and rest 10% contains other elements. The temperature of interior of sun is very high. Continuous fusion of hydrogen nuclei into helium nucleus is taking place, which result in the liberation of huge amount of energy.

619 **(a)**

$R = R_0 e^{-\lambda t}$

$\Rightarrow \left(\frac{1}{3}\right) = e^{-\lambda \times 3} = e^{-3\lambda}$ ... (i)

Again $\frac{R'}{R_0} = e^{-\lambda \times 9} = e^{-9\lambda} = (e^{-3\lambda})^3$

$= \left(\frac{1}{3}\right)^3$ [From Eq. (i)]

$= \frac{1}{27}$

$\Rightarrow R' = \frac{R_0}{27}$

Hence, in 9 days activity will become $\left(\frac{1}{27}\right)$ of the original value.

620 **(c)**

Mass of a uranium nucleus

$= 92 \times 1.6725 \times 10^{-27} + 143 \times 1.6747 \times 10^{-27}$

$= 393.35 \times 10^{-27} kg$

Number of nuclei in the given mass

$= \frac{1}{393.35 \times 10^{-27}} = 2.542 \times 10^{24}$

Energy released $= 200 \times 2.542 \times 10^{24} MeV$

$= 5.08 \times 10^{26} MeV = 8.135 \times 10^{13} J = 8.2 \times 10^{13} J$

621 **(c)**

$E = \Delta mc^2 = 10^{-6} \times (3 \times 10^8)^2 = 9 \times 10^{10} J$

622 **(a)**

$\overline{v} \propto \frac{1}{\lambda} \propto Z^2 \Rightarrow \lambda Z^2 = \text{constant} \Rightarrow \lambda = \frac{\lambda}{4} Z^2 \Rightarrow Z = 2$

623 **(a)**

Activity depends upon mass, but λ doesn't change

624 **(b)**

$E = 13.6 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$. For highest energy in Balmer series

$n_1 = 2$ and $n_2 = \infty \Rightarrow E = 13.6 \left[\frac{1}{(2)^2} - \frac{1}{(\infty)^2}\right] =$ $3.4\ eV$

626 **(a)**

After the removal of first electron remaining atom will be hydrogen like atom

So energy required to remove second electron from the atom $E = 13.6 \times \frac{2^2}{1} = 54.4 eV$

$\therefore$ Total energy required $= 24.6 + 54.4 = 79\ eV$

627 **(c)**

From the conservation of mass number and charge number

$${}_2^4\text{He} + {}_4^9\text{Be} \rightarrow {}_0^1n + {}_6^{12}X$$

Here, X can be carbon.

628 **(b)**

$M = M_0 \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}} \Rightarrow 25 = 100 \left(\frac{1}{2}\right)^{\frac{t}{1600}} \Rightarrow t$

$= 3200\ years$

629 **(d)**

Law of conservation of momentum gives

$$m_1 v_1 = m_2 v_2$$

$\Rightarrow \quad \frac{m_1}{m_2} = \frac{v_2}{v_1}$

But $\quad m = \frac{4}{3}\pi r^3 \rho$

or $\quad m \propto r^3$

$\therefore \quad \frac{m_1}{m_2} = \frac{r_1^3}{r_2^3} = \frac{v_2}{v_1}$

$\Rightarrow \quad \frac{r_1}{r_2} = \left(\frac{1}{2}\right)^{1/3}$

$\therefore \quad r_1 : r_2 = 1 : 2^{1/3}$

630 **(d)**

Fraction of atoms remains after five half lives

$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{t/T} = \left(\frac{1}{2}\right)^{5T/T} = \frac{1}{32}$

$\Rightarrow$ Percentage atom remains $= \frac{1}{32} \times 100 =$ 3.125%

631 **(d)**

Infinitely large transitions are possible (in principle) for the hydrogen atom

632 **(c)**

$N_t = N_0 \left(\frac{1}{2}\right)^{t/T} = 50000 \left(\frac{1}{2}\right)^{10/5} = 12500$

633 **(a)**

Nuclear force has the following properties

(i) Nuclear force is a short range force whose range is of the order of 2 to 3femtometre.

(ii) Nuclear force is a strongest force in nature.

(iii) Nuclear force is an attractive force acting between nucleons, which is charge independent.

Therefore, nuclear force is strong, short range and charge independent force.

634 **(a)**

$r_n \propto n^2 \Rightarrow A_n \propto n^4 \Rightarrow \frac{A_1}{A_0} = \left(\frac{2}{1}\right)^4 = \frac{16}{1}$

635 **(b)**

In 10 s, number of nuclei has been reduced to one fourth (25% to 6.25%)

Therefore it's half life is $T_{1/2} = 5\ s$

$\therefore$ Mean life $T = \frac{T_{1/2}}{0.693} = \frac{5}{0.693} = 7.21\ s$

637 **(c)**

Radiocarbon dating relies on a simple natural phenomenon. As the earth's upper is bombarded by cosmic radiation, atmospheric nitrogen is broken down into an unstable isotope of carbon-carbon (C-14).

The unstable isotope is brought to earth by atmospheric activity, such as storms, and becomes fixed in the biosphere. Because it reacts identically to C-12 and C-13, C-14 attached to complex organic molecules through photosynthesis in plants and becomes their molecular makeup. Animals eating those plants in turn absorb carbon−14 as well as stable isotopes. This process of ingesting C − 14 continues as long as the plant or animal remains alive.

The C − 14 within an organism is continually decaying into stable carbon isotopes, but organism is absorbing more C − 14 during its life, the ratio of C − 14 to C − 12 remains about same as the ratio in the atmosphere. Where the organism dies, the ratio of C-14 within its carcass begins to gradually decrease.

638 **(d)**

$E = mc^2$

$1000 \times 10^3 \times 3600 = m(3 \times 10^8)^2$

639 **(b)**

Nuclear radius is proportional to $A^{1/3}$

$R = R_0 A^{1/3}$

$\therefore \quad \frac{R_1}{R_2} = \left[\frac{7}{56}\right]^{1/3} = \frac{1}{2}$

641 **(b)**

Mass of electron = mass of positron = $9.1 \times 10^{-31} kg$

Energy released $E = (2m).c^2$

$= 2 \times 9.1 \times 10^{-31} \times (3 \times 10^8)^2 = 1.6 \times 10^{-13} J$

642 **(d)**

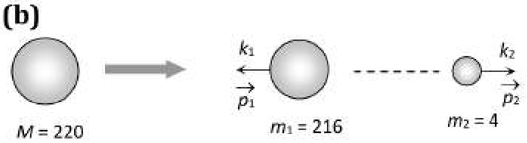
In practise, nuclear fusion is very difficult process. This is so when positively charged nuclei come very close for fusion, the force of electrical repulsion between them becomes very strong. For fusion against this force, they require very high energy. To impart, so much energy to them, very high temperature and very high pressure is required.

643 **(d)**

$2E - E = \frac{hc}{\lambda} \Rightarrow E = \frac{hc}{\lambda}$

$\frac{4E}{3} - E = \frac{hc}{\lambda'} \Rightarrow \frac{E}{3} = \frac{hc}{\lambda'} \therefore \frac{\lambda'}{\lambda} = 3 \Rightarrow \lambda' = 3\lambda$

644 **(b)**



Q-value of the reaction is $5.5\ MeV$

$i.e., k_1 + k_2 = 5.5\ MeV$ ...(i)

By conservation of linear momentum

$p_1 = p_2 \Rightarrow \sqrt{2(216)/k_1} = \sqrt{2(4)k_2}$

$\Rightarrow k_2 = 54\ k_1$ ...(ii)

On solving equation (i) and (ii)

We get $k_2 = 5.4\ MeV$

645 **(b)**

Number of half lives $n = \frac{19}{3.8} = 5$; Now $\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$

$\Rightarrow \frac{N}{10.38} = \left(\frac{1}{2}\right)^5 \Rightarrow N = 10.38 \times \left(\frac{1}{2}\right)^5 = 0.32g$

646 **(d)**

Density of nuclear matter is independent of mass number, so the required ratio is 1:1.

