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PHYSICS

15.STRUCTURE OF ATOMS AND NUCLEI ,9.ATOMS, MOLECULES AND NUCLEI

Single Correct Answer Type

1. Orbital acceleration of electron is
   a) $\frac{n^2h^2}{4\pi^2m^2n^3}$ b) $\frac{n^2h^2}{2n^2r^3}$
   c) $\frac{4\pi^2h^2}{x^2m^2r^3}$ d) $\frac{4n^2h^2}{4\pi^2m^2r^3}$
2. LASER is and acronym of:
   a) Light Analysis of Spontaneous Emission of Radiation
   b) Light Amplification of Spontaneous Emission of Radiation
   c) Light Amplification by Stimulated Emission of Radiation
   d) Light Analysis by Stimulated Emission of Radiation.
3. 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 $n = 5$ level to the $n = 2$ level?
   a) Red b) Yellow c) Green d) Violet
4. 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
5. In electron microscope the beam is focussed on an object by using:
   a) Electric field b) Condenser.
   c) Magnetic field d) Both 'A' and 'C'
6. To explain the theory of hydrogen atom, Bohr considered
   a) quantisation of linear momentum b) quantisation of angular momentum
   c) quantisation of angular frequency d) quantisation of energy
7. The first member of any series in hydrogen atom is (electron jumps from quantum no. p to n)
   a) $p = n + 2$ b) $p = n + 1$
   c) $p = n - 2$ d) $p = n - 1$
8. A body of mass 100 g moves at the speed of 36 km/hr. The de Broglie wavelength related to it is of the order________ m
   $(h = 6.626 \times 10^{-34}$ Js)
   a) 10^{-14} b) 10^{-24} c) 10^{-34} d) 10^{-44}
9. A helium atom at 300 K is moving with a, velocity of 2.40×10^2 ms^{-1}. The de–Broglie wavelength is about (At. wt. of He = 4.0)
   a) 0.416 nm b) 0.83 nm c) 803 Å d) 8000 Å
10. The de-Broglie wavelength of an electron in 4^{th} orbit is (r = radius 1^{st} orbit)
    a) $2\pi r$ b) $4\pi r$ c) $8\pi r$ d) $16\pi r$
11. Given a sample of radium −226 having half-life of 4 days. Find the probability, a nucleus disintegrates after 2 half-lifes.
    a) 1 b) 1/2
    c) 1.5 d) 3/4
12. An electron jumps from the first excited state to the ground state of hydrogen atom. What will be the percentage change in the speed of electron?
    a) 25% b) 500
    c) 100% d) 200%
13. A laser produces
    a) a beam *of* fast moving electrons
    b) a beam *of* X–rays
    c) a beam *of* monochromatic coherent photons
    d) a beam *of* monochromatic incoherent photons
14. Consider 3rd orbit of He^+ (Helium), using non-relativistic approach, the speed of electron in this orbit will be {given, $K = 9 \times 10^9$ constant, $Z = 2$ and h (Planck's constant) $= 6.6 \times 10^{-34}$ J − s }
    a) 2.92×10^6 ms^{-1} b) 1.46×10^6 ms^{-1}
    c) 0.73×10^6 ms^{-1} d) 3.0×10^8 ms^{-1}
15. For an electron to revolve around the atomic nucleus without radiating energy, the electronic orbit should be
    a) Circular
    b) Elliptical
    c) such that the angular momentum of the electron is an integral multiple of the

Planck's constant

d) such that it contains an integral number of the de–Broglie's wavelengths of the electron

16. The de-Broglie wavelength of an electron in 4 th orbit is (r = radius of 1st orbit)

a) $2\pi r$ b) $4\pi r$
c) $8\pi r$ d) $16\pi r$

17. Optical pumping is a process by which atoms are:

a) raised from ground state to excited state
b) lowered from excited state to ground state
c) raised to a position in between ground and excited state
d) raised from excited state to infinity

18. The speed of an electron in first Bohr orbit is v then the speed of an electron in 3rd Bohr orbit is:

a) V b) 3V c) $\frac{V}{3}$ d) 9V

19. Through what potential difference should an electron be accelerated so that its de–Broglie wavelength becomes 0.4 Å?

a) 999 V b) 242 V c) 941 V d) 520 V

20. 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) $n\lambda$

21. 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

22. In the Bohr's theory of H atom

a) The radius of the n^{th} orbit is proportional to n^2
b) Angular momentum is equal to $nh/2\pi$
c) The magnitude of the P. E. of the electron in any orbit is greater than its kinetic energy
d) All of these

23. Protons and α particles have the same de–Broglie wavelength. What is same for both of them?

a) mass b) linear momentum
c) frequency d) energy

24. The de Broglie wavelength of an electron revolving in the ground state orbit is

a) πr b) πr^2 c) $2\pi r$ d) $\sqrt{2\pi r}$

25. The average value of nuclear density in kg m^{-3} is

a) 10^{14} b) 10^{17} c) 10^{11} d) 10^8

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

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

27. During mean life of a radioactive element, the fraction that disintegrates is

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

28. An α-particle moving with a constant energy is scattered by the nucleus. The scattering angle will be maximum when the α-particle

a) Approaches the nucleus head on
b) Just passes the nucleus
c) Passes at large distance from the nucleus
d) Is attracted by the nucleus

29. Quantum condition is expressed as

a) $mvr = n\frac{h}{2\pi}$ b) $E_1 - E_r = hv$
c) $F = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2}$ d) $F = \frac{mv^2}{r}$

30. If an electron is revolving around the hydrogen nucleus at a distance of 0.1 nm, what should be speed ?

a) $2.188 \times 10^6\ ms^{-1}$ b) $1.094 \times 10^9\ ms^{-1}$
c) $4.376 \times 10^6\ ms^{-1}$ d) $159 \times 10^6\ ms^{-1}$

31. The correct formula for the wave number $\bar{V}$ when electron jumps from quantum number p to quantum number n is

a) $\bar{V} = R\left[\frac{1}{p^2} - \frac{1}{n^2}\right]$ b) $\bar{V} = R\left[\frac{1}{n^2} - \frac{1}{p^2}\right]$
c) $\bar{V} = \frac{R}{h}\left[\frac{p}{1} - \frac{1}{n}\right]$ d) $\bar{V} = R\left[\frac{1}{p} - \frac{1}{n}\right]$

32. In an atom, two electrons move round the nucleus in circular orbits of radii R and 4R. The ratio of the times taken by them to complete one revolution is

a) $\frac{1}{64}$ b) $\frac{1}{8}$ c) $\frac{4}{1}$ d) $\frac{2}{1}$

33. If an electron in hydrogen atom jumps from an orbit of level n = 3 to an orbit of level n = 2, emitted radiation has a frequency (R = Rydberg’s constant, c = velocity of light)

a) $\frac{3Rc}{27}$ b) $\frac{Rc}{25}$ c) $\frac{8Rc}{9}$ d) $\frac{5Rc}{36}$

34. A dust particle of mass 2 mg is carried by wind with a velocity of 100 cm/s. What is the de-Broglie wavelength associated with the dust

particle? ($h = 6.63 \times 10^{-34} J - s$)

a) $3.32 \times 10^{-31} m$ b) $6.64 \times 10^{-30} m$
c) $3.32 \times 10^{-34} m$ d) $3.32 \times 10^{-28} m$

35. According to Bohr the difference between the energies of the electron in the two orbits is equal to

a) h v b) hc/ λ
c) Both 'A' and 'B' d) Neither' A' nor 'B'

36. Using Bohr's model, the orbital period of electron in hydrogen atom in nth orbit is ($\varepsilon_0 =$ permittivity of free space, $h =$ Planck's constant, $m =$ mass of electron and $\theta =$ electronic charge)

a) $\frac{2\varepsilon_0^2 n^3 h^3}{me^4}$ b) . $\frac{8e_0^2 n^3 h^3}{me^4}$
c) $\frac{2E_0 n^2 h^2}{me^4}$ d) $\frac{4\varepsilon^2 n^3 h^3}{me^4}$

37. An electron of stationary hydrogen atom jumps from 4th energy level to ground level. The velocity that the photon acquired as a result of electron transition will be where, h=Plank's constant, R=Rydberg's constant and m=mass of photon)

a) $\frac{9\ Rh}{16\ m}$ b) $\frac{11\ hR}{16\ m}$
c) $\frac{13\ hR}{16\ m}$ d) $\frac{15\ hR}{16\ m}$

38. Hydrogen ($_1H^1$), deuterium ($_1H^2$), singly ionised helium ($_2He^4)^*$ and doubly ionised lithium ($_3Li^8)^{++}$ all have one electron around the nucleus.
Consider an electron transition from $n = 2$ to $n = 1$.
If the wavelengths of emitted radiation are $\lambda_1, \lambda_2, \lambda_3$ and λ_4 respectively, for tour elements. then approximately which one of the following is correct?

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

39. When electron moves in orbit round the nucleus, it has:

a) Potential energy only b) Kinetic energy only
c) Both 'A' and 'B' d) Zero energy

40. The wavelength of radiation emitted is λ_0 when an electron in hydrogen atom jumps from 3rd to 2 nd orbit. If in the hydrogen atom itself, the electron jumps from 4 th orbit to 2 nd orbit. Then, wavelength of emitted radiation will be

a) $\frac{25}{16}\lambda_0$ b) $\frac{27}{20}\lambda_0$
c) $\frac{20}{27}\lambda_0$ d) $\frac{16}{25}\lambda_0$

41. The ratio of the wavelengths of H_α and H_β lines of Paschen series is of the order of

a) 10 b) 1/10 c) 1.5 d) 100

42. Electron microscope was invented by :

a) Zernicke b) Lehmann
c) Knoll and Ruska d) Janseen and jana

43. 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

44. In hydrogen spectrum as the energy of energy level increases the spacing between them

a) Increases b) Decreases
c) Remains same d) Not predicted

45. The binding energy of an electron in the hydrogen atom is

a) Greater than total energy of electron.
b) Equal to total energy of electron
c) Less than total energy of electron
d) Numerically equal to total energy of electron from the

46. Relation between nuclear radius r and mass number A is given by

a) $r = r_0 A^3$ b) $r = r_0 A^{-1/3}$
c) $r = r_0 A$ d) $r = r_0 A^{1/3}$

47. When an electron of charge 'e' and mass m is accelerated through a potential difference of . V volt, the wavelength associated with the particle:

a) $\lambda = \frac{12.7}{V} A^0$ b) $\lambda = \frac{1.227}{\sqrt{V}} A^0$
c) $\lambda = \frac{12.27}{\sqrt{V}} A^0$ d) $\lambda = \frac{12.27}{V} A^0$

