DCAM classes

Dynamic Classes for Academic Mastery

12.ATOMS

## Single Correct Answer Type

1. 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
2. If $a$ is radius of first Bohr orbit in hydrogen atom, the radius of the third orbit is
a) 3 $a$ b) 9 $a$ c) 27 $a$ d) 81 $a$
3. An electron collides with a hydrogen atom in its ground state and excites it to $n$=3. The energy given to hydrogen atom in this inelastic collision is(neglect the recoiling of hydrogen atom)
a) 10.2 eV b) 12.1 eV c) 12.5 eV d) None of these
4. When a hydrogen atom is bombared, the atom is excited to then $n = 4$ state. The energy released, when the atom goes from $n = 4$ state to the ground state is
a) 1.275 eV b) 12.75 eV c) 5 eV d) 8 eV
5. Excitation energy of a hydrogen like atom in its first excitation state is 40.8 eV. Energy needed to remove the electron from the ion in ground state is
a) 40.8 eV b) 27.2 eV c) 54.4 eV d) 13.6 eV
6. The spectral series of the hydrogen atom that lies in the visible ragion of the electromagnetic spectrum
a) Paschen b) Balmer c) Lyman d) Brackett
7. 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) $v^2$ b) 1/m c) $1/v^4$ d) $1/Ze$
8. In terms of Bohr radius $a_o$, the radius of the second Bohr orbit of a hydrogen atoms is given by
a) 4 $a_o$ b) 8 $a_o$ c) $\sqrt{2}\, a_o$ d) 2 $a_o$
9. 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) $\frac{e^2}{2r^2}$
10. 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 $Li^{2+}$ is
a) 30.6 eV b) 13.6 eV c) 3.4 eV d) 122.4 eV
11. The ratio of minimum to maximum wavelength in Balmer series is
a) 5:9 b) 5:36 c) 1:4 d) 3:4
12. $V_1$ 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) $\frac{1}{v_1} = \frac{1}{v_2} + \frac{1}{v_3}$
13. The orbital frequency of an electron in the hydrogen atom is proportional to
a) $n^3$ b) $n^{-3}$ c) n d) $n^0$
14. Given that in a hydrogen atom, the energy of $n$th orbit $E_n = -\frac{13.6}{n^2}$ eV. The amount of energy required to send electron from first orbit to second orbit is
a) 10.2 eV b) 12.1 eV c) 13.6 eV d) 3.4 eV
15. The ratio of minimum to maximum wavelength in Balmer series is
a) 5: 9 b) 5: 36 c) 1: 4 d) 3: 4
16. Which state of triply ionised beryllium ($Be^{3+}$) has the same orbital radius as that of ground state of hydrogen?
a) $n = 3$ b) $n = 4$ c) $n = 1$ d) $n = 2$
17. The spin-orbit interaction has no effect in the level of the hydrogen atom
a) $s$ −level b) $p$ −level c) $d$ −level d) $f$ −level

18. If the radii of nuclei of $_{13}Al^{27}$ and $_{30}Zn^{64}$ are $R_1$ and $R_2$ respectively, then $\frac{R_1}{R_2}$ is equal to

a) $\frac{27}{64}$ b) $\frac{64}{27}$ c) $\frac{4}{3}$ d) $\frac{3}{4}$

19. For ionising an excited hydrogen atom, the energy required (in eV) will be

a) A little less than 13.6 b) 13.6 c) More than 13.6 d) 3.4 or less

20. Let the PE of hydrogen atom in the ground state be zero. Then its total energy in the first excited state will be

a) 27.2 eV b) 23.8 eV c) 12.6 eV d) 10.2 eV

21. The ground state energy of hydrogen atom is −13.6 eV. When its electron is in the first excited state, its excitation energy is

a) 3.4 eV b) 6.8 eV c) 10.2 eV d) zero

22. Two energy lavels of an electron in an atom are separated by 2.3 eV. The frequency of radiation emitted when the electrons go from higher to 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

23. A neon sign does not produce

a) A line spectrum b) An emission spectrum
c) An absorption spectrum d) Photons

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

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

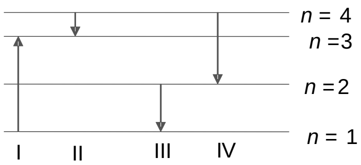
25. The required energy to detach one electron from Balmer series of hydrogen spectrum is

a) 13.6 eV b) 10.2 eV c) 3.4 eV d) −1.5 eV

26. 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 $212 \times 10^{-11}$ m. What is the principal quantum number $n$ of the final state of atom?

a) $n = 4$ b) $n = 2$ c) $n = 16$ d) $n = 3$

27. 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) III b) IV c) I d) II

28. When hydrogen atom is in its first excited level, its radius is how many times its ground state radius?

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

29. An electron jumps from the 4th orbit to 2nd orbit of hydrogen atom. Given the Rydberg's constant $R = 10^5$ cm $^{-1}$, the frequency in hertz 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) $\frac{3}{4} \times 10^{15}$