649 **(c)**

$\frac{C_{14}}{C_{12}} = \frac{1}{4} = \left(\frac{1}{2}\right)^{t/5700} \Rightarrow \frac{t}{5700} = 2 \Rightarrow t$

$= 11400\ years$

650 **(a)**

After 2 days , we have

$A = 6g, B = (12 - 6)\ g = 6g$

After 4 days, we have

$A = 3g, B = (12 - 3)\ g = 9g$

651 **(d)**

Radius of n^{th} orbit $r_n \propto n^2$, graph between r_n and n is a parabola. Also, $\frac{r_n}{n_1} = \left(\frac{n}{1}\right)^2 \Rightarrow \log_e\left(\frac{r_n}{r_1}\right) = 2\log_e(n)$

Comparing this equation with $y = mx + c$

Graph between $\log_e\left(\frac{r_n}{r_1}\right)$ and $\log_e(n)$ will be a straight line, passing from origin

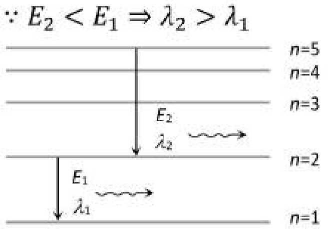
Similarly it can be proved that graph between $\log_e\left(\frac{f_n}{f_1}\right)$ and $\log_e n$ is a straight line. But with negative slope

652 **(a)**

In nuclear reactors the moderators are used to decrease (slowdown) the speed of neutrons. Heavy water, graphite is used for this purpose. While heavy water is the best moderator

654 **(d)**

$\because E_2 < E_1 \Rightarrow \lambda_2 > \lambda_1$



655 **(b)**

$\frac{N}{N_0} = \frac{1}{1+7} = \frac{1}{8}$

$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n = \frac{1}{8}$

$\therefore n = 3$

$t = nT = 3 \times 10^9$ yr

656 **(c)**

1 Ci = 3.7×10^{10} dis/s

657 **(a)**

The phenomena in which proton flips is nuclear magnetic resonance

658 **(c)**

First excited state $i.e.$, second orbit $(n = 2)$

Second excited state $i.e.$, third orbit $(n = 3)$

$\because E = -\frac{13.6}{n^2} \Rightarrow \frac{E_2}{E_3} = \left(\frac{3}{2}\right)^2 = \frac{9}{4}$

659 **(d)**

${}_1H^2 + {}_1H^2 \rightarrow {}_1H^3 + {}_1H^1$

660 **(a)**

We know,

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

Where N_0 is original number of atoms, n is number of half-lives

$$n = \frac{t}{T_{1/2}} = \frac{180}{60} = 3$$

$$\therefore \quad \frac{N}{N_0} = \left(\frac{1}{2}\right)^n = \left(\frac{1}{2}\right)^3 = \frac{1}{8}$$

$$\therefore \quad N = \frac{N_0}{8} = 0.125\, N_0 = 12.5\,\%\, N$$

Amount decayed= $100 - 12.5 = 87.5\,\%$ N

661 **(a)**

$$T = \frac{T_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

T is the time observed by the person on earth in relative motion $w.r.t.$ the asteroid. T_0 is measured by the person at rest

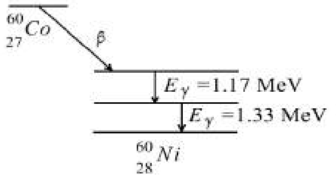
$\therefore T_A > T_B (T_B = T_0)$

662 **(d)**

$p \rightarrow \pi^+ + n, n \rightarrow p + \pi^-$ and $n \rightarrow n' + \pi^0$

663 **(b)**

The successive emission of gamma rays of energies 1.17 MeV and 1.33 MeV from the deexcitation of ${}^{60}_{28}Ni$ nuclei formed from β –decay of ${}^{60}_{27}Co$. This process is as shown in the figure through an energy level diagram



664 **(c)**

Angular momentum

$$= n\left(\frac{h}{2\pi}\right) = 2\left(\frac{h}{2\pi}\right) = \frac{h}{\pi}$$

665 **(c)**

The activity $\left(-\frac{dN}{dt}\right) = \lambda N \Rightarrow N = \left(-\frac{dN}{dt}\right)\left(\frac{T_{1/2}}{\log_e 2}\right)$

Taking the ratio of this expression for ${}^{240}Pu$ to this same expression for ${}^{243}Am$

$$\frac{N_{Pu}}{N_{Am}} = \frac{\left(-\frac{dN_{Pu}}{dt}\right)(T_{1/2})_{Pu}}{\left(-\frac{dN_{Am}}{dt}\right)(T_{1/2})_{Am}} = \frac{(5\mu ci) \times (6560y)}{(4.45\mu ci) \times (7370y)} = 1$$

$i.e.$, the two samples contains equal number of nuclei

666 **(b)**

P.E. $= 2 \times$ Total energy $= 2 \times (-13.6) = -27.2eV$

668 **(c)**

$r \propto (A)^{1/3}$

670 **(a)**

$$\frac{1}{\lambda} = R\left[\frac{1}{4} - \frac{1}{9}\right] = \frac{5R}{36}$$

$$\therefore R = \frac{36}{5\lambda} = \frac{36}{5 \times 6563 \times 10^{-10}} = 1.09 \times 10^7 m^{-1}$$

671 **(d)**

The infrared radiations have lower energy than uv radiations. Therefore, the only possible transition is from $n = 5$ to $n = 4$. As n increases, difference of energy levels and hence energy emitted decreases

672 **(d)**

If $n = 4$

Lines $= \frac{n(n-1)}{2} = 6$

673 **(c)**

$(T_{1/2})_x = (t_{\text{mean}})_y$

$\Rightarrow \frac{0.693}{\lambda_x} = \frac{1}{\lambda_y} \Rightarrow \lambda_x = 0.693\lambda_y$ or $\lambda_x < \lambda_y$

Also rate of decay $= \lambda N$

Initially number of atoms (N) of both are equal but since $\lambda_y > \lambda_x$, therefore, y will decay at a faster rate than x

674 **(c)**

Cadmium rods absorb the neutrons so they are used to control the chain reaction process

675 **(d)**

$N = N_0 e^{-\lambda t}$ and $A = A_0 e^{-\lambda t} = \lambda N_0 e^{-\lambda t}$

$\therefore N_{\text{decayed}} = N_0 - N = N_0 - N_0 e^{-\lambda t} \Rightarrow N_{\text{decayed}}$

$$= N_0 - \frac{A}{\lambda}$$

This is equation of straight line with negative slope

676 **(b)**

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{t/T} = \frac{m}{m_0}\left(\frac{1}{2}\right)^{19/3.8} = \frac{m}{10.38}$$

$$\left(\frac{1}{2}\right)^{19/3.8} = \frac{m}{10.38}$$

$$m = 10.38 \times \left(\frac{1}{2}\right)^5 = \frac{10.38}{32} = 0.32 \text{ g}$$

678 **(b)**

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n = \left(\frac{1}{2}\right)^5$$

679 **(c)**

Wave number $\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] = R\left[\frac{1}{4} - \frac{1}{16}\right] = \frac{3R}{16}$

680 **(c)**

Since in spectral series of hydrogen atom, Lyman series lies lower to Balmer series

681 **(d)**

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n = \frac{1}{16}; n = 4$$

$\therefore t = 4 \times 140 = 560$ days

682 **(c)**

Decay constant $\lambda = \frac{0.693}{T_{1/2}}$

$$= \frac{0.693}{69.3} = 0.01 \text{ s}^{-1}$$

684 **(b)**

$$N = N_0 \times \left(\frac{1}{2}\right)^{11400/5700}$$

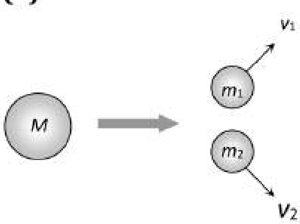
$$= N_0 \left(\frac{1}{2}\right)^2 = 0.25\, N_0$$

685 **(c)**

To nucleus one fourth it takes time $t = 2(T_{1/2}) = 2 \times 40 = 80\ years$

Decay constant $\lambda = \frac{0.693}{T_{1/2}} = \frac{0.693}{40} = 0.0173 years$

686 **(a)**



By conservation of momentum $m_1 v_1 = m_2 v_2$

$\Rightarrow \frac{v_1}{v_2} = \frac{8}{1} = \frac{m_2}{m_1}$ ...(i)

Also from $r \propto A^{1/3} \Rightarrow \frac{r_1}{r_2} = \left(\frac{A_1}{A_2}\right)^{1/3} = \left(\frac{1}{8}\right)^{1/3} = \frac{1}{2}$

687 **(c)**

$$\frac{1}{\lambda} = Rz^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

688 **(c)**

At closest distance of approach

Kinetic energy = Potential energy

$$\Rightarrow 5 \times 10^6 \times 1.6 \times 10^{-19} = \frac{1}{4\pi\varepsilon_0} \times \frac{(ze)(2e)}{r}$$

For uranium $z = 92$, so $r = 5.3 \times 10^{-12} cm$

690 **(a)**

$(4n + 2)$ series starts from U^{238} and it's stable end product is Pb^{206}

691 **(d)**

Control rods or safety rods used in a nuclear reactor are cadmium rods or boron rods

693 **(c)**

According to Bohr's second postulate

694 **(d)**

Because radioactivity is a spontaneous phenomenon

695 **(b)**

Energy $\propto c^2$; $\therefore$ Decrease in energy $\propto \frac{4}{9}$

696 **(b)**

$${}_ZX^A \xrightarrow{{}_{-1}\beta^0} {}_{Z+1}Y^A \xrightarrow{{}_2He^4(\alpha)} {}_{Z-1}K^{A-4} \xrightarrow{{}_0\gamma^0} {}_{Z-1}K^{A-4}$$

697 **(c)**

$\tau_m = 1.442\, T$

$T = 1.442 \times 1600 = 2308$ yr

698 **(c)**

$4({}_2\text{He}^4) = {}_8\text{O}^{16}$

Mass defect,

$$\Delta m = \{4(4.0026) - 15.9994\} \text{ amu}$$
$$= 0.01\text{l amu}$$

$\therefore$ Energy released per oxygen nuclei

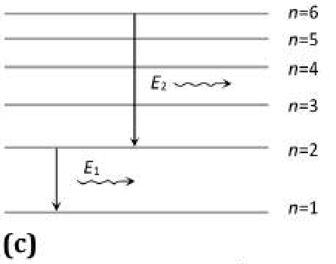
$$= (0.011)(931.48) \text{ MeV}$$
$$= 10.24 \text{ MeV}$$

699 **(a)**

$\because E_1 > E_2$

$\therefore v_1 > v_2$

i.e., photons of higher frequency will be emitted if transition takes place from $n = 2$ to 1