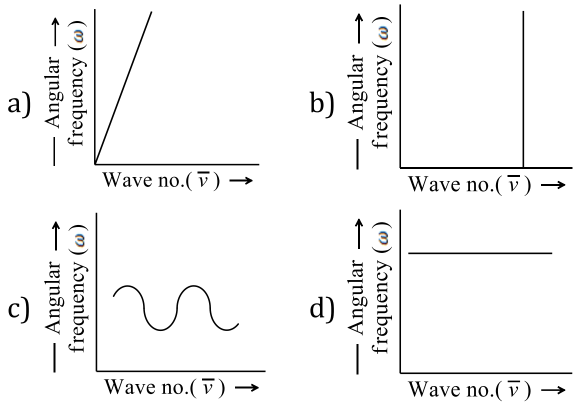
48. Electron microscope is NOT used in

a) Investigation of atomic structure
b) Surface mapping and analysis of materials
c) To give details of textile fibres, surfaces and

polymers
d) To study structure of electron

49. As the radius of orbit in Bohr's atom increases, the P. E. of the electron
a) Decreases
b) Increases
c) Remains same
d) May increase or decrease

50. The graph between wave number ($\bar{v}$) and angular frequency (ω) is



51. If the wavelength of spectral line emitted by , hydrogen gas is 6560 A.U., the transition of electron must be :
a) $4 \rightarrow 2$ b) $3 \rightarrow 2$ c) $5 \rightarrow 2$ d) $2 \rightarrow 1$

52. 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) 24 hR/25 m b) 25 hR/24 m
c) 25m/24 hR d) 24 m/25 hR

53. Age of a tree is determined by using radio-isotope of
a) Carbon b) Cobalt
c) Iodine d) Phosphorus

54. The energy of an electron
a) Is greater in outer orbit
b) Is greater in inner orbit than in outer orbit
c) Is always the same whichever is the orbit
d) Decreases or depends on the atomic number of atom

55. E_1 is the energy of electron in first Bohr's orbit and R (Rydberg's constant) Then they are elated as :
a) $E_1 = \frac{Ch}{R}$ b) $E_1 = ChR$
c) $E_1 = -ChR$ d) $E_1 = \frac{R}{Ch}$

56. If series limit of Balmer series is 6400 Å, then series limit of Paschen series will be
a) 64000 Å b) 18680 Å c) 14400 Å d) 2400 Å

57. According to Bohr's postulates, which of the following quantities takes discrete values?
a) Kinetic energy b) Angular momentum
c) Potential energy d) Linear momentum

58. The necessary condition for laser is
a) Population density b) Population constant
c) Population inversion d) Population explosion

59. In the reaction
${}_{Z}X^{A} \rightarrow {}_{Z+1}Y^{A} \rightarrow {}_{Z-1}K^{A-4} \rightarrow {}_{Z-1}K^{A-4}$,
Radioactive radiations are emitted in the sequence
a) α, β, γ b) β, α, γ c) γ, α, β d) β, γ, α

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

61. The potential energy of an electron in n^{th} Bohr orbit is :
a) Directly proportional to radius
b) Directly proportional to square of radius
c) Inversely proportional to square of radius
d) Inversely proportional to radius

62. Which of the following quantity is independent of principle quantum number (n)
a) V.r b) e. ε_0 c) E.R d) E/r

63. Alpha–particles that come closer to nuclei
a) Are deflected more
b) Are deflected less
c) Make more collisions
d) Are solved down more

64. Bohr's atom model is the modification of Rutherford's atom model by the application of
a) Newtons theory
b) Huygen's theory
c) Maxwell's theory
d) Planck's quantum theory

65. 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 level is
a) 6.95×10^{14} Hz b) 3.68×10^{15} Hz
c) 5.6×10^{14} Hz d) 7.28×10^{14} Hz

66. If an electron has an energy such that its de Broglie wavelength is 5500 Å, then the energy value of that electron is ($h = 6.6 \times 10^{-34}$ Js, $m_c = 9.1 \times 10^{-31}$kg)
a) 8×10^{-20} J b) 8×10^{-10} J
c) 8 J d) 8×10^{-25} J

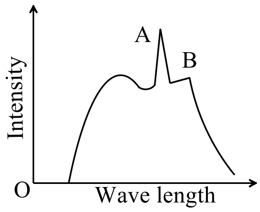
67. If the electron in hydrogen atom jumps from

second Bohr orbit to ground state and difference between energies of the two states is radiated in the form of photons. If the work function of the material is 4.2eV, then stopping potential is

(Energy of electron in nth orbit $= -\frac{13.6}{n^2}$ eV)

a) 2 V b) 4 V
c) 6 V d) 8 V

68. The figure represents the observed intensity of X-rays emitted by an X-ray tube as a function of wavelength. The sharp peaks A and B denote



a) Band spectrum
b) Continuous spectrum
c) Characteristic spectrum
d) White spectrum

69. The activity of a radioactive sample is measured as 9750 count per min at $t = 0$ and 975 count per min at $t = 5$ min. The decay constant is nearly

a) $0.922\ min^{-1}$ b) $0.691\ min^{-1}$
c) $0.461\ min^{-1}$ d) $0.230\ min^{-1}$

70. When the electron in hydrogen atom is excited from the 4^{th} stationary orbit to the 5^{th} stationary orbit, the change in the angular momentum of the electron in joule-second is ($h = 6.64 \times 10^{-34}$Js)

a) 4.16×10^{-34} b) 3.32×10^{-34}
c) 1.05×10^{-34} d) 2.08×10^{-34}

71. If R and R' are the Rydberg constants for hydrogen and helium respectively, then:

a) R' = R b) R' < R c) R' > R d) R' = 8R

72. The half-life of Bi^{210} is 5 days. What time is taken by $(7/8)^{th}$ part of the sample to decay?

a) 3.4 days b) 10 days c) 15 days d) 20 days

73. Electrons in the atom are held by :

a) Nuclear forces b) Coulomb forces
c) Gravitational forces d) Vender war's forces

74. An electron microscope is superior to an optical microscope in

a) Quick in of observation
b) Being easy to handle
c) Having a higher resolving power
d) Being cheap and handly

75. The Lyman transitions involve

a) largest changes of energy
b) smallest changes of energy
c) largest changes of potential energy
d) Smallest changes in potential energy

76. The orbital velocity of the electron in the ground state of hydrogen atom is v. What will be its orbital velocity when excited to the energy state −0.544 eV?

a) $\frac{v}{9}$ b) $\frac{v}{4}$ c) $\frac{v}{5}$ d) $\frac{v}{2}$

77. In the process of nuclear fusion,

a) Only heavy nucleus break into light nuclei
b) Fusion of light nuclei at normal temperature takes place
c) Fusion of light nuclei at high pressure and low temperature takes place
d) Fusion of light nuclei at high pressure and high temperature takes place

78. An electron with kinetic energy 5eV is incident on an H-atom in its ground state. The collision

a) must be elastic b) may be partially elastic
c) may be completely elastic d) may be completely inelastic

79. The rest mass of an electron as well as that of positron is 0.51 MeV. When an electron and positron 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 ∞

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

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

81. In hydrogen atom spectrum, frequency of 27×10^{15} Hz of electromagnetic wave is emitted when transmission takes place from 2 to 1 . If it moves from 3 to 1 , the frequency emitted will be

a) 3.2×10^{15} Hz b) 32×10^{15} Hz
c) 1.6×10^{15} Hz d) 16×10^{15} Hz

82. Transitions between three energy levels in a particular atom give rise to three spectral lines of wavelengths, in increasing magnitude, λ_1, λ_2 and λ_3. Which one of the following equations correctly relates λ_1, λ_2 and λ_3?

a) $\lambda_1 = \lambda_2 - \lambda_3$ b) $\lambda_1 = \lambda_2 < \lambda_3$
c) $\frac{1}{\lambda_1} = \frac{1}{\lambda_2} + \frac{1}{\lambda_3}$ d) $\frac{1}{\lambda_1} = \frac{1}{\lambda_3} - \frac{1}{\lambda_2}$

83. The size of atom is nearly equal to :

a) 10^{-14}m b) 10^{-8}m c) 10^{-10}m d) 10^{-12}m

84. In an orbit of hydrogen atom, the ratio of kinetic energy and potential energy of an electron is
a) 1/2 b) 2 c) $-1/2$ d) -2
85. Kinetic energy of the electron in the first Bohr orbit of the hydrogen atom is
a) -13.6 eV b) 13.6 eV
c) -27.2 eV d) -6.8 eV
86. Binding energy per nucleon for C^{12} is 7.68 MeV and that for C^{13} us 7.47 MeV. The energy required to remove a neutron from C^{13} is
a) 5.49 MeV b) 4.95 MeV
c) 9.45 MeV d) 5.94 MeV
87. 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 to closest approach is r_0. The energy of the projectle is
a) directly proportional to $M_1 \times M_2$ b) directly proportional to Z_1, Z_2
c) directly proportional to Z_1 d) directly proportional to mass M,
88. The radius of hydrogen atom in its ground state is 5.3×10^{-11} m. After collision with an electron, it is found to have a radius of 21.2×10^{-11} m. What is the principal quantum number n of the final state of atom?
a) $n = 4$ b) $n = 2$
c) $n = 16$ d) $n = 3$
89. The de-Broglie wavelength of a particle with mass 1 g and velocity 100 m/s
a) 6.63×10^{-35}m b) 6.63×10^{-34}m
c) 6.63×10^{-33}m d) 6.63×10^{-32}m
90. Angular speed of an electron in the Bohr's orbit is given by
a) $\omega = \frac{\pi m e^4}{2 \in_0^2 n^3 h^3}$ b) $\omega = \frac{4 \in_0^2 n^3 h^3}{m e^4}$
c) $\omega = \frac{m e^4}{4 \in_0^2 n^3 h^3}$ d) All of these
91. Which of the following is stable?
a) Proton b) Positron c) Neutron d) Electron
92. The ratio of speed of an electron in the ground state in the Bohr's first orbit of hydrogen atom to velocity of light (c) is
(γ = Planck's constant, ε_0 = permittivity of free space and θ = charge on electron)
a) $\frac{2\theta^2\varepsilon_0}{hc}$ b) $\frac{e^3}{2\varepsilon_0 hc}$
c) $\frac{e^2}{2\varepsilon_d hc}$ d) $\frac{2\varepsilon_0/hc}{e^2}$
93. Ionization potential of hydrogen atom is 13.6 eV. Hydrogen atom in the ground state is excited by monochromatic radiation of photon energy 12.1 eV. The number of spectral lines emitted by hydrogen atoms according to Bohr's theory will be
a) 1 b) 2 c) 3 d) 4
94. A radioactive decay can form an isotope of the original nucleus with the emission of particles
a) One α and one β b) One α and four β
c) Four α and one β d) One α and two β
95. The integral multiple of $\frac{h}{2\pi}$ for nonradiative stationary orbit is known as :
a) Orbital quantum number
b) Magnetic quantum number
c) Principal quantum number
d) Spin quantum number
96. If E and λ are energy and de Broglie wavelength of particle of mass m moving with a velocity V, then the energy will be :
a) $E = \frac{1}{2m}\left(\frac{h}{\lambda}\right)^2$ b) $E = \frac{1}{2m}\left(\frac{\lambda}{h}\right)^2$
c) $E = \frac{m}{2}\left(\frac{h}{\lambda}\right)^2$ d) $E = \frac{1}{2m} \times \frac{h}{\lambda}$
97. Atom consists negatively charged electron embeded in a positively charged sphere was given by:
a) J. J. Thomson b) Rutherford
c) Sommerfeld d) Bohr
98. The ratio of molecular masses of two radioactive substances is 3/2 and the ratio of their decay constants is 4/3. Then, the ratio of their initial activities per mole will be
a) 2 b) 4/3
c) 8/9 d) 9/8
99. From Rutherford's experiment, estimated sizes of nucleus and atom are
a) 10^{-15} m, 10^{-10} m b) 10^{-13} m, 10^{-14} m
c) 10^{-15} m, 10^{-20} m d) 10^{-15} m, 10^{-15} m
100. What will be the angular momentum in fourth orbit, it L is the angular momentum of the electron in the second orbit of hydrogen atom?
a) 2L b) $\frac{3}{2}$L