700 **(c)**

$T = 100\ \mu s = 10^{-4}$ s

$$\lambda = \frac{0.6931}{T} = \frac{0.6931}{10^{-4}} = 0.6931 \times 10^4 \text{s}^{-1}$$

Number of atoms in 215 mg

$$= \frac{0.6931 \times 10^{23}}{215} \times 215 \times 10^{-3}$$

$\therefore N = 6.023 \times 10^{20}$

Activity, $\frac{dN}{dt} = \lambda N$

$= 0.6931 \times 10^{4} \times 6.023 \times 10^{20}$

$= 4.17 \times 10^{24}\text{Bq}$

701 **(b)**

$A = 238 - 4 = 234$ and $Z = 92 - 2 = 90$

702 **(c)**

Energy liberated

$= 2 \times 117 \times 8.5 - 236 \times 7.6$

$= 1989 - 1793.6$

$= 195.4 \text{ MeV} \approx 200 \text{ MeV}$

703 **(d)**

Number of electrons $= 8 + 2 = 10$

Number of protons $= 8$

Number of neutrons, $N = 8$

Atomic number, $Z =$ number of protons $= 8$

Mass number, $A = Z + N = 8 + 8 = 16$

The proper symbol of the species is ${}^{16}O_8^{2-}$

704 **(d)**

Mass defect $\Delta m = \frac{2.23}{931} = 0.0024\ amu$

705 **(c)**

The number of counts left after time t

$$N = N_0 \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$$

$\therefore \quad 30 = 240 \left(\frac{1}{2}\right)^{\frac{60}{T_{1/2}}}$

or $\quad (\because t = 1\text{h} = 60 \text{ min})$

$\frac{30}{240} = \left(\frac{1}{2}\right)^{\frac{60}{T_{1/2}}}$

or $\left(\frac{1}{2}\right)^{3} = \left(\frac{1}{3}\right)^{\frac{60}{T_{1/2}}}$

Comparing the powers, we get

$\therefore \quad \frac{60}{T_{1/2}} = 3$

$T_{1/2} = \frac{60}{3}$

$T_{1/2} = 20$ min

706 **(d)**

At the distance of closest approach, r

$K = \frac{1}{4\pi\varepsilon_0}\frac{(2e)(Ze)}{r}$

$r = \frac{2Ze^2}{4\pi\varepsilon_0 K}$

Where, $Ze =$ charge of the nucleus

$2e =$ charge of the alpha particle

$K =$ kinetic energy of the alpha particle

$\therefore K = \frac{p^2}{2m}$

Where p is the momentum of the α-particle and m is the mass of the electron

$\therefore r = \frac{2Ze^2 2m}{4\pi\varepsilon_0 p^2}$

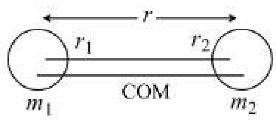
Or $r \propto \frac{1}{p^2}$

$\frac{r'}{r} = \left(\frac{p}{p'}\right)^2 = \left(\frac{p}{2p}\right)^2 = \frac{1}{4} \Rightarrow r' = \frac{r}{4}$

708 **(c)**

In a nuclear fusion, when two light nuclei of different masses are combined to form a stable nucleus, then some mass is lost and appears in the form of energy called the mass defect. So, the mass of resultant nucleus is always less than the sum of masses of fusing nuclei, *ie*, $m_3 < (m_1 + m_2)$.

710 **(d)**



$m_1 r_1 = m_2 r_2$

$r_1 + r_2 = r$

$\therefore r_1 = \frac{m_2 r}{m_1 + m_2}, r_2 = \frac{m_1 r}{m_1 + m_2}$

$\therefore \varepsilon = \frac{1}{2} I\omega^2$

$= \frac{1}{2}(m_1 r_1^2 + m_2 r_2^2).\omega^2 \quad$ ...(i)

$mvr = \frac{nh}{2\pi} = I\omega$

$\Rightarrow \omega = \frac{nh}{2\pi l}$

$\therefore \varepsilon = \frac{1}{2} I.\frac{n^2h^2}{4\pi^2 I^2}$

$= \frac{n^2h^2}{8\pi^2}.\frac{1}{(m_1 r_1^2 + m_2 r_2^2)}$

$= \frac{n^2h^2}{8\pi^2}\frac{1}{m_1\frac{m_2^2 r^2}{(m_1+m^2)^2} + m_2\frac{m_1^2 r^2}{(m_1+m_2)^2}}$

$= \frac{n^2h^2}{8\pi^2 r^2}\frac{(m_1+m_2)^2}{m_1 m_2 (m_1+m_2)} = \frac{(m_1+m_2)n^2h^2}{8\pi^2 r^2 m_1 m_2}$

$= \frac{(m_1+m_2)n^2\hbar^2}{2m_1 m_2 r^2}$

711 **(d)**

$E_n = \frac{-13.6}{n^2} = \frac{-13.6}{4} = -3.4eV$

712 **(c)**

Decay rate $R = \lambda N$

$R = R_0 = \lambda N_0$

$\lambda = (\ln 2)/T_{1/2} = (\ln 2)/(78 \text{ h})$

$= 8.89 \times 10^{-3} \text{ h}^{-1}$ then $N_0 = M/m$

Now $m = (67u)(1.661 \times 10^{-24}\text{ g/u})$
$= 1.113 \times 10^{-22}$ g

and $N_0 = (3.4\text{ g})/(1.113 \times 10^{-22}\text{ g})$
$= 3.05 \times 10^{22}$

Thus, $R_0 = (8.89 \times 10^{-3}\text{ h}^{-1})(3.05 \times 10^{22})$
$= 2.71 \times 10^{20}\text{ h}^{-1} = 7.53 \times 10^{16}\text{s}^{-1}$

713 **(c)**

Decrease in mass number due to emission of 3α-particles

and a β − particle = 3 × 4 = 12

Decrease in charge number in the process

$= 3 \times 2 - 1 = 5$

∴ For the resulting element,

$A = 228 - 12 = 216$

$Z = 88 - 5 = 83$

714 **(c)**

Wave number $= \frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

For first Balmer line $n_1 = 2, n_2 = 3$

∴ Wave number $= R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = R\left(\frac{9-4}{9\times4}\right) = \frac{5R}{36}$

715 **(b)**

Energy from the sun is released on account of fusion reaction of ${}_2He^3$

716 **(a)**

$r_n \propto n^2$

717 **(c)**

Energy of electron in H atom $E_n = \frac{-13.6}{n^2}eV$

$\Rightarrow -1.5 = \frac{-13.6}{n^2} \Rightarrow n^2 = \frac{13.6}{1.5} = 3$

Now angular momentum

$L = n\frac{h}{2\pi} = \frac{3 \times 6.6 \times 10^{-34}}{2 \times 3.14} = 3.15 \times 10^{-34} J \times s$

718 **(a)**

According to scattering formula

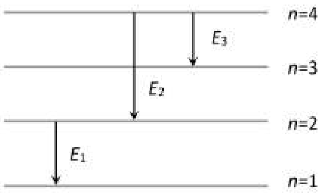
$N \propto \frac{1}{\sin^4(\theta/2)} \Rightarrow \frac{N_2}{N_1} = \left[\frac{\sin(\theta_1/2)}{\sin(\theta_2/2)}\right]^4$

$\Rightarrow \frac{N_2}{N_1} = \left[\frac{\sin\frac{90°}{2}}{\sin\frac{60°}{2}}\right]^4 = \left[\frac{\sin 45°}{\sin 30°}\right]^4$

$\Rightarrow N_2 = \left(\sqrt{2}\right)^4 \times N_1 = 4 \times 56 = 224$

720 **(b)**

$E_1 > E_2 > E_3$



722 **(b)**

Because atom is hollow and whole mass of atom is concentrated in a small centre called nucleus

723 **(a)**

When anα-particle is emitted from a nucleus, the resultant nucleus reduces in mass number by 4 unit and in atomic number by 2 unit.

Loss in number $= 232 - 204 = 28$

Therefore, number of α-particles emitted

$= \frac{28}{4}$

$= 7$

724 **(a)**

Potential energy $U = eV = eV_0 \ln\frac{r}{r_0}$

∴ Force $F = -\left|\frac{dU}{dt}\right| = \frac{eV_0}{r}$

∴ The force will provide the necessary centripetal force. Hence $\frac{mv^2}{r} = \frac{eV_0}{r}$

$\therefore \Rightarrow v = \sqrt{\frac{eV_0}{m}}$ ...(i)

and $mvr = \frac{nh}{2\pi}$ ...(ii)

From equations (i) and (ii)

$mr = \left(\frac{nh}{2\pi}\right)\sqrt{\frac{m}{eV_0}}$ or $r \propto n$

725 **(d)**

Minimum energy required to excite from ground state

$= 13.6\left[\frac{1}{1^2} - \frac{1}{2^2}\right] = 10.2eV$

726 **(d)**

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

So disintegrated part $= 1 - \frac{N}{N_0} = 1 - \frac{1}{4} = \frac{3}{4}$

728 **(b)**

Potential energy of electron in n^{th} orbit of radius r in H-atom $U = -\frac{e^2}{r}$ (in CGS)

$\because$ K. E. $= \frac{1}{2}|P.E.| \Rightarrow K = \frac{e^2}{2r}$

729 **(c)**

γ-rays are highly penetrating

730 **(d)**

Pauli proposed the existence of a particle neutrino to account for the abnormalities in β- decay.

731 **(a)**

$mvr = \frac{nh}{2\pi} \Rightarrow v = \frac{nh}{2\pi mr} \Rightarrow \frac{v^2}{r} = \frac{n^2h^2}{4\pi^2m^2r^3}$

732 **(c)**

${}_{84}X^{202} \xrightarrow{\alpha-\text{decay}} {}_{82}Y^{198} + {}_2He^4$ and

${}_{82}Y^{198} \xrightarrow{\beta-\text{decay}} {}_{83}Z^{198} + {}_{-1}\beta^0$

733 **(c)**

The radius of an electron in a hydrogen atom is of the order of $10^{-11}\ m$. The value of Bohr's radius is $5.29 \times 10^{-11} m$

734 **(a)**

Number of emission spectral lines

$N = \frac{n(n-1)}{2}$

$\therefore 3 = \frac{n_1(n_1-1)}{2}$, in first case

Or $n_1^2 - n_1 - 6 = 0$ or $(n_1 - 3)(n_1 + 2) = 0$

Take positive root

$\therefore n_1 = 3$

Again, $6 = \frac{n_2(n_2-1)}{2}$, in second case

Or $n_2^2 - n_2 - 12 = 0$ or $(n_2 - 4)(n_2 + 3) = 0$

Take positive root, or $n_2 = 4$

Now velocity of electron $v = \frac{2\pi KZe^2}{nh}$

$\therefore \frac{v_1}{v_2} = \frac{n_2}{n_1} = \frac{4}{3}$

735 **(d)**

$mvr = \frac{h}{2\pi}$ (for first orbit)

$\Rightarrow m\omega r^2 = \frac{h}{2\pi} \Rightarrow m \times 2\pi v \times r^2 = \frac{h}{2\pi} \Rightarrow v$

$= \frac{h}{4\pi^2 mr^2}$

$= \frac{6.6 \times 10^{-34}}{4(3.14)^2 \times 9.1 \times 10^{-31} \times (0.53 \times 10^{-10})^2}$

$= 6.5 \times 10^{15} \frac{rev}{s}$

736 **(b)**

From conservation of momentum, two identical photons must travel in opposite directions with equal magnitude of momentum and energy $\frac{hc}{\lambda}$

from conservation of energy $\frac{hc}{\lambda} + \frac{hc}{\lambda} = m_0c^2 + m_0c^2$

$\Rightarrow \lambda = \frac{h}{m_0 c}$

737 **(a)**

Actual mass of the nucleus is always less than total mass of nucleons, so $M < (NM_n + Zm_p)$

738 **(b)**

Rate of disintegration $\frac{dN}{dt} = 10^{17} s^{-1}$

Halt life $T_{1/2} = 1445\ year$

$= 1445 \times 365 \times 24 \times 60 \times 60 = 4.55 \times 10^{10} s$

Now decay constant

$\lambda = \frac{0.693}{T_{1/2}} = \frac{0.693}{4.55\times10^{10}} = 1.5 \times 10^{-11}$ per s

The rate of disintegration

$\frac{dN}{dt} = \lambda \times N_0 \Rightarrow 10^{17} = 1.5 \times 10^{-11} \times N_0$

$\Rightarrow N_0 = 6.6 \times 10^{27}$

739 **(a)**

Let number of α-particles emitted be x and number of β-particles emitted be y.

Difference in mass number $4x = 238 - 206 = 32$

$x = 8$

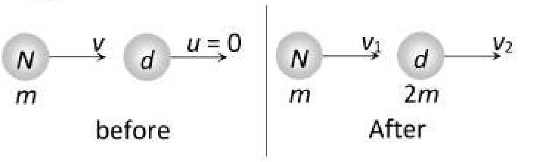
Difference in charge number $2x - 1y = 92 - 82 = 10$

$16 - y = 10, y = 6$

741 **(d)**

Neutron velocity $= v$, mass $= m$

Deuteron contains 1 neutron and 1 proton, mass $= 2m$



In elastic collision both momentum and $K.E.$ are conserved $p_i = p_f$

$mv = m_1v_1 + m_2v_2 \Rightarrow mv = mv_1 + 2mv_2$ ...(i)

By conservation of kinetic energy

$\frac{1}{2}mv^2 = \frac{1}{2}mv_1^2 + \frac{1}{2}(2m)v_2^2$ ...(ii)

By solving (i) and (ii), we get

$v_1 = \frac{m_1 - m_2}{m_1 + m_2}v + \frac{2m_2}{(m_1 + m_2)}v \Rightarrow v_1 = \frac{m_1 + 2m}{3m}$

$= -\frac{v}{3}$

$K_i = \frac{1}{2}mv^2, K_f = \frac{1}{2}mv_1^2 \Rightarrow \frac{K_i - K_f}{K_i} = 1 - \frac{v_1^2}{v^2}$

$= 1 - \frac{1}{9} = \frac{8}{9}$ [Fractional change in $K.E.$]

742 **(c)**

$\frac{mv^2}{a_0} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{a_0^2} \Rightarrow v = \frac{e}{\sqrt{4\pi\varepsilon_0 a_0 m}}$

743 **(d)**

de-Broglie wavelength $\lambda = \frac{-h}{mv} = \frac{h}{p}$

Where p =momentum

By conservation of momentum

$P_1 + P_2 = 0$

$$P_1 = P_2$$
$$\lambda_1 = \lambda_2 = \lambda$$

744 **(a)**

$$n = \frac{72000}{24000} = 3$$

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n = \left(\frac{1}{2}\right)^3 = \frac{1}{8}$$

745 **(c)**

Nuclear radius is proportional to $A^{1/3}$, where A is the mass number of Nucleus

$$R = R_0 A^{1/3}$$

where $R_0 = 1.2$ fm

$$\frac{R_1}{R_2} = \frac{R_0(216)^{1/3}}{R_0(125)^{1/3}} = \frac{6}{5}$$

746 **(a)**

When nuclear masses are measured, the mass is always found to be less than the sum of the masses of the individual nucleons bound in the nucleus. This difference between the nuclear mass and the sum of individual masses is known as mass defect. Hence

Mass of nucleons = isotopic mass + mass defect

Hence, mass of nucleons together in a heavy nucleus is greater than the mass of nucleus.

747 **(d)**

$$\frac{dN}{dt} = -\lambda N \Rightarrow \left|\frac{dN}{dt}\right| = \frac{0.693}{T_{1/2}} \times N$$

$$= \frac{0.693}{1.2 \times 10^7} \times 4 \times 10^{15} = 2.3 \times 10^8 atoms/s$$

748 **(b)**

Read time for 50 count rate, it gives half life period of 3 hrs, one small square gives 600 counts (10×60). The number of small squares between graph and time axis are approx 24

Hence count rate $= 24 \times 600 = 14400$

749 **(c)**

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

For first line of Lyman series $n_1 = 1$ and $n_2 = 2$

For first line of Balmer series $n_2 = 2$ and $n_2 = 3$

So, $\frac{\lambda_{\text{Lyman}}}{\lambda_{\text{Balmer}}} = \frac{5}{27}$

750 **(b)**

The time required for the number of parent nuclei to fall to 50% is called half-life $T^{1/2}$ and may be related to λ as follows.

Since $0.5\, N_0 = N_0 e^{-T_{1/2}}$

We have, $\lambda T_{1/2} = \ln(2) = 0.693$

Or $T_{1/2} = \frac{0.693}{\lambda}$

Or $\lambda = \frac{0.693}{T_{1/2}}$

Given, $T_{1/2} = 77$ days

$\therefore$ $\lambda = \frac{0.693}{77} = 9 \times 10^{-3} \text{days}^{-1}$

751 **(d)**

$$E = \Delta mc^2, \Delta m = \frac{0.1}{100} = 10^{-3} kg$$

$$\therefore E = 10^{-3} \times (3 \times 10^8)^2 = 10^{-3} \times 9 \times 10^{16}$$
$$= 9 \times 10^{13} J$$

752 **(d)**

$$T_{1/2} = \frac{0.693}{\lambda}$$

Activity $I_1 = N_1\lambda,\ I_2 = N_2\lambda$

Let λ = disintegration constant

$$(I_1 - I_2) = (N_1 - N_2)\frac{0.693}{\tau_{1/2}}$$

$$(N_1 - N_2) \propto (I_1 - I_2)\tau_{1/2}$$

753 **(a)**

The multiplication factor (k) is an important reactor parameter and is the ratio of number of neutrons present of the beginning of a particular generation to the number present at the beginning of the next generation. It is a measure of the growth rate of the neutrons in the reactor. For $k = 1$, the operation of the reactor is said to be critical

Note: If k becomes greater than one, the reaction rate and the reactor power increase exponentially. Unless the factor k is brought down very close to unity, the reactor will become supercritical and can even explode

754 **(c)**

$${}_1H^1 + {}_1H^1 + {}_1H^2 \rightarrow {}_2He^4 + {}_{+1}e^0 + \text{energy}$$

755 **(c)**

Cadmium rods are used in the form of control rods. In a nuclear reactor the material that can absorb the neutrons are used to control the nuclear chain reaction. Cadmium and Boron rods are used for this purpose.