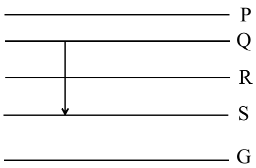
c) $\frac{2}{3}L$ d) $\frac{L}{2}$

101. A material found within the body of an organism trapped in an ice berg had a $_6C^{14}$ activity of about 0.144 Bq per g. $_6C^{14}$ activity of the living organism is 0.28 Bq per g and its half life 5730 years. The age of the organism would be
a) 1250 yr b) 2400 yr c) 5500 yr d) 7600 yr

102. The nuclear force
a) is purely an electrostatic force
b) obeys inverse square law of distance
c) is equal in strength to gravitational force
d) is short range force

103. The ionization potential of hydrogen atom is 13.6 volt. The energy required to remove an electron in the $n = 2$ state of the hydrogen atom is
a) 27.2 eV b) 13.6 eV c) 6.8 eV d) 3.4 eV

104. 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

105. First orbit velocity of electron is 2.1×10^6 m/s then the velocity of 3rd orbit electron is
a) $7 \times 10^6 m/s$
b) $6 \times 10^6 m/s$
c) $7 \times 10^7 m/s$
d) $0.7 \times 10^6 m/s$

106. Life time of a state is the:
a) Stay time in ground state
b) average stay time in ground state
c) stay time in excited state
d) average stay time in excited state

107. Nucleons are
a) Protons and neutrons
b) Protons and electrons
c) Neutrons and electrons
d) All of the above

108. If the kinetic energy of free electron is made double, the new de Broglie wavelength will be ______ times that of initial wave length
a) $\sqrt{2}$ b) $\frac{1}{\sqrt{2}}$ c) 2 d) $\frac{1}{2}$

109. Half-life of a substance is 10 minutes. The time between 33% decay and 67% decay is
a) 5 min b) 10 min c) 20 min d) 40 min

110. If the electron in the hydrogen atom jumps from third orbit to second orbit, the wavelength of the emitted radiation in term of Rydberg constant is
a) $\frac{6}{5R}$
b) $\frac{36}{5R}$
c) $\frac{64}{7R}$
d) None of these

111. 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) $\lambda(A_1 - A_2)$

112. In He–Ne laser the percentage of a mixture of helium and neon respectively is about
a) 40 % and 60 %
b) 50 % and 50 %
c) 10 % and 90 %
d) 90 % and 10 %

113. The de-Broglie wavelength 'λ' of a particle
a) Is proportional to mass
b) Is proportional to impulse
c) Is inversely proportional to impulse
d) Does not depend on impulse

114. Of the following transactions in hydrogen atom, the one which gives an absorption line of lowest frequency is:
a) $n = 1$ to $n = 2$
b) $n = 3$ to $n = 8$
c) $n = 2$ to $n = 1$
d) $n = 8$ to $n = 3$

115. Rutherford's atomic model was failed because, he assumed that:
a) Electrons revolve along only permitted circular orbits
b) Electrons are positively charged and protons are –ve ly charged
c) Electrons are negatively charged and protons are positively charged
d) Electrons revolve along a circular orbits of any radii and radiate energy

116. A diatomic molecule is made of two masses m, and m_2 which are separated by a distance r. If we calculate its rotational energy by applying Bohr's rule of angular momentum quantisation, its energy will be given by (n is an integer)
a) $\frac{(m_1+m_2)^2n^2h^2}{2m_1^2m_2^2r^2}$
b) $\frac{n^2h^2}{2(m_1+m_2)r^2}$
c) $\frac{2n^2h^2}{(m_1+m_2)r^2}$
d) $\frac{(m_1+m_2)n^2h^2}{2m_2r_2r^2}$

117. The half life of a radioactive substance is 20 minutes. The time taken between 50% decay and 87.5% decay of the substance will be
a) 25 minutes b) 30 minutes
c) 10 minutes d) 40 minutes

118. Centripetal acceleration of electron in the first Bohr orbit will be
a) $9 \times 10^{22}\ m/s^2$ b) $4 \times 10^{22}\ m/s^2$
c) $6 \times 10^{22}\ m/s^2$ d) $2 \times 10^{22}\ m/s^2$

119. A small particle of mass m moves such that potential energy $PE = \frac{1}{2}mr^2\omega^2$. Assuming Bohr's model of quantisation of angular momentum and circular orbit, radius of r th orbit is proportional to
a) $\sqrt{n}$ b) $\sqrt{n^3}$
c) $\frac{1}{\sqrt{n}}$ d) $\frac{1}{\sqrt{n^3}}$

120. 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

121. The idea of matter wave was given by :
a) Einstein b) de–Broglie
c) Plank d) Thomson

122. 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. Then, the ratio n_1/n_2
a) 4: 3 b) 3: 4
c) 2: 1 d) 1: 2

123. The ionisation energy of Li^{2+} is equal to
a) 9hcR b) 6hch
c) 2hc R d) hcR

124. 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) $\lambda = \frac{9}{5R}$

125. Which of the following transitions gives the highest frequency for electron emission?
a) $n_1 = 1$ to $n_2 = 2$ b) $n_1 = 2$ to $n_2 = 1$
c) $n_1 = 2$ to $n_2 = 5$ d) $n_1 = 5$ to $n_2 = 2$

126. The fraction of atoms of radioactive element that decays in 6 days is 7/8. The fraction that decays in 10 days will be
a) 77/80 b) 71/80
c) 31/32 d) 15/16

127. The ratio of the speed of an electron in ground state of Bohr's first orbit of hydrogen atom to velocity of light in air is
a) $\frac{e^2}{2\epsilon_0 nh}$ b) $\frac{2\epsilon_0 hc}{e^2}$ c) $\frac{e^2}{2\epsilon_0 hc}$ d) $\frac{2\epsilon_0 nh}{e^2}$

128. Energy of the lowest level of hydrogen atom is −13.6 eV. The energy of the photon emitted in the transition from $n = 3$ to $n = 1$ is
a) 27 eV b) 9 eV c) 3 eV d) 12.09 eV

129. The potential energy of the orbital electron in the ground state of hydrogen atom is −E, what is the kinetic energy?
a) 4E b) 2E
c) $\frac{E}{2}$ d) $\frac{E}{4}$

130. Approximate value of wavelength of electron waves in Davisson experiment at maximum diffraction is
a) 1.67 Å b) 1.65 Å c) 1.22 Å d) 1.81 Å

131. Rutherford's atomic model could account for
a) stability of atoms b) origin of spectra
c) the positive charged central core of an atom d) concept of stationary orbits

132. The average life T and the decay constant λ, of a radioactive nucleus are related as
a) $T\lambda = 1$ b) $T = \frac{0.693}{\lambda}$
c) $\frac{T}{\lambda} = 1$ d) $T = \frac{c}{\lambda}$

133. The ratio of the largest to shortest wavelengths in Lyman series of hydrogen spectra is
a) $\frac{25}{9}$ b) $\frac{17}{6}$ c) $\frac{9}{5}$ d) $\frac{4}{3}$

134. Which of the statement is correct as regards to hydrogen spectrum
a) There are finite lines inlyman series
b) There are finite lines in balmer series
c) There are infinite lines in microfarad region
d) There are infinite lines in ultraviolet region

135. The activity of a radioactive sample is measured as N_0 counts per minute at $t = 0$ and Nie counts per minute at = 5 min. The time (in min) at which the activity reduces to half of its value is
a) $\log_e 2/5$ b) $\frac{5}{\log_e 2}$
c) $5\log_{10} 2$ d) $5\log_4 2$

136. The de–Broglie wavelength of an electron moving with speed of 6.6×10^5 m/s is nearly equal to :
a) 10^{-11} m b) 10^{-9} m c) 10^{-7} m d) 10^{-5} m

137. With increasing quantum number, the energy ,

difference between adjacent energy levels ina hydrogen atom

a) Decreases
b) Increases
c) Remains constant
d) Decreases for low z and increases for high z.

138. In Davisson-Germer experiment, when electron strikes the Ni-crystal, which of the following is produced?

a) X-rays b) γ-rays
c) Electrons d) Photon

139. Mass defect of a nucleus is the

a) Difference between sum of masses of constituent nucleons and actual mass of nucleus
b) Difference between mass of proton and mass of neutron
c) Difference between mass of nucleus and mass of electrons
d) Difference between actual mass of nucleus and sum of masses of constituent nucleons

140. A hydrogen atom is in excited state of principal quantum number n. It emits a photon of wavelength λ, when returns to ground state. The value of n is

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

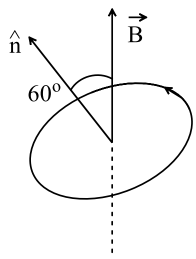
141. Which device is used to emit electrons in the electron microscope?

a) Electron gun
b) Cathode plate
c) Anode plate
d) Electrode positively charged

142. Balmer series of hydrogen atom lies in

a) microwave region b) visible region
c) ultraviolet region d) infrared region

143. An electron in the ground state of hydrogen atom is revolving in anticlockwise direction in the circular orbit of radius R. The atom is placed in a uniform magnetic induction B such that the plane normal of the electron orbit makes an angle 60° with the magnetic induction. The torque experienced by the electron is



a) $\frac{ehB\sqrt{2}}{4\pi m}$ b) $\frac{ehB\sqrt{2}}{8\pi m}$ c) $\frac{ehB\sqrt{3}}{4\pi m}$ d) $\frac{ehB\sqrt{3}}{8\pi m}$

144. In a radioactive material the activity at time f_1 is R_1. and at a later time t_2, it is R_2. If the decay constant of the material is λ_1, then

a) $R_1 = R_2 e^{-\lambda l_1 - t_2 l}$ b) $R_1 = R_2 e^{\mu t_2 - t_2 !}$
c) $R_1 = R_2(t_2/t_1)$ d) $R_1 = R_2$

145. According to Bohr's postulates which of the following quantities takes discrete values

a) Kinetic energy b) Angular momentum
c) Potential energy d) Linear momentum

146. In Bohr's atomic model, the lowest orbit corresponds to

a) Zero energy b) Minimum energy
c) Maximum energy d) Infinite energy

147. 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

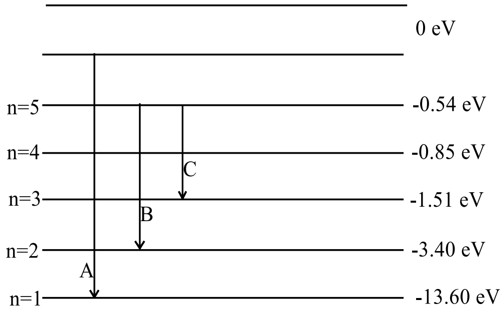
148. In Balmer series, wavelength of first line is λ_1 and in Brackett series, wavelength of first line is λ_2, then $\frac{\lambda_1}{\lambda_2}$ is

a) 0.162 b) 0.124
c) 0.138 d) 0.188

149. In stimulated emission process, photons are emitted

a) by their own
b) when photons stimulate the atoms
c) both 'A' and 'B'
d) neither 'A' nor 'B'

150. In figure, the energy levels of the hydrogen atom have been shown along with some transitions marked A, B, C. The transitions A, B and C respectively, represents



a) the first member of the Lyman series, third member of Balmer series and second member of Paschen series
b) the ionisation potential of H, second member of Balmer series and third member of Paschen series
c) the series limit of Lyman series, second member of Balmer series and second member of Paschen series
d) the series limit of Lyman series, third member of Balmer series and second member of Paschen series

151. Wavelength of electron beam used in electron , microscope is
a) 2×10^{-5} m
b) 5×10^{-12} m
c) 1.2×10^{-10} m
d) 0.2×10^{-10} m

152. Binding energy of a nucleus is equivalent to
a) Mass of the proton
b) Mass of the neutron
c) Mass of the nucleus
d) Mass defect of the nucleus

153. Find the de-Broglie wavelength of an electron with kinetic energy of 120 eV
a) 112 pm b) 95 pm c) 124 pm d) 102 pm

154. The repulsive force between the positively charged protons does not throw them apart because
a) Coulomb force does not act at small distances
b) Nuclear forces are stronger
c) Neutrons sit in between the protons
d) Electrons revolves around nucleus

155. The wavelength of the first line of the Lyman series of hydrogen is 121.6 nm. The wavelength of the second member of the Balmer series is
a) 30.4 nm b) 60.8 nm c) 243.2 nm d) 486.4 nm

156. A Laser is a coherent source because it contains
a) many wavelength
b) unco–ordinated wave of a particular wavelength
c) co–ordinated wave of a many wavelength
d) co–ordinated wave of a particular wavelength

157. The energy radiated from a source is in the form of
a) Atoms
b) Photons
c) Electrons
d) Deuterons

158. Line spectrum is obtained from the substance in
a) Atomic state
b) Molecular state
c) Nuclear state
d) None of these

159. The energy required to remove an electron in hydrogen atom from n = 10 state is :
a) 13.6 eV
b) 0.136 eV
c) 1.36 eV
d) 0.0136 eV

160. Which of the following isotopes is fissionable?
a) $_{92}U^{238}$ b) $_{92}Np^{239}$ c) $_{92}U^{235}$ d) $_{2}He^{4}$

161. The first line of Balmer series has wavelength 6563 Å. What will be the wavelength of the first member of Lyman series?
a) 1215 Å b) 2500 Å c) 7500 Å d) 600 Å

162. For uranium nucleus, how does its mass very with volume?
a) $m \propto V$ b) $m \propto 1/V$ c) $m \propto \sqrt{V}$ d) $m \propto V^2$

163. Which series of H_2 atom lie in infrared region?
a) Lyman
b) Balmer
c) Brackett, Paschen, Pfund
d) All of these

164. When hydrogen atom is in its first excited lever, its radius is :
a) Same
b) Half
c) Twice
d) Four times

165. The half-life of a radioactive isotope X is 20yr. It deceys to another element Y which is stable. The two elements X and Y were found to be in the ratio 1: 7 in a sample of a given rock. The age of the The age of the rock is estimeted to be
a) 40yr
b) 60yr
c) 80yr
d) 100yr

166. The shortest wavelength for Lyman series is 912 Å. What will be the longest wavelength in Paschen series?
a) 1216 Å b) 3646 Å c) 18751 Å d) 8208 Å

167. In tritium nucleus, there are
a) One proton +1 neutron
b) One proton +2 neutrons
c) 1 proton +3 neutrons
d) 1 proton +4 neutrons

168. According to Bohr's model an electron can continuously revolve around the nucleus if its orbit is a circle of:
a) Permitted radius b) Decreasing radius
c) Increasing radius d) Orbitrary radius

169. In the given nuclear reaction A, B, C, D, E represent
$_{92}U^{238} \xrightarrow{\alpha} {}_{B}Th^{A} \xrightarrow{\beta} {}_{D}Pa^{C} \xrightarrow{E} {}_{92}U^{234}$
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) $A = 234, B = 90, C = 234, D = 93, E = \alpha$

170. If an electron in hydrogen atom jumps from an orbit of ' 'evel $n = 3$ to an orbit of level $n = 2$, emitted radiation has a frequency
($R =$ Rydberg's constant, $c =$ velocity of light)
a) $\frac{3Rc}{27}$ b) $\frac{Rc}{25}$
c) $\frac{8Rc}{9}$ d) $\frac{5Ac}{36}$

171. The life time of metastable state is:
a) 10^{-10} s b) 10^{-3} s c) 10^{-8} s d) 10^{-1} s

172. The electron in first orbit of hydrogen with velocity 2.18×10^{6} m/s. If radius of first orbit is 0.53 Å, then orbital current is
a) 0.41 mA b) 1.04 mA c) 1.84 mA d) 2.4 mA

173. 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) $\frac{1}{v_1} = \frac{1}{v_2} + \frac{1}{v_3}$

174. The problem of unstability of Rutherford's atomic model was solved by
a) Thomson's atomic model
b) Sommerfield's atomic model
c) Bohr's atomic model
d) Quantum atomic model

175. Consider the spectral line resulting from the transition from $n = 2$ to $n = 1$, in atoms and ions given below. The shortest wavelength is produced by
a) hydrogen atom b) deuterium atom
c) singly ionised helium d) doubly ionised lithium

176. Which type of beam is used to observe image in the electron microscope?
a) White beam of light b) Red beam of light
c) Blue light d) Electron beam

177. A 200 g cricket ball is thrown with a speed of 3×10^{3} cm/s. What will be its de-Broglie wavelength?
a) 1.1×10^{-32} cm b) 2.2×10^{-32} cm
c) 0.55×10^{-32} cm d) 3.2×10^{-32} cm

178. In the process of nucleus fission of 1 g uranium, the mass lost is 0.90 milligram. The efficiency of power station run by it is 10%. To obtain 200 megawatt power from the power station, the uranium required per hour is ($c = 3 \times 10^{8}$ m/s)
a) 24 g b) 49 g c) 68 g d) 89 g

179. Let X and Z be the frequencies of series limit of Lyman series and Balmer series respectively. If Y is the frequency of first line of Lyman series, then
a) $X - Y = Z$ b) $Y - X = Z$
c) $Z = \frac{X + Y}{2}$ d) $X + Y = Z$

180. 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

181. According to Bohr's theory the relation between the period of revolution of electron and principle quantum number is
a) $T \propto 1/n^2$ b) $T \propto 1/n^3$ c) $T \propto n^2$ d) $T \propto n^3$

182. In Bohr 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

183. Which of the following is in the increasing order of penetrating power?
a) α, β, γ b) β, α, γ c) γ, α, β d) γ, β, α

184. As per Bohr model, the minimum energy (in eV) required to remove an eiectron from the ground state of double ionised Li atom ($Z = 3$) is
a) 1.51 b) 13.6
c) 40.8 d) 122.4

185. If by successive disintegration of $_{92}U^{238}$, the final product obtained is $_{82}Pb^{206}$, then how many number of α and β particles are emitted?
a) 8 and 6 b) 6 and 8 c) 12 and 6 d) 8 and 12

186. In the hydrogen atom spectrum, the series which lies in ultraviolet region is
a) Lyman series b) Balmer series

c) Paschen series d) Brackett series

187. The radius of hydrogen atom, in its ground state, is of the order of
a) 10^{-8}cm b) 10^{-6}cm c) 10^{-5}cm d) 10^{-4}cm

188. Which of the following is not a mode of radioactive decay?
a) Positron emission b) Electron capture
c) Fusion d) Alpha decay

189. Which of the following expression is the formula for the total energy of electron in hydrogen atom?
a) $E = -\frac{me^4}{8\pi\varepsilon_0^2 h^2 n^2}$ b) $E = -\frac{me^4}{8\varepsilon_0 h^2 n^2}$
c) $E = -\frac{e^2}{8\pi\varepsilon_0 r}$ d) $E_n = -\frac{Rch}{n^2}$

190. Rutherford assumed in his atomic model that
a) The mass is concentrated at the centre
b) Charge mass is concentrated at the centre
c) Both the mass and charge are concentrated at the centre
d) Electrons are positively charged particle

191. The ratio of half-life times of two elements A and B is $\frac{T_A}{T_B}$. The ratio of respective 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) $\frac{T_A - T_B}{T_A}$

192. Which of the following is incorrect:
a) MASER destroy control system in plane
b) MASER measures frequency of specific molecular transition.
c) MASER require high temperature for its operation
d) MASER cause disfunctionality of human brain.

193. 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

194. When a hydrogen atom is excited from the ground state,
a) K.E. and P.E. both will increase
b) K.E. and P.E. both will decrease
c) K.E. increases but P.E. decreases
d) K.E. decreases but P.E. increases

195. For the de-Broglie wavelength of 10^{-17} metre, momentum of a particle will be
a) 13.25×10^{-17} kgm/s
b) 26.5×10^{-17} kgm/s
c) 6.625×10^{-17} kgm/s
d) 3.3125×10^{-17} kgm/s

196. Wavelength of first line in Lyman series is λ. The wavelength of first line in Balmer series is
a) $\frac{5}{27}\lambda$ b) $\frac{36}{5}\lambda$
c) $\frac{27}{5}\lambda$ d) $\frac{5}{36}\lambda$

197. 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

198. Which crystal is used to scatter electrons in the Davisson and Germer experiment?
a) Cobalt b) Nickel c) Calcite d) Silver

199. The series limit wavelength of the Lyman Series for the hydrogen atom is given by
a) $\frac{1}{R}$ b) $\frac{4}{R}$ c) $\frac{9}{R}$ d) $\frac{16}{R}$

200. Which of the following types of radiation is not emitted by the electronic structure of atoms?
a) Ultraviolet light b) X – Ray
c) Visible light d) γ– rays

N.B.Navale

Date : 28.03.2025
Time : 03:00:00
Marks : 200

TEST ID: 60
PHYSICS

15.STRUCTURE OF ATOMS AND NUCLEI ,9.ATOMS, MOLECULES AND NUCLEI

: ANSWER KEY :