756 **(b)**

$$E_n = -\frac{13.6}{n^2} eV$$

757 **(c)**

If in the rock there is no Y element, then the time taken by element X to reduce to $\frac{1}{8}th$ the initial value will be equal to $\frac{1}{8} = \left(\frac{1}{2}\right)^n$ or $n = 3$

Therefore, from the beginning three half life time is spent. Hence the age of the rock is

$= 3 \times 1.37 \times 10^9 = 4.11 \times 10^9 years$

758 **(d)**

$$\frac{N}{N_0}=\left(\frac{1}{2}\right)^{t/T}\Rightarrow\frac{1}{16}=\left(\frac{1}{2}\right)^{t/48}$$

$$\Rightarrow\left(\frac{1}{2}\right)^{4}=\left(\frac{1}{2}\right)^{t/48}\Rightarrow t=192\ hours$$

759 **(d)**

$$\frac{1}{\lambda}=RZ^2\left(\frac{1}{1^2}-\frac{1}{2^2}\right)$$

For di-ionised lithium the value of Z is maximum

760 **(d)**

After one half life period, the activity of Tritium becomes 50%

After 2 half life period 25%

After 3 half life period 12.5%

After 4 half life period 6.25%

After 5 half life period 3.12% = 3%

It is 5×12.5 years + 7 years $i.e.$ approximately 70 years only

761 **(a)**

Total mass of reactants

$=(2.0141)\times 2=4.0282\ amu$

Total mass of products $=4.0024\ amu$

Mass defect $=4.0282\ amu-4.0024\ amu$

$=0.0258\ amu$

$\therefore$ Energy released $E=931\times 0.0258=24\ MeV$

762 **(c)**

$${}^{234}_{92}U\xrightarrow{\alpha}{}^{230}_{90}Th+\alpha$$

The mass number of thorium is 230 and its atomic number, Z is 90

763 **(c)**

As $\frac{I}{I_0}e^{-\mu x}\therefore\frac{1}{8}=e^{-\mu}37.5$ ...(i)

and $\frac{1}{2}=e^{-\mu x}$

Put in Eq. (i), $e^{-3\mu x}=e^{-\mu}(37.5)$

$$x=\frac{37.5}{3}=12.5\text{ mm}$$

764 **(b)**

For Lyman series

$\overline{v}=\frac{1}{\lambda}=R\left(\frac{1}{1^2}-\frac{1}{n^2}\right)$ here $n=2,3,4,5$ ....

For first time $\overline{v}=R\left(\frac{1}{1^2}-\frac{1}{2^2}\right)\Rightarrow\overline{v}=R\left(1-\frac{1}{4}\right)=\frac{3R}{4}$

765 **(c)**

$$\frac{BE}{nucleon}=\frac{0.042\times 931}{7}=5.6MeV$$

766 **(b)**

$$\frac{\text{Binding energy}}{\text{Nucleon}}=\frac{0.0303\times 931}{4}=7$$

767 **(d)**

A beta minus particle (β^-) is an electron.

Emission of β^- involves transformation of a neutron into a proton, an electron and a third particle called antineutrino ($\bar{v}$).

$${}_0n^1={}_1p^1+{}_{-1}\beta^0+\bar{v}$$

769 **(d)**

Number of nuclei remained after time t can be written as

$$N=N_0e^{-\lambda t}$$

Where N_0 is initial number of nuclei of both the substances.

$$N_1=N_0e^{-5\lambda t}\quad .....(i)$$

and $N_2=N_0e^{-\lambda t}$ ....(ii)

Dividing Eq.(i) by Eq.(ii) , we obtain

$$\frac{N_1}{N_2}=e^{(-5\lambda+\lambda)t}=e^{-4\lambda t}=\frac{1}{e^{4\lambda t}}$$

But, we have given

$$\frac{N_1}{N_2}=\left(\frac{1}{e}\right)^2=\frac{1}{e^2}$$

Hence ,$\frac{1}{e^2}=\frac{1}{e^{4\lambda t}}$

Comparing the powers, we get

$$2=4\lambda t$$

or $t=\frac{2}{4\lambda}=\frac{1}{2\lambda}$

770 **(b)**

The size of the atom is of the order of $1\text{Å}=10^{-10}m$

771 **(d)**

As charge number is fixed (=92), therefore, number of protons and electrons is same. As atomic weight is greater by 3, therefore ${}_{92}U^{238}$ contains 3 more neutrons.

772 **(b)**

$$n=\frac{t}{T}=\frac{42}{6}=7$$

$$\frac{N}{N_0}=\left(\frac{1}{2}\right)^n=\left(\frac{1}{2}\right)^7=\frac{1}{128}$$

As rate of disintegration $\propto N$,

$$\therefore\frac{R}{R_0}=\frac{1}{128};R=\frac{R_0}{128}=\frac{1024}{128}=8\min^{-1}$$

773 **(a)**

Relation between half-life and decay constant is

$$T=\frac{1}{\lambda}=\log_e 2$$

774 **(c)**

Remaining material $N=\frac{N}{2^{t/T}}$

$\Rightarrow N = \frac{10}{(2)^{20/15}} = \frac{10}{2.51} = 3.96g$

So decayed material $= 10 - 3.96 = 6.04\ g$

775 **(b)**

$Q = 4(x_2 - x_1)$

777 **(c)**

Helium nucleus $\rightarrow\ _2He^4$

Number of protons $= Z = 2$

Number of neutrons $= A - Z = 2$

778 **(a)**

We know that $E_n = -13.6\frac{z^2}{n^2} = eV$ and $r_n = 0.53\frac{n^2}{Z}$ (Å)

Here for $n = 1, E_1 = -54.4\ eV$

Therefore $-54.4 = -13.6\frac{Z^2}{1^2} \Rightarrow Z = 2$

Hence radius of first Bohr orbit $r = \frac{0.53(1)^2}{2} = 0.265$ Å

779 **(d)**

Fusion reaction of deuterium is

$_1H^2 +\ _1H^2 \rightarrow\ _2He^3 +\ _0n^1 + 3.27\ MeV$

So $E = \frac{6.02\times10^{23}\times10^3\times3.27\times1.6\times10^{-13}}{2\times2} = 7.8 \times 10^{13}J$

$= 8 \times 10^{13}J$

780 **(d)**

Number of wavelength $= \frac{n(n-1)}{2}$, where $n =$ No. of orbit from which transition takes place

$\therefore 6 = \frac{n(n-1)}{2} \Rightarrow n = 4$

In all given options wavelength of emitted radiation's will be maximum for transition $n = 4$ to $n = 3$

781 **(a)**

Wave number $\overline{v} = \frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]; n_2 = \infty$ and $n_1 = 1$

$\Rightarrow \overline{v} = R = 1.097 \times 10^7 m^{-1} = 109700\ cm^{-1}$

782 **(a)**

$\frac{1}{\lambda_{\max}} = R\left[\frac{1}{(1)^2} - \frac{1}{(2)^2}\right] \Rightarrow \lambda_{\max} = \frac{4}{3R} \approx 1213$ Å

and $\frac{1}{\lambda_{\min}} = R\left[\frac{1}{(1)^2} - \frac{1}{\infty}\right] \Rightarrow \lambda_{\min} = \frac{1}{R} \approx 910$ Å

783 **(a)**

Here radius of electron orbit $r \propto 1/m$ and energy $E \propto m$, where m is the mass of the electron

Hence energy of hypothetical atom

$E_0 = 2 \times (-13.6eV) = -27.2eV$ and radius $r_0 = \frac{a_0}{2}$

784 **(d)**

$E_3 = -\frac{13.6}{9} = -1.51eV; E_4 = -\frac{13.6}{16} = -0.85eV$

$\therefore E_4 - E_3 = 0.66\ eV$

785 **(b)**

$E_n = -13.6\left(\frac{z^2}{n^2}\right) = -13.6\left(\frac{4}{4}\right) = -13.6eV$

786 **(a)**

Decay constant remains unchanged in a chemical reaction

787 **(a)**

In the reaction

$_7N^{14} + \alpha \rightarrow\ _8X^{17} +\ _1p^1$

8 is the atomic number of oxygen molecule.

So, here X is oxygen (O_2) molecule.

788 **(a)**

Electronic configuration of iodine is 2, 8, 18, 18, 7

Here $r_n = (0.053 \times 10^{-9}m)\frac{n^2}{Z}$

Here $n = 5$ and $Z = 53$

Hence $r_n = 2.5 \times 10^{-11}m$

789 **(c)**

$mvr = \frac{nh}{2\pi}$, for $n = 1$ it is $\frac{h}{2\pi}$

790 **(a)**

In fusion reaction, two lighter nuclei combine

791 **(d)**

If E is the energy radiated in transition then

$E_{R\to G} > E_{Q\to S} > E_{R\to S} > E_{Q\to R} > E_{P\to Q}$

For getting blue line energy radiated should be maximum $\left(E \propto \frac{1}{\lambda}\right)$. Hence (d) is the correct option

792 **(a)**

$\left|\frac{dN}{dt}\right| =$ |Activity of radioactive substance|

$= \lambda N = \lambda N_0 e^{-\lambda t} \quad (\because N = N_0 e^{-\lambda t})$

Taking log both sides

$\ln\left|\frac{dN}{dt}\right| = \ln(\lambda N_0) - \lambda t$

Hence, $\ln\left|\frac{dN}{dt}\right|$ *versus* t graph is a straight line with slope-λ.

From the graph we can see that,

$\lambda = \frac{1}{2} = 0.5\ yr^{-1}$

Now applying the equation

$N = N_0\ e^{-\lambda t} = N_0\ e^{-0.5\times4.16}$

$= N_0 e^{-2.08} = 0.125\ N_0$

$= \frac{N_0}{8}$

ie, nuclei decreases by a factor of 8.