1)	a	2)	c	3)	d	4)	d	105)	d	106)	d	107)	a	108)	b
5)	c	6)	b	7)	b	8)	c	109)	b	110)	b	111)	c	112)	d
9)	a	10)	c	11)	b	12)	b	113)	c	114)	b	115)	d	116)	d
13)	c	14)	b	15)	d	16)	c	117)	d	118)	a	119)	a	120)	c
17)	a	18)	c	19)	c	20)	d	121)	b	122)	b	123)	a	124)	a
21)	a	22)	d	23)	b	24)	c	125)	b	126)	c	127)	b	128)	d
25)	b	26)	a	27)	c	28)	a	129)	c	130)	a	131)	c	132)	a
29)	a	30)	d	31)	a	32)	b	133)	d	134)	d	135)	d	136)	b
33)	d	34)	d	35)	c	36)	d	137)	a	138)	c	139)	d	140)	c
37)	d	38)	c	39)	c	40)	c	141)	a	142)	b	143)	d	144)	a
41)	c	42)	c	43)	a	44)	b	145)	b	146)	b	147)	b	148)	a
45)	d	46)	d	47)	c	48)	d	149)	b	150)	d	151)	b	152)	d
49)	b	50)	a	51)	b	52)	a	153)	a	154)	b	155)	d	156)	d
53)	a	54)	a	55)	c	56)	c	157)	b	158)	a	159)	b	160)	c
57)	b	58)	c	59)	b	60)	d	161)	a	162)	a	163)	c	164)	d
61)	d	62)	c	63)	a	64)	d	165)	b	166)	c	167)	b	168)	a
65)	c	66)	d	67)	c	68)	c	169)	a	170)	d	171)	b	172)	b
69)	c	70)	c	71)	c	72)	c	173)	a	174)	c	175)	d	176)	d
73)	b	74)	c	75)	a	76)	c	177)	a	178)	d	179)	a	180)	d
77)	d	78)	a	79)	a	80)	b	181)	d	182)	c	183)	a	184)	d
81)	a	82)	c	83)	c	84)	c	185)	a	186)	a	187)	a	188)	c
85)	b	86)	b	87)	b	88)	b	189)	a	190)	a	191)	a	192)	c
89)	c	90)	a	91)	c	92)	c	193)	b	194)	d	195)	c	196)	c
93)	c	94)	d	95)	c	96)	a	197)	a	198)	b	199)	a	200)	b
97)	a	98)	b	99)	a	100)	a								
101)	c	102)	d	103)	d	104)	d								

N.B.Navale

Date : 28.03.2025 **TEST ID: 60**
Time : 03:00:00 **PHYSICS**
Marks : 200

15.STRUCTURE OF ATOMS AND NUCLEI ,9.ATOMS, MOLECULES AND NUCLEI

: HINTS AND SOLUTIONS :

Single Correct Answer Type

1 **(a)**

According to Bohr's quantisation.

$$mvr = \frac{nh}{2\pi} \Rightarrow v = \frac{nh}{2\pi mr}$$

Orbital acceleration $= \frac{v^2}{r} = \frac{n^2h^2}{4\pi^2m^2r^3}$

3 **(d)**

As difference between the levels increases, energy emitted increases and hence wavelength decreases. It means colour must change to violet

4 **(d)**

In emission spectrum, number of bright lines is given by

$$\frac{n(n-1)}{2} = \frac{4(4-1)}{2} = 6$$

6 **(b)**

While proposing the theory of hydrogen atom, Bohr considered quantisation of angular momentum as the essential condition for the stationary orbits.

8 **(c)**

$$\lambda = \frac{h}{mv} \Rightarrow \frac{6.626 \times 10^{-34}}{0.1 \times 10} = 6.626 \times 10^{-34} \text{ m}$$

10 **(c)**

$$L = mv\,r = \frac{nh}{2\pi}$$

For $n = 4, mvr_4 = \frac{2h}{\pi} \Rightarrow h = \frac{mvr_4\pi}{2}$

But $r_4 = 16\ r$

$$\therefore h = \frac{mv16r\pi}{2} \Rightarrow h = mvr8\pi$$

$$\therefore \lambda = \frac{h}{mv} = 8\pi r$$

11 **(b)**

Disintegration of each nuclei is independent of any factor. Hence, each nuclei has same chance of disintegration, l.e. its probability is 50% or $\frac{1}{2}$.

12 **(b)**

Speed of electron in nth shell,

$$v_n \propto \frac{1}{n}$$

So, $\frac{v_2}{v_1} = \frac{n_1}{n_2} = \frac{1}{2}$

i.e. $v_2 = \frac{v_1}{2} \Rightarrow \Delta v = v_1 - v_2 = \frac{v_1}{2}$

Hence, % change $= 50\%$

14 **(b)**

Energy of electron in the 3rd orbit of He^+, E_3

$$= -13.6 \times \frac{Z^2}{n^2} eV = -13.6 \times \frac{4}{3^2} eV$$

$$= -13.6 \times \frac{4}{9} \times 1.6 \times 10^{-19} \text{ J}$$

From Bohr's model, $E_3 = -(KE)_3 = -\frac{1}{2}m_eV^2$

$$\Rightarrow \frac{1}{2} \times 9.1 \times 10^{-31} \times v^2$$

$$\Rightarrow v^2 = \frac{13.6 \times 16 \times 4 \times 2 \times 10^{12}}{9 \times 9.1}$$

or $v = 146 \times 10^6 \text{ ms}^{-1}$

16 **(c)**

de-Broglie wavelength, $\lambda = \frac{h}{p}$

According to Bohr's quantisation condition

$$mvr_n = \frac{nh}{2\pi} \Rightarrow pr_n = \frac{nh}{2\pi}$$

From Eqs. (i) and (ii), we get

$$\lambda = \frac{h \times 2\pi r_n}{nh} = \frac{2\pi r_n}{n}$$

For fourth orbit $(n = 4)_n \lambda = \frac{2\pi r_4}{4}$

Moreover,

$r \propto n^2$

$\frac{r_1}{r_4} = \frac{(1)^2}{(4)^2} \Rightarrow r_4 = 16r_1$

Substituting the value of r_4 in Eq. (iii), we get

$$\lambda = \frac{2\pi(16r_1)}{4} = 8\pi r_1 \text{ or } 8\pi r$$

19 **(c)**

$$\lambda = \frac{12.27}{\sqrt{V}}$$

$$\therefore V = \frac{12.27 \times 10^{-10} \times 12.27 \times 10^{-10}}{0.16 \times 10^{-20}} = \frac{150}{0.16}$$
$$= 941V$$

20 **(d)**

According to Bohr's theory,

$$mvr = n\frac{h}{2\pi}$$

$\therefore$ Circumference, $2\pi r = n\left(\frac{h}{mv}\right) = n\lambda$

21 **(a)**

Let the percentage of B^{10} atoms be x

$\therefore$ Hence percentage of B^{11} atom $= (100 - x)$

Average atomic weight

$$= \frac{10x + 11(100 - x)}{100} = 10.81 \Rightarrow x = 19$$

$$\therefore \frac{N_{B^{10}}}{N_{B^{11}}} = \frac{19}{81}$$

26 **(a)**

The energy of the electron in the m th orbit is

Given, = −

$$E \propto Z^2 + \frac{1}{n^2}$$

$$Z_H = 1, Z_{H_0} = 2$$

$$\frac{E_H}{E_{H_0}} = \frac{Z_H^2}{Z_{H_0}^2} = \frac{1}{4}$$

$$E_{H_0} = 4E_H$$

$$E_H = E_n$$

$$E_{H_0} = 4E_n$$

27 **(c)**

By using $N = N_0e^{-\lambda t}$ and average life time

$$t = \frac{1}{\lambda}$$

$$\therefore N = N_0e^{-\lambda \times 1/\lambda} = N_0e^{-1}$$

$$\therefore \frac{N}{N_0} = e^{-1} = \frac{1}{e}$$

$\therefore$ Disintegrated fraction $= 1 - \frac{N}{N_0} = 1 - \frac{1}{e} = \frac{e-1}{e}$

30 **(d)**

Electrostatic force = Centripetal force

$$\frac{1}{4\pi z_0}\frac{Ze^2}{r^2} = \frac{mv^2}{t}$$

$$v = \frac{1}{\sqrt{4\pi_0 \frac{Ze^2}{mr}}}$$
$$= \frac{9 \times 10^9 \times 1 \times (16 \times 10^{-19})^2}{(9.1 \times 10^{-51}) \times (0.1 \times 10^{-9})}$$
$$= 1.59 \times 10^6 \text{ ms}^{-1}$$

32 **(b)**

$T = \frac{2\pi r}{v}$, $r \propto n^2$ and

$$v \propto \frac{1}{n} \Rightarrow T \propto n^3$$

$$\therefore \frac{T_1}{T_2} = \frac{{n_1}^3}{(2n_1)^3} = \frac{1}{8}$$

33 **(d)**

$$\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$\therefore \frac{1}{\lambda} = \left[\frac{1}{2^2} - \frac{1}{3^2}\right] = \frac{5}{36}R$$

$$\therefore f = \frac{c}{\lambda} = \frac{5}{36}Rc$$

34 **(d)**

$$\lambda = \frac{h}{mv} = \frac{6.63 \times 10^{-34}}{2 \times 10^{-3} \times 10^{-3} \times 100 \times 10^{-2}}$$
$$= 3.32 \times 10^{-28}\text{m}$$

36 **(d)**

The orbital period of revolution of electron in nth orbit is

$$T_n = \frac{2\pi r_n}{V_n}$$

As we know, $r_n = \left(\frac{h^2\varepsilon_0}{\pi me^2}\right)\frac{n^2}{Z}$

and $v_n = \left(\frac{e^2}{2h\varepsilon_0}\right)\frac{z}{n}$

$$T_n = 2\pi\frac{h^2\varepsilon_0 n^2}{\pi me^2Z} \times \frac{2h\varepsilon_0^n}{e^2Z} = \frac{4\varepsilon_0^2n^3h^3}{me^4Z^2}$$

For hydrogen atom, } Z=1

$$T_n = \frac{4\varepsilon_0^2n^3h^3}{me^4}$$

37 **(d)**

Given, $n_1 = 1, n_2 = 4$

We know that,

$$\frac{1}{\lambda} = P\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$\frac{1}{\lambda} = R\left[\frac{1}{(1)^2} - \frac{1}{(4)^2}\right]$$

$$\Rightarrow \frac{1}{\lambda} = R\left[1 - \frac{1}{16}\right] = R\left[\frac{16 -}{16}\right.$$

$$\Rightarrow \frac{1}{\lambda} = \frac{15}{1}$$

$$\Rightarrow \lambda = \frac{1}{15}$$

Eut p =

$$\Rightarrow mv = \frac{h}{\lambda}$$

$$\Rightarrow v = \frac{h}{m\lambda}$$

$v = \frac{h}{m} \times \frac{15R}{16}$ [from Eq. (i)]

$$v = \frac{15hA}{16m}$$

38 **(c)**

For hydrogen, we get

$$\frac{1}{\lambda} = RZ^2\left(\frac{1}{1^2} - \frac{1}{2^2}\right)$$

$$\Rightarrow \frac{1}{\lambda_1} = R(1)^2\left(\frac{3}{4}\right)$$

$$\frac{1}{\lambda_2} = A(1)^2\left(\frac{3}{4}\right)$$

$$\Rightarrow \frac{1}{\lambda_3} = A(2)^2\left(\frac{3}{4}\right)$$

$$\frac{1}{\lambda_4} = A(3)^2\left(\frac{3}{4}\right)$$

$$\Rightarrow \frac{1}{\lambda_1} = \frac{1}{4\lambda_3} = \frac{1}{9\lambda_4} = \frac{1}{\lambda_2}$$

$$\Rightarrow \lambda_1 = \lambda_2 = 4\lambda_3 = 9\lambda_4$$

40 **(c)**

From the relation, $\frac{1}{\lambda_0} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = \frac{5R}{36}$ and also $\frac{1}{\lambda} = F\left(\frac{1}{2^2} - \frac{1}{4^2}\right) = \frac{3R}{16}$

From Eqs. (i) and (ii), we get

$$\frac{\lambda}{\lambda_0} = \frac{5R/36}{3R/16} = \frac{20}{27} \Rightarrow \lambda = \frac{20}{27}\lambda_0$$

43 **(a)**

For hydrogen and hydrogen-like atoms,

$$(T.E)_n = -13.6\frac{Z^2}{n^2}\text{eV}$$

$$(P.E.)_n = 2(T.E)_n = -27.2\frac{Z^2}{n^2}\text{eV and}$$

$$(K.E)_n = |(T.E)_n| = 13.6\frac{Z^2}{n^2}\text{eV}$$

From these three relations, we can see that as n decreases, $K.E_n$ will increase but $(T.E)_n$ and $(P.E)_n$ will decrease

50 **(a)**

$$\omega = 2\pi v = \frac{2\pi c}{\lambda} = 2\pi c\bar{v} \Rightarrow \omega \propto \bar{v}$$

52 **(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,

$$p = \frac{h}{\lambda} = h \times R \times \frac{24}{25} = mv = \frac{24hR}{25}$$

$$\therefore v = \frac{24hr}{25m}$$

55 **(c)**

$$E_n \frac{-me^4}{8\in_0^2 h^2n^2} = \frac{-me^4}{8\in_0^2 h^2n^2} \times hc = \frac{-Rhc}{n^2}$$

$$E_n = \frac{-Rhc}{n^2} \quad n = 1 \quad E_1 = -Rhc$$

56 **(c)**

For Balmer series,

$$\frac{1}{\lambda_B} = R\left[\frac{1}{2^2} - \frac{1}{n^2}\right]$$

And for Paschen series,

$$\frac{1}{\lambda_P} = R\left[\frac{1}{3^2} - \frac{1}{n^2}\right]$$

Now, for series limit, $n = \infty$

$$\therefore \frac{\left(\frac{1}{\lambda_B}\right)}{\left(\frac{1}{\lambda_P}\right)} = \frac{\left(\frac{1}{4}\right)}{\left(\frac{1}{9}\right)}$$

$$\therefore \frac{\lambda_P}{\lambda_B} = \frac{9}{4}$$

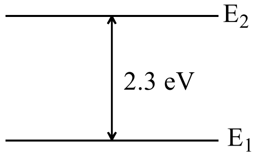
$$\therefore \lambda_p = \frac{9}{4} \times 6400 = 9 \times 1600 = 14400\ \text{Å}$$

59 **(b)**

$${}_zX^A \xrightarrow{{}_{-1}\beta^0} {}_{z+1}Y^A \xrightarrow{{}_2He^4(\alpha)}$$

$${}_{z-1}K^{A-4} \xrightarrow{{}_0\gamma^0} {}_{z-1}K^{A-4}$$

65 **(c)**



Using, $E_2 - E_1 = hv$ we get,

$$v=\frac{E_2-E_1}{h}=\frac{2.3\times1.6\times10^{-19}J}{6.6\times10^{-34}\ Js}$$
$$=0.56\times10^{15}s^{-1}=5.6\times10^{14}Hz$$

66 **(d)**

$$\lambda=\frac{h}{p}$$
$$K.E.=\frac{P^2}{2m}$$

67 **(c)**

The energy difference between two states is given as

$$\Delta E=E_2-E_1=\frac{-13.6}{2^2}-\left(\frac{-13.6}{1^2}\right)$$
$$\Rightarrow\quad \Delta E=\frac{13.6}{1^2}-\frac{13.6}{2^2}$$
$$\Rightarrow\quad \Delta E=13.6\left(\frac{4-1}{4}\right)=13.6\times\frac{3}{4}$$
$$\therefore\quad \Delta E=10.2eV$$

Since, the energy is radiated in form of photons, so we have

Energy of photons $=h_N=10.2$ V

From Einstein's photoelectric equation, we have

$$hv=\phi_0+V_s$$

Substituting the given values, we get

$$10.2\ V=4.2\ V+V_s$$
$$\Rightarrow\quad 6\ V=V_s$$
$$\therefore\quad V_s=6\ V$$

68 **(c)**

In X-ray spectra, depending on the accelerating voltage and the target element, we may find sharp peaks superimposed on continuous spectrum. These are at different wavelength for different elements. They form characteristic X-ray spectrum

69 **(c)**

Activity,

$$A=A_0\theta^{-\lambda t}$$
$$975=9750e^{-\lambda\times5}$$
$$\frac{1}{10}=e^{-\lambda\times5}$$

Taking logarithm on both sides, we have

$$-\log_e 10=-5\lambda$$
$$-2.3026=-5\lambda$$
$$\lambda=\frac{2.3026}{5}=0.461\ \text{min}^{-1}$$

70 **(c)**

Change in angular momentum of electron,

$$L_5-L_4=\frac{h}{2\pi}[5-4]=\frac{6.64\times10^{-34}}{2(3.14)}$$
$$=1.05\times10^{-34}$$

72 **(c)**

Using $N=N_0\left(\frac{1}{2}\right)^{t/T}$

$$\therefore N=\left(1-\frac{7}{8}\right)N_0=\frac{1}{8}N_0$$
$$\therefore \frac{1}{8}N_0=N_0\left(\frac{1}{2}\right)^{t/T}$$
$$\therefore \left(\frac{1}{2}\right)^3=\left(\frac{1}{2}\right)^{t/5}\Rightarrow t=15\text{ days}$$

76 **(c)**

Energy of electron, $E_n=\frac{-13.6}{n^2}eV$

$$\therefore -0.544\ eV=\frac{-13.6}{n^2}eV$$
$$\therefore n^2=25\Rightarrow n=5$$

Orbital velocity of electron in ground state,

$$v_n=\frac{e^2}{2\varepsilon_0 hn}=\frac{e^2}{2\varepsilon_0 h(5)}=\frac{v}{5}$$

78 **(a)**

In hydrogen atom, $E_2-E_1=10.2eV$. Since, energy difference is 10.2eV which is greater than kinetic energy 5eV. So, the electron excites the hydrogen atom and hence, collision must be elastic.

79 **(a)**

Since electron and positron annihilate,

$$\lambda=\frac{hc}{E_{Total}}=\frac{6.6\times10^{-34}\times3\times10^8}{(0.51+0.51)\times10^6\times1.6\times10^{-19}}$$
$$=1.21\times10^{-12}m=0.012\ Å$$

80 **(b)**

Given that, $A_0=8$ count, $A=1$ count, $t=3$ hours

$\frac{A}{A_0}=\left(\frac{1}{2}\right)^n$, where n is the number of half lives

$$\therefore \frac{1}{8}=\left(\frac{1}{2}\right)^n\Rightarrow\left(\frac{1}{2}\right)^3=\left(\frac{1}{2}\right)^n\Rightarrow n=3$$

Now, $n=\frac{t}{T_{1/2}}$, where $T_{1/2}$ is the half-life of a radioactive sample

$$\therefore T_{1/2}=\frac{t}{n}=\frac{3}{3}=1\text{ hour}$$

81 **(a)**

The frequency v of the emitted electromagnetic radiation, when a hydrogen atom de-excites from level n_2 to n_1 is

$$v=RcZ^2\left(\frac{1}{n_1^2}-\frac{1}{n_2^2}\right)$$

When transition takes place from $n_2 = 2$ to $n_1 = 1$, then $2.7 \times 10^{15} = RcZ^2\left(\frac{1}{1^2} - \frac{1}{2^2}\right)$

When transition takes places from $n_2 = 3$ to $n_1 = 1$, let frequency be V.

$\therefore\ v = RcZ^2\left(\frac{1}{1^2} - \frac{1}{3^2}\right)$

From Eqs. (i) and (ii), we get

$$v = \frac{32 \times 2.7 \times 10^{15}}{27} = 3.2 \times 10^{15}\ \text{Hz}$$

84 **(c)**

$T.E. = \frac{1}{2}(P.E.) = (K.E.)$

$\frac{K.E.}{P.E.} = -\frac{1}{2}$

85 **(b)**

$K.E. = \frac{e^2}{8\pi\varepsilon_0 r}$

$= \frac{(1.6 \times 10^{-19})^2}{8(3.14)(8.854 \times 10^{-12})} eV$

$(0.529 \times 10^{-10})(1.6 \times 10^{-10}$

$= 13.6\ eV$

87 **(b)**

Energy of projectile will be directly proportional to the product of charges of Z_1Z_2.

Since, $E = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Z_1Z_2\theta^2}{r_0}$

88 **(b)**

1. $r = n^2$, ie. $\frac{t_1}{r} = \left(\frac{n_t}{n_5}\right)^2$

$\Rightarrow \frac{21.2 \times 10^{-19}}{5.3 \times 10^{-11}} = \left[\frac{n}{1}\right]^2$

$\Rightarrow n^2 = 4 \Rightarrow n = 2$

89 **(c)**

$$\lambda = \frac{h}{mv} = \frac{6.63 \times 10^{-34}}{10^{-3} \times 100} = 6.63 \times 10^{-33} m$$

92 **(c)**

The speed of electron in the nth state of hydrogen atom is

$$v_n = \frac{\left(\frac{e^2}{2hc_0}\right)\frac{1}{n}\ m}{s}$$

For ground state $(n = 1), v_1 = \frac{e^2}{2h\varepsilon_0}$ m/s

$\therefore\ \frac{v_1}{c} = \frac{e^2}{2\varepsilon_0 hc}$

93 **(c)**

Ground state energy $= -$ (Ionisation potential)

$= -13.6$ eV

$E_f = -13.6 + 12.1 = -1.5$ eV

$\therefore$ Energy state, $n^2 = \frac{E_i}{E_f} = \frac{-13.6}{-1.5} = 9$

$\therefore$ n = 3 i.e., second excited state

$\therefore$ Number of spectral lines from

$n = 3$ to $n = 1 = \frac{n(n-1)}{2} = \frac{3(2)}{2} = 3$

94 **(d)**

$_Z X^A \xrightarrow{\alpha} {}_{Z-2}Y^{A-4} \xrightarrow{2\beta^-} {}_Z X^{A-4}$

98 **(b)**

Activity, $A = \frac{-dN}{dt} = \lambda N$

Initially, the number of nuclei (M) per mole are equal for both the substances, in respective of their molecular mass, therefore

$$A \propto \lambda \Rightarrow \frac{A_1}{A_2} = \frac{\lambda_1}{\lambda_2} = \frac{4}{3}$$

99 **(a)**

Size of nucleus and atom are respectively, 10^{-15} m and 10^{-10} m.