Hence the answer is 8.

793 **(b)**

Kinetic energy = |Total energy|

794 **(b)**

From Einstein's mass energy relation the energy released is

$$\Delta E = \Delta mc^2$$
where Δm is mass and c is speed is light.
Given
$\Delta m = 1\text{mg} = 1 \times 10^{-6}\text{kg}, c = 3 \times 10^8 \text{ m/s}$
$\therefore \quad \Delta E = 1 \times 10^{-6} \times (3 \times 10^8)^2$
$\Delta E = 9 \times 10^{10}$ J
The rate at which energy is dissipated is known as power, *ie*,
$$P = \frac{\Delta E}{t} = \frac{9 \times 10^{10}}{1} = 9 \times 10^{10}\text{W}$$
Since, 10^3 W = 1k W
$\therefore \quad P = 9 \times 10^7$ kW

795 **(a)**
Diameter of nucleus is of the order of $10^{-14}m$ and radius of first Bohr orbit of hydrogen atom $r = 0.53 \times 10^{-10}m$

797 **(b)**
The given reaction is a nuclear reaction, which can take place only if a proton (a hydrogen nucleus) comes into contact with a lithium nucleus. If the hydrogen is in the atomic from, the interaction between it's electron cloud and the electron cloud of a lithium atom keeps the two nuclei from getting close to each other. Even if isolated protons are used, they must be fired at the Li atom with enough kinetic energy to overcome the electric repulsion between the proton and Li atom

798 **(d)**
$$\frac{3}{2}kT = 7.7 \times 10^{-14}\text{ J}$$
$$\text{T} = \frac{2 \times 7.7 \times 10^{-14}}{3 \times 1.38 \times 10^{-23}} = 3.7 \times 10^9 \text{ K}$$

799 **(b)**
Millikan oil drop method determines the charge on an electron. Liquid drop model explains nuclear fission, Shell model explains the stability of nuclei and Bohr's model accounts for the stability of the atom and the line spectra of hydrogen atom.

800 **(c)**
Average life = 5h, in one average life approximately 63 % radioactive nuclei decay.

801 **(a)**
$$E\left(=\frac{hc}{\lambda}\right) \propto \frac{Z^2}{n^2} \Rightarrow \lambda \propto \frac{1}{Z^2}$$
Hence $\lambda_{He^+} = \frac{20.397}{4} = 5.099\ cm$

802 **(d)**
$$M = M_0\left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}} = 20 \times \left(\frac{1}{2}\right)^{\frac{36}{3.6}} = 20 \times \left(\frac{1}{2}\right)^{10}$$
$$= 0.019mg$$

803 **(d)**
$$A = A_0\left(\frac{1}{2}\right)^{t/T_{1/2}} \Rightarrow 5 \times 10^{-6} = 64 \times 10^{-5}\left(\frac{1}{2}\right)^{t/3}$$
$$\Rightarrow \frac{1}{128} = \left(\frac{1}{2}\right)^{t/3} \Rightarrow t = 21\ days$$

804 **(d)**
$${}_7N^{13} \rightarrow {}_6C^{13} + {}_{+1}e^0$$

805 **(c)**
By using $N = N_0\left(\frac{1}{2}\right)^{t/T}$; where $N = \left(1 - \frac{7}{8}\right)N_0 = \frac{1}{8}N_0$
So $\frac{1}{8}N_0 = N_0\left(\frac{1}{2}\right)^{t/T} \Rightarrow \left(\frac{1}{2}\right)^3 = \left(\frac{1}{2}\right)^{t/5} \Rightarrow t = 15\ days$

806 **(d)**
$$(rm) = \left(\frac{m^2}{Z}\right)(0.53\text{Å}) = (n \times 0.53\text{Å}) \Rightarrow \frac{m^2}{Z} = n$$
$m = 5$ for ${}_{100}Fm^{257}$ [the outermost shell]
and $z = 100 \Rightarrow n = \frac{(5)^2}{100} = \frac{1}{4}$

808 **(d)**
Number of neutrons $= A - Z = 23 - 11 = 12$

809 **(a)**
An atomic reactor or a nuclear pile is a device in which a self-sustaining controlled chain reaction is produced in a fissionable material. It is thus, a source of controlled energy which is utilised for many useful purposes.

810 **(c)**
Energy equivalent to ${}_1H^2 = 2 \times 1.112 = 2.224\ MeV$
Energy equivalent to ${}_2He^4 = 4 \times 7.047 = 28.188\ MeV$
From the equation, energy released
$= 28.188 - 2 \times 2.224 = 23.74\ MeV \approx 24\ MeV$

812 **(b)**
$${}_0n^1 = {}_1p^1 + {}_{-1}e^0 + \overline{v}$$
Antineutrino is required for conservation of spin

813 **(a)**
The nuclei having different Z and A but equal $(A - Z)$ are called isotones

814 **(b)**
Energy of γ-ray photon $= 0.5 + 0.5 + 0.78 = 1.78MeV$

815 **(b)**
$${}_1H^2 + {}_1H^2 \rightarrow {}_2He^4 + \text{energy}$$
Binding energy of a $({}_1H^2)$ deuterium nuclei

$= 2 \times 1.1 = 2.2\ MeV$

Total binding energy of two deuterium nuclei

$= 2.2 \times 2 = 4.4\ MeV$

Binding energy of a $({}_2H^4)$ nuclei $= 4 \times 7 = 28\ MeV$

So, energy released in fusion $= 28 - 4.4 = 23.6\ MeV$

816 **(a)**

Energy ε is related only when lighter nuclei fuse to form a heavier nucleus such as in reaction (i)

$$A + B \rightarrow C + \varepsilon$$

Again ,energy is released when a heavy nucleus splits into lighter nuclei as in(iv)

$$F \rightarrow D + E + \varepsilon$$

817 **(a)**

Activity, $A = \lambda N = \frac{0.693}{T_{1/2}} N$

Where $T_{1/2}$ is the half-life of a radioactive sample,

$\therefore \quad \frac{A_1}{A_2} = \frac{N_1}{T_1} \times \frac{T_2}{N_2}$

$$\frac{T_1}{T_2} = \frac{A_2}{A_1} \times \frac{N_1}{N_2}$$

$$= \frac{2A_1}{A_1} \times \frac{2N_2}{N_2} = \frac{4}{1}$$

818 **(a)**

For X, energy = 200 × 7.4 =1480 MeV

For A, energy = 110 × 8.2 =902 MeV

For B, energy = 80 × 8.1 =648 MeV

Therefore energy released

$$= (902 + 648) - 1480$$

$$= 1550 - 1480 = 70 \text{ MeV}$$

819 **(c)**

Mean life $= \frac{1}{\lambda} = 6.67 \times 10^8 s$

820 **(c)**

Number of neutrons in ${}_{92}U^{235}$

$$= 235 - 92 = 143$$

and number of protons=92

∴ Number of neutrons more than number of protons

$$= 143 - 92 = 51$$

823 **(a)**

Distance of closest approach $r_0 = \frac{Ze^2}{2mv^2\pi\varepsilon_0}$

$\Rightarrow r_0 \propto \frac{1}{m}$

824 **(b)**

During fusion binding energy of daughter nucleus is always greater than the total energy of the parent nuclei so energy released $= c - (a + b) = c - a - b$

825 **(a)**

$$\omega = 2\pi v = \frac{2\pi c}{\lambda} = 2\pi c\overline{v} \Rightarrow \omega \propto \overline{v}$$

826 **(a)**

Orbital speed varies inversely as the radius of the orbit

$v \propto \frac{1}{n}$

827 **(a)**

The energy required to produce a pair of electron –positron is 1.02 MeV

Now, the kinetic energy of electron–positron pair

$$= 2 \times 0.29 \text{ MeV} = 0.58 \text{ MeV}$$

Hence, the energy of photon

$$= (1.02 + 0.58) \text{ MeV} = 1.60 \text{ MeV}$$

828 **(a)**

Rest mass of parent nucleus should be greater than the rest mass of daughter nuclei.

NUCLEI

Assertion - Reasoning Type

This section contain(s) 0 questions numbered 1 to 0. Each question contains STATEMENT 1(Assertion) and STATEMENT 2(Reason). Each question has the 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

a) Statement 1 is True, Statement 2 is True; Statement 2 **is** correct explanation for Statement 1

b) Statement 1 is True, Statement 2 is True; Statement 2 **is not** correct explanation for Statement 1

c) Statement 1 is True, Statement 2 is False

d) Statement 1 is False, Statement 2 is True

1

Statement 1: Cobalt-60 is useful in cancer therapy

Statement 2: Cobalt-60 is source of γ-radiations capable of killing cancerous cell

2

Statement 1: A certain radioactive substance has a half-life period of 30 days. Its disintegration constant is 0.0231 day $^{-1}$

Statement 2: The decay constant is related with half-life $\lambda = \frac{0.6931}{T}$

3

Statement 1: (A) Fission of $^{235}_{92}U$ is brought about by thermal neutron, whereas that of $^{238}_{92}U$ is brought about by a fast neutron.

Statement 2: $^{235}_{92}U$is an even-odd nucleus, whereas $^{238}_{92}U$ is an even-even nucleus.

4

Statement 1: Neutrons penetrate matter more readily as compared to protons

Statement 2: Neutrons are slightly more massive than protons

5

Statement 1: 1 amu is equivalent to 931 MeV.