100 **(a)**

We know that, the angular momentum of the electron in hydrogen atom, $L_n = \frac{nh}{2\pi}$

But according to question, the angular momentum in second orbit is L.

So,

$$L = \frac{2h}{2\pi} = \frac{h}{\pi}$$

Hence, the angular momentum in fourth orbit is

$$L_4 = \frac{4h}{2\pi} = \frac{2h}{\pi} = 2L\ \text{[from Eq. (ii)]}$$

102 **(d)**

The nuclear force is short range force.

103 **(d)**

Energy required to remove electron in the $n = 2$ state $= +\frac{13.6}{(2)^2} = 3.4$ eV

104 **(d)**

If the energy radiated in the transition be E, then we have,

$E_{R\to G} > E_{Q\to S} > E_{R\to S} > E_{Q\to R} > E_{P\to Q}$

For getting blue line, the energy radiated should be maximum $\left(\because E \propto \frac{1}{\lambda}\right)$

105 **(d)**

$v_n \propto \frac{1}{n} \Rightarrow \frac{v_3}{v_1} = \frac{n_1}{n_3} = \frac{1}{3}$

$\therefore v_3 = \frac{2.1 \times 10^6}{3} = 0.7 \times 10^6 \mathrm{m/s}$

108 **(b)**

$\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mk}} \Rightarrow \lambda \propto \frac{1}{\sqrt{k}}$

110 **(b)**

Wavelength of emitted radiation is given by

$$\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = R\left(\frac{1}{4} - \frac{1}{9}\right)$$

$$\frac{1}{\lambda} = R\left(\frac{9-4}{36}\right) = \frac{5R}{36} \Rightarrow \lambda = \frac{36}{5R}$$

111 **(c)**

$A_1 = \lambda N_1$ and $A_2 = \lambda N_2$

$\therefore N_1 - N_2 = \left[\frac{A_1 - A_2}{\lambda}\right]$

114 **(b)**

$E = hv$, E should be minimum then frequency is minimum. Here E is minimum for n = 1 to n =2

116 **(d)**

Rotational hinetic energy of the two bodiy systerm rotating about their centre of mass is

KE = 1 Aur

where. $I = \frac{m_1 m_2}{(m_1+m_2)} > r^2$

and angular momentum, $L = A_1 = \frac{mh}{2\pi}$.

$\therefore$ Rotational kinetic energy $= \frac{(m_1+m_2)n^2n^2}{2m,n)r^2}$

117 **(d)**

$t_2 - t_1 = \frac{T}{\log_e} \log_e\left(\frac{N_1}{N_2}\right)$

$= \frac{20}{\log_e 2} \log_e\left(\frac{50}{12.5}\right)$

$= \frac{20}{\log_e 2} \log_e 4 = 40$ minutes

119 **(a)**

$F = \frac{-dU}{dr} = -m\omega^2 r$.

Since, $mvr = \frac{nh}{2\pi}$ or $mr^2\omega = \frac{nh}{2\pi}$

$(\because v = rw)$

$\Rightarrow r^2 = \frac{nh}{2\pi m\omega}$

$\Rightarrow r = \sqrt{\frac{nh}{2\pi m\omega}} \Rightarrow r \propto \sqrt{n}$

120 **(c)**

For Paschen series

$\bar{v} = \frac{1}{\lambda} = R\left[\frac{1}{3^2} - \frac{1}{n^2}\right]; n = 4, 5, 6 \ldots$

For first member of Paschen series n = 4

$\frac{1}{\lambda_1} = R\left[\frac{1}{3^2} - \frac{1}{4^2}\right] \Rightarrow \frac{1}{\lambda_1} = \frac{7R}{144}$

$\therefore R = \frac{144}{7\lambda_1} = \frac{144}{7 \times 18800 \times 10^{-10}} = 1.1 \times 10^7$

For shortest wave length $n = \infty$

So $\frac{1}{\lambda} = R\left[\frac{1}{3^2} - \frac{1}{\infty}\right] = \frac{R}{9}$

$\therefore \lambda = \frac{9}{R} = \frac{9}{1.1 \times 10^{-7}} = 8.225 \times 10^{-7}$ m

$= 8225$ Å

122 **(b)**

Number of emitted spectral lines,

Case I

$N = \frac{n(n-1)}{2}$

$N = 3$

$3 = \frac{n_1(n_1 - 1)}{2}$

$\Rightarrow n_1^2 - n_1 - 6 = 0$

$n_1 = 3, -2 \quad \Rightarrow (n_1 - 3)(n_1 + 2) = 0$

Negative value of n_1 is not possible.

$\therefore n_1 = 3$

Case II $N = 6$

Again, $6 = \frac{n_2(n_2 - 1)}{2}$

$\Rightarrow n_2^2 - n_2 - 12 = 0$

$\Rightarrow (n_2 - 4)(n_2 + 3) = 0$

$n_2 = 4_1 - 3$

Again, as n_2 is always positive, therefore

$n_2 = 4$

$\therefore \frac{n_1}{n_2} = \frac{3}{4}$

123 **(a)**

Ionisation energy = Rch Z^2

$Z = 3$ for Li^{2+}

gy $= (3)^2$Rch = 9Ach

$\therefore$ Ionisation energy $= (3)^2$Rch = 9Ach (a) in hydrogen atom, $E_2 - E_1 = 10.2$eV. Since, energy difference is 10.2eV which is greater than kinetic energy 5eV. So, the electron excites the hydrogen atom and hence, collision must be elastic.

124 **(a)**

For Balmer series,

$$\frac{1}{\lambda}=R\left(\frac{1}{2^2}-\frac{1}{n^2}\right)$$

When $n=3,4,5$

For second line $n=4$

$$\therefore \frac{1}{\lambda}=R\left(\frac{1}{2^2}-\frac{1}{4^2}\right)=\frac{3}{16}R$$

$$\therefore \lambda=\frac{16}{3R}$$

126 **(c)**

By using, $N=N_0\left(\frac{1}{2}\right)^{T_{\frac{1}{2}}}$

$$\Rightarrow\ t=\frac{T_{\frac{1}{2}}\log_0\left(\frac{N_0}{N}\right)}{\log_e(2)}$$

$$\Rightarrow\ t\propto\log_e\frac{N_0}{N}\Rightarrow\frac{t_1}{t_2}=\frac{\log_0\left(\frac{N_0}{N}\right)_1}{\log_0\left(\frac{N_0}{N}\right)_2}$$

Hence, $\frac{6}{10}=\frac{\log_0(8/1)}{\log_0(N_0/N)}$

$$\Rightarrow\ \log_0\frac{N_0}{N}=\frac{10}{6}\log_0(8)=\log_0 32$$

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

So, fraction that decays $=1-\frac{1}{32}=\frac{31}{32}$

128 **(d)**

Since for $n=3$,

$$E_3=\frac{-13.6}{3^2}=-1.51\ \text{eV}$$

For $n=1, E_1=\frac{-13.6}{1^2}=-13.6\ \text{eV}$

$\therefore$ The energy of the photon emitted in the transition from $n=3$ to $n=1$ is

$E_3-E_1=(-1.51)-(-13.6)=12.09\ \text{eV}$

129 **(c)**

Potential energy of electron in the ground state of a hydrogen atom is given by

$$U=-\frac{ke^2}{r}=\frac{-e^2}{4\pi\varepsilon\sigma r}=-E$$

Kinetic energy of the orbital electron in the ground state of hydrogen atom is given by

$K=\frac{ke^2}{2r}=\frac{e^2}{8\pi\varepsilon_0 r}=\frac{1}{2}\left(\frac{e^2}{4\pi\varepsilon_0 r}\right)=\frac{E}{2}$ [using Eq. (i)]

131 **(c)**

Rutherford's atomic model could account for the positively charge core of an atom.

132 **(a)**

Average life

$$T=\frac{\text{Sum of all lives of all the atom}}{\text{Total number of atoms}}=\frac{1}{\lambda}$$

$\therefore T\lambda=1$

133 **(d)**

For Lyman series,

$$\frac{1}{\lambda_{max}}=R\left[\frac{1}{1^2}-\frac{1}{2^2}\right]=\frac{3}{4}R$$

$$\frac{1}{\lambda_{min}}=R\left[\frac{1}{1^2}-\frac{1}{\infty^2}\right]=\frac{R}{1}$$

$$\therefore\frac{\lambda_{max}}{\lambda_{min}}=\frac{4}{3}$$

135 **(d)**

Fraction remains after n half-lives,

Given $=N_0=$

Given, $N=\frac{N_0}{e}$

$\Rightarrow\ \frac{N_0}{eN_0}=\left(\frac{1}{2}\right)^{5/T}$ or $\frac{1}{e}=\left(\frac{1}{2}\right)^{5/T}$

Taking log on both sides, we get

$\Rightarrow$ $T=5\log_e 2$ Now, let t' be the time after which activity reduces to half

$$\log_0 1-\log_e e=\frac{5}{T}\log_0\frac{1}{2}$$

$$-1=\frac{5}{T}(-\log_e 2)$$

$$T=5\log_e 2$$

Now, let t' be the time after which activity reduces $=$

$$\left(\frac{1}{2}\right)^{r'/5\log 2}\ \Rightarrow t'=5\log_e 2$$

137 **(a)**

As n increase, energy difference between adjacent energy levels decreases.

140 **(c)**

Energy of photon, $E=Rhc\left(1-\frac{1}{n^2}\right)$

or $\frac{hc}{\lambda}=Rch\left(1-\frac{1}{n^2}\right)$ or $\frac{1}{\lambda}=R\left(1-\frac{1}{n^2}\right)$

or

$$\frac{1}{\lambda R}=1-\frac{1}{n^2}\ \text{or}\ \frac{1}{n^2}=1-\frac{1}{\lambda R}$$

$$=\frac{(\lambda R-1)}{\lambda R}\ \text{or}\ n=\sqrt{\frac{\lambda R}{(\lambda R-1)}}$$

142 **(b)**

Balmer series lies in visible region.

144 **(a)**

The decay rate R of a radioactive material is the number of decays per second.

From radipactive decay law.

$$-\frac{dN}{dt} = N \text{ or } -\frac{dN}{dt} = \lambda N$$

$$\text{Thus, } A = -\frac{dN}{dt} \text{ or } A = \lambda N$$

$$\text{or } A = iN\beta^{\dots n}$$

Thus, $R = -\frac{dN}{dt}$ or $R = \lambda N$

or $R = iN_0 e^{-i2}$ . . . (i)

where, $P_0 = \lambda . N_0$ is the activity of the radioactive material at time $t = 0$.

At time to $R_1 = R_\theta e^{-\lambda h_1}$

...(ii)

At time be.