Statement 2: Energy equivalent (E) or mass (m) is $E = mc^2$

6

Statement 1: $4{}_1^1\text{H} \rightarrow {}_2^4\text{He}^{2+} + 2e^+ + 26$ MeV,represents fusion.

Statement 2: The above case is a β −decay.

7

Statement 1: The binding energy per nucleon, for nuclei with atomic mass number $A > 100$, decreases with A

Statement 2: The nuclear forces are weak for heavier nuclei

8

Statement 1: The positively charged nucleus of an atom has a radius of almost $10^{-15}m$

Statement 2: In α-particle scattering experiment, the distance of closest approach for α-particles is $\simeq 10^{-15}m$

9

Statement 1: If the half-life of a radioactive substance is 40 days then 25% substance decays in 20 days

Statement 2: $N = N_0 = \left(\frac{1}{2}\right)^n$ where $n = \frac{\text{Time elapsed}}{\text{half−life period}}$

10

Statement 1: Balmer series lies in the visible region of electromagnetic spectrum.

Statement 2: $\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{n^2}\right)$, where $n = 3, 4, 5$

11

Statement 1: ${}_ZX^A$undergoes 2α −decays, 2β −decays and 2γ −decays and the daughter product is ${}_{Z-2}Y^{A-8}$

Statement 2: In α-decay the mass number decreases by 4 and atomic number decrease by 2. In β-decay the mass number remains unchanged, but atomic number increases by 1 only

12

Statement 1: Amongst alpha, beta and gamma rays, α-particle has maximum penetrating power

Statement 2: The alpha particle is heavier than beta and gamma rays

13

Statement 1: Energy is released in nuclear fission

Statement 2: Total binding energy of the fission fragments is larger than the total binding energy of the parent nucleus

14

Statement 1: According to classical theory, the proposed path of an electron in Rutherford atom model will be parabolic

Statement 2: According to electromagnetic theory an accelerated particle continuously emits radiation

15

Statement 1: Half-life of a certain radioactive element is 100 days. After 200 days, fraction left undecayed will be 50%

Statement 2: $\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$, where symbols have usual meaning.

16

Statement 1: ^{90}Sr from the radioactive fall out from a nuclear bomb ends up in the bones of human beings through the milk consumed by them. It causes impairment of the production of red blood cells.

Statement 2: The energetic β −particles emitted in the decay of ^{90}Sr damage the bone marrow.

17

Statement 1: $_{38}Sr^{90}$ from the radioactive fall out from a nuclear bomb ends up in the bones of human beings through the milk consumed by them. It causes impairment of the production of red blood cells

Statement 2: The energy β −particle emitted in the decay of ^{90}Sr damage to bone marrow

18

Statement 1: Electron capture occurs more often than positron emission in heavy elements

Statement 2: Heavy elements exhibit radioactivity

19

Statement 1: The mass of β-particles when they are emitted is higher than the mass of electrons obtained by other mean

Statement 2: β-particle and electron, both are similar particles

20

Statement 1: Isobars are the element having same mass number but different atomic number

Statement 2: Neutrons and protons are present inside nucleus

21

Statement 1: For the scattering of α-particles at large angles, only the nucleus of the atom is responsible

Statement 2: Nucleus is very heavy in comparison to electrons

22

Statement 1: The ionizing power of β-particle is less compared to α-particles but their penetrating power is more

Statement 2: The mass of β-particle is less than the mass of α-particle

23

Statement 1: Hydrogen atom consists of only one electron but its emission spectrum has many lines

Statement 2: Only Lyman series is found in the absorption spectrum of hydrogen atom whereas in the emission spectrum, all the series are found

24

Statement 1: The mass of a nucleus can be either less than or more than the sum of the masses of nucleons present in it

Statement 2: The whole mass of the atom is considered in the nucleus

25

Statement 1: Density of all the nuclei is same

Statement 2: Radius of nucleus is directly proportional to the cube root of mass number

26

Statement 1: All nuclei are not of same size

Statement 2: Size depends on atomic mass

27

Statement 1: The force of repulsion between atomic nucleus and α-particle varies with distance according to inverse square law

Statement 2: Rutherford did α-particle scattering experiment

28 This question contains statements I and statements II of the four choices given after the statements, choose the one that best describes the two statements.

Statement 1: Energy is released when heavy nuclei undergo fission of light nuclei undergo fusion.

Statement 2: For heavy nuclei, binding energy per nucleon increases with increasing Z while for light nuclei it decreases with increasing Z.

29

Statement 1: It is not possible to use ^{35}Cl as the fuel for fusion energy

Statement 2: The binding energy of ^{35}Cl is too small

30

Statement 1: On a decay, daughter nucleus shifts two places to the left from the parent nucleus.

Statement 2: An alpha particle carries four units of mass.

31

Statement 1: A nucleus having energyE_1 decays be β^- emission to daughter nucleus having energy E_2, but the β^- rays are emitted with a continuous energy spectrum having end point energy $E_1 - E_2$.

Statement 2: To conserve energy and momentum in $\beta -$ decay at least three particles must take part in the transformation.

32

Statement 1: Radioactive nuclei emits β^{-1} particles

Statement 2: Electrons exist inside the nucleus

33

Statement 1: Radioactivity of 10^8 undecayed radioactive nuclei of half life of 50 days is equal to that of 1.2×10^8 number of undecayed nuclei of some other material with half life of 60 days

Statement 2: Radioactivity is proportional to half-life

34

Statement 1: The ratio of time taken for light emission from an atom to that for release of nuclear energy in fission is 1 : 100.

Statement 2: Time taken of the light emission from an atom is of the order of 10^{-8}s.

35

Statement 1: Electrons in the atom are held due to coulomb forces

Statement 2: The atom is stable only because the centripetal force due to Coulomb's law is balanced by the centrifugal force

36

Statement 1: Bohr had to postulate that the electrons in stationary orbits around the nucleus do not radiate

Statement 2: According to classical physics all moving electrons radiate

37

Statement 1: The ionisation potential of hydrogen to be 13.6 eV, the ionised potential of doubly ionized lithium is 122.4 eV.

Statement 2: Energy in nth state of hydrogen atom is $E_n = -\frac{13.6}{n^2}$

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: ANSWER KEY :

1)	a	2)	a	3)	b	4)	b	21)	a	22)	b	23)	b	24)	d
5)	a	6)	c	7)	c	8)	a	25)	a	26)	a	27)	b	28)	a
9)	d	10)	a	11)	a	12)	d	29)	c	30)	a	31)	c	32)	c
13)	b	14)	d	15)	d	16)	b	33)	c	34)	b	35)	c	36)	b
17)	a	18)	b	19)	b	20)	b	37)	a						

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: HINTS AND SOLUTIONS :

1 **(a)**
Factual

2 **(a)**
From the relation,

$$\lambda = \frac{0.6931}{T}$$

$$\therefore \lambda = \frac{0.6931}{30} = 0.0231 \text{ day}^{-1}$$

3 **(b)**
Fission of U^{235} occurs by slow neutrons only (of energy about 1 eV) or even by thermal neutrons (of energy bout 0.025eV). Fission of $^{238}_{92}U$ is brought about by a fast neutron. $^{235}_{92}U$ has odd mass number and even atomic number, hence it is an even-odd nucleus whereas $^{238}_{92}U$ has even mass number and even atomic number, hence it is an even-even nucleus.

4 **(b)**
Neutron is about 0.1 more massive than proton. But the unique thing about the neutron is that while it is heavy, it has no charge (it is neutral). This lack of charge gives it the ability to penetrate matter without interacting as compared to the beta particles or alpha particles

5 **(a)**
Substituting $m = 1$ amu $= 1.67 \times 10^{-24}$kg and

$c = 3 \times 10^8$ ms^{-1}in the energy-mass equivalence relation

$$E = mc^2$$

$$= 1.67 \times 10^{-27} \times (3 \times 10^8)^2$$

$$= 1.67 \times 10^{-27} \times 9 \times 10^{16}\text{J}$$

$$= \frac{1.67 \times 10^{-27} \times 9 \times 10^{16}}{1.6 \times 10^{-13}}\text{MeV} = 931 \text{ MeV}$$

6 **(c)**
From the reaction hydrogen is converted into helium, with the nucleus releasing two positions and energy. Because of positron emission it cannot be β − decay. The energy emitted and participation of light nuclei correspond to the fusion reaction.

7 **(c)**
Nuclear foce is nearly same for all nucleus

8 **(a)**
In α-particle scattering experiment, Rutherford found a small number of α-particles which were scattered back through an angle approaching to 180°. This is possible only if the positive charges are concentrated at the centre or nucleus of the atom

9 **(d)**

Here, $N = N_0 \left(\frac{1}{2}\right)^{t/T}$

or $\frac{N}{N_0} = \left(\frac{1}{2}\right)^{t/T}$ ...(i)

where T is the half-life period and $\frac{N}{N_0}$ is fraction of atoms left after time t. Here , $T = 40$ days and $\frac{N}{N_0} = \frac{25}{100} = \frac{1}{4}$

Putting the values of T and $\frac{N}{N_0}$ in Eq. (i), we get

$$\frac{1}{4} = \left(\frac{1}{2}\right)^{t/40} \text{ or } \left(\frac{1}{2}\right)^2 = \left(\frac{1}{2}\right)^{t/40}$$

or $\frac{t}{40} = 2$ or $t = 80$ days

10 **(a)**
The wavelength in Balmer series is given by

$$\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{n^2}\right), n = 3,4,5 \ldots$$

$$\frac{1}{\lambda_{max}} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$$

$$\frac{1}{\lambda_{max}} = \frac{36}{5R} = \frac{36 \times 1}{5 \times 1.097 \times 10^7} = 6563 \text{ Å}$$

and $\frac{1}{\lambda_{min}} = R\left(\frac{1}{2^2} - \frac{1}{\infty^2}\right)$

$$\lambda_{min} = \frac{4}{R} = \frac{4}{1.097 \times 10^7} = 3646 \text{ Å}$$

11 **(a)**

In α=decay, the mass number decreases by 4 and atomic number decreases by 2. In β-decay, the mass number does not change but atomic number changes by 1.In α-decay the atomic and mass number remain unchanged.