$R_2 =$

$R_0 e^{-L/2}$ .... (iii)

On dividing Eq. (ii) by Eq. (iii), we have

$\frac{R_1}{R_2} = \frac{e^{-im}}{e^{-it_2}} = e^{-i\phi_1 - t_2)}$ or $R_1 =$

$R_2 e^{-\lambda t_1 - t_2\}}$

146 **(b)**

Energy increases from lower state to higher state

147 **(b)**

20 g substance reduces to 10 g

$\therefore T_{1/2} = 4$ min

Using, $M = M_0 \left(\frac{1}{2}\right)^{t/T_{1/2}}$

$\therefore 10 = 80 \left(\frac{1}{2}\right)^{t/4}$

$\Rightarrow \frac{1}{8} = \left(\frac{1}{2}\right)^3 = \left(\frac{1}{2}\right)^{t/4}$

$\Rightarrow t = 12$ min

148 **(a)**

The wavelength of a line in Balmer series is given by

$\frac{1}{2} = A\left(\frac{1}{2^2} - \frac{1}{n^2}\right)$ (for n = 3,4,5, ...)

where, R = Rydberg constant.

For first line n = 3,

$\frac{1}{\lambda_1} = A\left(\frac{1}{4} - \frac{1}{9}\right) \Rightarrow \lambda_1 = \frac{36}{5A}$ ... (i)

The wavelength of a line in Brackett series is given by

$\frac{1}{2} = R\left(\frac{1}{4^2} - \frac{1}{n^2}\right)$ (for n = 5,6,7 ...)

For first line n = 5,

$\Rightarrow \frac{1}{\lambda_2} = R\left(\frac{1}{16} - \frac{1}{25}\right) \Rightarrow \lambda_2 = \frac{400}{9R}$ ...(ii)

On dividing Eq. (i) by Eq. (ii), we get

$\frac{\lambda_1}{\lambda_2} = \frac{36}{5R} \times \frac{9R}{400} = \frac{81}{500} = 0.162$

150 **(d)**

A represents series limit of Lyman series, B represents third member of Balmer series and C represents second member of Paschen series.

153 **(a)**

K. E. = 120 eV

$\therefore V = 120$ V

$\lambda = \frac{12.27}{\sqrt{V}} = \frac{12.27}{\sqrt{120}} = 1.12 \text{ Å} = 1.12 \times 10^{-10}\text{m}$

$= 112 \times 10^{-12}\text{m} = 112$ pm

155 **(d)**

$\frac{1}{\lambda_1} = R\left[\frac{1}{1^2} - \frac{1}{2^2}\right] = R\left[\frac{4-1}{4}\right] = \frac{3R}{4}$

$\therefore \lambda_1 = \frac{4}{3R} = 121.6$ nm ... (i)

Let $\frac{1}{\lambda_2} = R\left[\frac{1}{2^2} - \frac{1}{4^2}\right] = R\left[\frac{16-4}{64}\right] = \frac{12R}{64}$

$\therefore \lambda_2 = \frac{64}{12R}$ ... (ii)

From equations (i) and (ii),

$\frac{\lambda_2}{\lambda_1} = \frac{\lambda_2}{121.6} = \frac{64}{12R} \times \frac{3R}{4}$

$\therefore \lambda_2 = 4 \times 121.6 = 486.4$ nm

161 **(a)**

$\frac{\lambda_B}{\lambda_L} = \frac{\left(\frac{1}{1^2} - \frac{1}{2^2}\right)}{\left(\frac{1}{2^2} - \frac{1}{3^2}\right)} = \frac{3/4}{5/36} = \frac{27}{5}$

$\therefore \lambda_L = \frac{5}{27}\lambda_B = \frac{5}{27} \times 6563 = 1215.4 \text{ Å} \approx 1215 \text{ Å}$

162 **(a)**

Since nuclear density is constant,

$\therefore$ mass $\propto$ volume

165 **(b)**

As, $\frac{N}{N_0} = \left(\frac{1}{2}\right)^n = \frac{N}{N_0} = \left(\frac{1}{2}\right)^3 = \frac{1}{8}$

Number of half-lives = 3 ⇒ T = 20yr

$T = \frac{t}{n}$ or $t = T \times n = 20 \times 3yr = 60yr$

166 **(c)**

For Lyman series,

$\frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{n^2}\right]$

$\therefore \frac{1}{\lambda_{min}} = R\left[1 - \frac{1}{\infty}\right] - R$ ... (i)

For Paschen series,

$\frac{1}{\lambda_{max}} = R\left[\frac{1}{3^2} - \frac{1}{4^2}\right] = \frac{7R}{144}$ ... (ii)

$\therefore$ By dividing equation (i) by equation (ii),

$\frac{\lambda_{max}}{\lambda_{min}} = R \times \frac{144}{7R} = \frac{144}{7}$

$\therefore \lambda_{max} = \frac{144}{7} \times 912 = 18761$ Å

169 **(a)**

${}_{92}U^{238} \xrightarrow{\alpha} {}_{90}Th^{234} \xrightarrow{\beta} {}_{91}Pa^{234} \xrightarrow{({}_{-1}\beta^0)} {}_{92}U^{234}$

170 **(d)**

When an electron jumps from orbit n_i to orbit n_t $(n_i > n_t)$, the frequency of emitted photon is given by

$$v = cR\left[\frac{1}{n_f^2} - \frac{1}{n_1^2}\right] = cR\left[\frac{1}{2^2} - \frac{1}{3^2}\right]$$

$$= cA\left[\frac{5}{36}\right] = \frac{5cA}{36}$$

172 **(b)**

Using, $I = \frac{ev}{2\pi r} = \frac{1.6 \times 10^{-19} \times 2.18 \times 10^6}{2 \times 3.14 \times 0.53 \times 10^{10}}$

$= 1.04 \times 10^{-3} A = 1.04$ mA

173 **(a)**

Frequency, $v = Rc\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$v_1 = Rc\left[1 - \frac{1}{\infty}\right] = Rc$

$v_2 = Rc\left[1 - \frac{1}{4}\right] = \frac{3}{4}Rc$

$v_3 = Rc\left[\frac{1}{4} - \frac{1}{\infty}\right] = \frac{Rc}{4} \Rightarrow v_1 - v_2 = v_3$

175 **(d)**

As, wavelength radiated during transition is given by $\frac{hc}{\lambda} = E_2 - E_1 = \Delta E$ and $\Delta E \propto \frac{Z^2}{n^2}$

So, for doubly ionised lithium atom Z will be higher and therefore, it produces shortest wavelength.

177 **(a)**

$\lambda = \frac{h}{mv} = \frac{6.63 \times 10^{-27}\ erg - s}{200g \times 3 \times 10^3 cms^{-1}}$

$= 1.1 \times 10^{-32} cm$

179 **(a)**

$\bar{v} = R\left[\frac{1}{n_1{}^2} - \frac{1}{n_2{}^2}\right]$

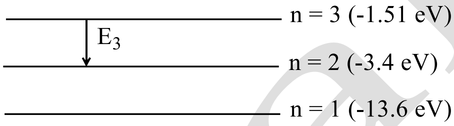
$X = R$ ...(Lyman series)

$Z = R\left(\frac{1}{4}\right)$ ...(Balmer series)

$\therefore Y = R\left(1 - \frac{1}{4}\right) = \frac{3}{4}R$

From above, $X = Y + Z \Rightarrow Z = X - Y$

180 **(d)**



$E_{3\to2} = -3.4 - (-1.51) = -1.89$ eV

$\therefore |E_{3\to2}| \approx 1.9$ eV

182 **(c)**

$T \propto n^3 \Rightarrow \frac{T_2}{T_1} = \frac{2^3}{1^3} = \frac{8}{1}$

183 **(a)**

Penetration power of γ is 100 times of β, while that of β is 100 times of α

184 **(d)**

$E = -(3)^2 \times 13.6eV$

$= -9 \times 13.6eV = -122.4eV$

So, ionisation energy is $+122.4eV$.

185 **(a)**

Assuming x α-particles are emitted we get,

$238 - 206 = 4x$

$\Rightarrow x = 8$

If 8 α-particles are emitted, atomic number will decrease by 16. Also if y β-particles are emitted atomic number will increase by y.

Hence we get,

$92 - 16 + y = 82$

$\Rightarrow y = 6$

188 **(c)**

In fusion, two lighter nuclei combines which is not radioactivity decay

191 **(a)**

Half-life of a radioactive element,

$T = \frac{0.693}{\lambda}$ or $\therefore \frac{\lambda_A}{\lambda_B} = \frac{T_B}{T_A}$

193 **(b)**

P. E. $= 2 \times$ Total energy

$= 2 \times (-13.6) = -27.2$ eV

195 **(c)**

$$p = \frac{h}{\lambda} = \frac{6.625 \times 10^{-34}}{10^{-17}} = 6.625 \times 10^{-17} \text{kg m s}^{-1}$$

196 **(c)**

According to Bohr, the wavelength emitted when an electron jumps from n_1 th to n_2 th orbit is

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

For first line in Lyman series,

$$\frac{1}{\lambda_L} = R\left(\frac{1}{t^2} - \frac{1}{2^2}\right) = \frac{3R}{4} \qquad \text{...(i)}$$

For first line in Balmer series,

$$\frac{1}{\lambda_B} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = \frac{5R}{36} \qquad \text{....(ii)}$$

From Eqs. (i) and (ii), we get

$$\therefore \frac{\lambda_B}{\lambda_L} = \frac{3R}{4} \times \frac{36}{5R} = \frac{27}{5}$$

$$\therefore \lambda_B = \frac{27}{5}\lambda$$

$(\because \lambda_1 = \lambda)$

197 **(a)**

Activity, $R = R_0 e^{-\lambda t}$

$$\Rightarrow \left(\frac{1}{3}\right) = e^{-\lambda \times 3} = e^{-3\lambda}$$

$$\text{Again, } \frac{R'}{R_0} = e^{\lambda \times \theta} = e^{-0\lambda} = \left(e^{-3\lambda}\right)^3$$

$$= \left(\frac{1}{3}\right)^3$$

$$= \frac{1}{27}$$

$$\Rightarrow A' = \frac{R_0}{27}$$

$$\Rightarrow \left(\frac{1}{3}\right) = e^{-\lambda \times 3} = e^{-3\lambda}$$

$$\text{Again, } \frac{R'}{R_0} = e^{\lambda \ll \theta} = e^{-e\lambda} = \left(e^{-3\lambda}\right)^3$$

$$= \left(\frac{1}{3}\right)^3 \quad \text{[from Eq. (i)]}$$

$$= \frac{1}{27}$$

$$\Rightarrow A' = \frac{R_0}{27}$$

Hence, in 9 days activity will become $\left(\frac{1}{27}\right)$ of the original value.

199 **(a)**

For Lyman series, $n_1 = 1, n_2 = \infty$

$$\therefore \frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) = R\left(\frac{1}{1^2} - \frac{1}{\infty}\right) = R$$

$$\therefore \lambda = \frac{1}{R}$$