The reaction can be summarised as

$$_ZX^A \xrightarrow{2\alpha} {}_{Z-4}M^{A-B} \xrightarrow{2\beta} {}_{Z-2}Y^{A-8} \xrightarrow{2\gamma} {}_{Z-2}Y^{A-8}$$

Thus, at a far extent reason explain assertion but not completely

12 **(d)**

The penetrating power is maximum in case of gamma rays because gamma rays are electromagnetic radiations of very small wavelength

13 **(b)**

In a nuclear fission, when a bigger nucleus is fissioned into two light weight nuclei, then due to mass defect some energy is released. According to concept of binding energy, fission can occur because the total mass energy will decrease; that is ΔE_{bn}(binding energy) will increase. We see that for high mass nuclide ($A = 240$), the binding energy per nucleon is about 7.6MeV/nucleon. For the middle weight nuclides ($A = 120$), it is about 8.5 MeV/nucleon. Thus, binding energy of fission fragments is larger than the total binding energy of the parent nucleus

14 **(d)**

According to classical electromagnetic theory, an accelerated charged particle continuously emits radiation. As electrons revolving in circular paths are constantly experiencing centripetal acceleration, hence they will be losing hteir energy continuously and the orbital radius will go on decreasing, form spiral and finally the electron will fall in the nucleus

15 **(d)**

Number of half-lives

$$n = \frac{t}{T} = \frac{200}{100} = 2$$

The fraction left undecayed is given

$$\therefore \frac{N}{N_0} = \left(\frac{1}{2}\right)^n = \left(\frac{1}{2}\right)^2 = \frac{1}{4} = \frac{1}{4} \times 100\% = 25\%$$

16 **(b)**

1. If Assertion is True, Reason is True, Reason is correct explanation of 1
2. If Assertion is True, Reason is True, Reason is not correct explanation of 1
3. If Assertion is True, Reason is False
4. If Assertion is False, Reason is True

17 **(a)**

$_{38}Sr^{90}$decays to $_{39}Y^{90}$when β-rays emission is occurred. Sr gets absorbed in bones along with calcium which causes impairment of the production of red blood cells. So, assertion is true.

Now, $Sr^{90} \xrightarrow{\beta} Y^{90}$

Sr decays to Yttrium Sr ^{90}emits β-rays of very high energy. Bone marrow is damaged by these high energetic β-particles. So, reason is also true

18 **(b)**

Electron capture occurs more often than positron emission in heavy elements. This is because if positron emission is energetically allowed, electron capture is necessarily allowed, but the reverse is not true, *i.e.*, when electron capture is energetically allowed, positron emission is not necessarily allowed

19 **(b)**

β-particles are emitted with very high velocity (up to 0.99 c). So, according to Einstein's theory of relatively, the mass of a β-particle is much higher compared to its rest mass (m_0). The velocity of electrons obtained by other means is very small compared to c (velocity of light). So its mass remains nearly m_0. But β-paricle and electron both are similar particles

21 **(a)**
We know that an electron is very light particle as compared to an α-particle. Hence electron cannot scatter the α-particle at large angles, according to law of conservation of momentum. On the other hands, mass of nucleus is comparable with the mass of α-particle, hence only the nucleus of atom is responsible for scattering of α-particles

22 **(b)**
β-particles, being emitted with very high speed compared to α-particles, pass for very little time near the atoms of the medium. So the probability of the atoms being ionized is comparatively less. But due to this reason, their loss of energy is very slow and they can penetrate the medium through a sufficient depth

23 **(b)**
When the atom gets appropriate energy from outside, then this electron rises to some higher energy level. Now it can return either directly to the lower energy level or come to the lowest energy level after passing through other lower energy levels, hence all possible transitions take place in the source and many lines are seen in the spectrum

24 **(d)**
The whole mass of the atom is concentrated at nucleus and $M_{nucleus}$ < (Sum of the masses of nucleons) because, when nucleons combine some energy is wasted

25 **(a)**
Experimentally, it is found that the average radius of a nucleus is given by

$R = R_0 A^{1/3}$ where $R_0 = 1.1 \times 10^{-15} M = 1.1 fm$

and A = mass number

26 **(a)**
The radius of nucleus is given by $R = R_0 A^{1/3}$ where R_0 is a constant $= 1.1 \times 10^{-15}$m. For different nuclei mass number A is different, therefore R is different

27 **(b)**
Rutherford confirmed that the repulsive force on α-particle due to nucleus varies with distance according to inverse square law and that the positive charges are concentrated at the centre and not distributed throughout the atom

28 **(a)**
Here, statement I is correct and Statement II is wrong can be directly concluded from binding energy/nucleon curve.

29 **(c)**
In fusion, lighter nuclei are used so fusion is not possible with ^{35}Cl. Also binding energy of ^{35}Cl is not too small

31 **(c)**
In particle situation , at least three particles take place in transformation, so energy for β-particle+ energy of third particle= $E_1 - E_2$
Hence, energy of β-particle $\leq E_1 - E_2$

32 **(c)**
Nuclear stability depends upon the ratio of neutron to proton. If the n/p ratio is more than the critical value, then a neutron gets converted into a proton forming a β^- particle in the process
$n \rightarrow p + e^-$

The β^- particle (e^-) is emitted from the nucleus in some radioactive transformation. So electrons do not exist in the nucleus but they result in some nuclear transformation

33 **(c)**
Radioactivity $= -\frac{dN}{dt} = \lambda N = \frac{0.693N}{T_{1/2}}$

$$= \frac{0.693 \times 10^8}{50} = \frac{0.693 \times 1.2 \times 10^8}{60}$$
$$= 0.693 \times 2 \times 10^6$$

Radioactivity is proportional to $1/T_{1/2}$, and not to $T_{1/2}$

35 **(c)**
According to postulates of Bohr's atom model, the electron revolves around the nucleus in fixed orbit of definite radii. As long as the electron is in a certain orbit it does not radiate any energy

36 **(b)**
Bohr postulated that electrons in stationary orbits around the nucleus do not radiate.

This is the one of Bohr's postulate. According to this the moving electrons radiates only when they go from one orbit to the next lower orbit

37 **(a)**

From Bohr's theory the energy of hydrogen atom in the n^{th}state is given by $E_n = \frac{13.6}{n^2}$ eV. For an atom of atomic number Z, with one electron in the outer orbit (singly ionised He or double ionised lithium) we use $E_n = -\frac{13.6Z^2}{n^2}$ eV,where Z is atomic number. Hence, ground state energy of doubly ionised lithium is $\frac{-13.6\times 9}{1^2} = -122.4$ eV

Ionisation potential (potential to be applied to electron to overcome this energy) is 122.4V.

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Matrix-Match Type

This section contain(s) 0 question(s). Each question contains Statements given in 2 columns which have to be matched. Statements (A, B, C, D) in **columns I** have to be matched with Statements (p, q, r, s) in **columns II**.

1. Column II gives certain systems undergoing a process. Column I suggests changes in some of the parameters related to the system. Match the statements in Column I to the appropriate process(es) from Column II

	Column-I		Column- II
(A)	The energy of the system is increased	(p)	System : A capacitor, initially unchanged Process : It is connected to a battery
(B)	Mechanical energy is provided to the system, which is converted into energy of random motion of its parts	(q)	System : A gas in an adiabatic container fitted with an adiabatic piston Process : The gas is compressed by pushing the piston
(C)	Internal energy of the system is converted into its mechanical energy	(r)	System : A gas in rigid container Process : The gas gets cooled due to colder atmosphere surrounding it
(D)	Mass of the system is decreased	(s)	System : A heavy nucleus, initially at rest Process : The nucleus fissions into two fragments of nearly equal masses and some neutrons are emitted
		(t)	System : A resistive wire loop Process : The loop is placed in a time varying magnetic field perpendicular to its plane

CODES :

	A	B	C	D
a)	P,q,s,t	q	s	s
b)	q	s	s	p,q,s,t
c)	s	q	p,q,s,t	s
d)	s	p,q,s,t	q	s

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: ANSWER KEY :

1) a

: HINTS AND SOLUTIONS :

1 **(a)**

(A) (p) Capacitor is charged, hence its energy is increased

(q) The temperature is increased, henc its energy is increased or as the external positive work is done, hence energy increases

(r) The temperature decreases, its energy is decreased

(s) All natural process, energy of the system decreases

(t) The current is produced. Hence energy of the system increases

(B) (p), (r), (s) no mechanical energy is provided to the system

(q) The mechanical energy is provided which increases the temperature and hence random motion of molecules

(t) Mechanical work is done to change the magnetic field, which increases the mechanical energy of electron and these electrons strike with stationary positive charge and energy is converted in random motion

(C) (s) Internal binding energy is converted into mechanical energy

(D) (s) Mass changes only in nuclear process