30. An electron is moving in an orbit of a hydrogen atom from which there can be a maximum of six transition. An electron is moving in an orbit of another hydrogen atom from which there can be a maximum of three transition. The ratio of the velocities of the electron in these two orbits is

a) $\frac{1}{2}$ b) $\frac{2}{1}$ c) $\frac{5}{4}$ d) $\frac{3}{4}$

31. The ionization energy of $Li^{2+}$ is equal to

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

32. An $\alpha$-particle of energy 5 MeV is scattered through 180° by a fixed uranium nucleus. The distance of the closest approach is of the order of

a) 1Å b) $10^{-10}$ cm c) $10^{-12}$ cm d) $10^{-15}$ cm

33. 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 quantities is proportional to quantum number $n$?

a) $\frac{R}{E}$ b) $\frac{E}{V}$ c) $RE$ d) $VR$

34. The energy of a hydrogen atom in its ground state is $-13.6$eV. The energy of the level corresponding to the quantum number $n = 5$ is

a) $-0.54$ eV b) $-5.40$ eV c) 20.58 eV d) $-2.72$ eV

35. Three photons coming from excited atomic hydrogen sample are observed, their energies are 12.1 eV, 10.2 eV and 1.9 eV. These photons must come from

a) Single atom
b) Two atoms
c) Three atoms
d) Either two or three atom

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

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

37. Radius of $_2He^4$ nucleus is 3fermi. The radius of $_{82}Pb^{206}$ nucleus will be

a) 5 fermi b) 6 fermi c) 11.16 fermi d) 8 fermi

38. In an inelastic collision an electron excites a hydrogen atom from its ground state to a M-shell state. A second electron collides instantaneously with the excited hydrogen atom in the M-state and ionizes it.At least how much energy the second electron transfers to the atom in the M-state?

a) +3.4 eV b) + 1.51 eV c) - 3.4 eV d) -1.51eV

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

a) $2.188 \times 106\ \mathrm{ms}^{-1}$ b) $1.094 \times 106\ \mathrm{ms}^{-1}$ c) $4.376 \times 106\ \mathrm{ms}^{-1}$ d) $1.59 \times 106\ \mathrm{ms} - 1$

40. Ionisation potential of hydrogen atom is 13.6 eV. The least energy of photon of Balmer series is

a) 3.4 eV b) 1.89 eV c) 10.2 ev d) 8.5 eV

41. The angular momentum of electron in hydrogen atom is proportional to

a) $\sqrt{r}$ b) $1/r$ c) $r^2$ d) $1/\sqrt{r}$

42. Hydrogen atoms are excited from ground state of the principal quantum number 4. Then the number of spectral lines observed will be

a) 3 b) 6 c) 5 d) 2

43. Wavelength of first line in Lyman series is $\lambda$. 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) $\frac{5}{36}\lambda$

44. Mercury vapour lamp gives

a) Continuous spectrum
b) Line spectrum
c) Band spectrum
d) Absorption spectrum

45. For an electron in the second orbit of Bohr's hydrogen atom, the moment of linear momentum is

a) $n\pi$ b) $2\pi h$ c) $\frac{2h}{\pi}$ d) $\frac{h}{\pi}$

46. The angular momentum ($L$) of an electron moving in a stable orbit around nucleus is

a) Half integral multiple of $\frac{h}{2\pi}$
b) integral multiple of $h$
c) integral multiple of $\frac{h}{2\pi}$
d) Half integral multiple of $h$

47. The shortest wavelength in Lyman series is 91.2 nm. The longest wavelength of the series is

a) 121.6 nm b) 182.4 nm c) 234.4 nm d) 364.8 nm

48. The first excited state of hydrogen atoms is 10.2 eV above its ground state. The temperature 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

49. The ratio of the energies of the hydrogen atom in its first to second excited states is

a) 9/4 b) 4/1 c) 8/1 d) 1/8

50. If $\lambda$ is the wavelength of hydrogen atom from the transition $n$ =3 to $n$=1, then what is the wavelength for doubly ionised lithium ion for same transition?

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

51. In H spectrum, the wavelength of $H_\alpha$ line is 656 nm whereas in a distance galaxy, the wavelength of $H_\alpha$ line is 706 nm. Estimate the speed of galaxy with respect to earth

a) $2 \times 10^8 ms^{-1}$ b) $2 \times 10^7 ms^{-1}$ c) $2 \times 10^6 ms^{-1}$ d) $2 \times 10^5 ms^{-1}$

52. In a hydrogen atom, the electron in a given orbit has total energy $-1.5$ eV. The potential energy is

a) 1.5 eV b) $-1.5$ eV c) 3.0 eV d) $-3.0$ eV

53. The first member of the Balmer's series of the hydrogen has a wavelength $\lambda$, the wavelength of the second member of its series is

a) $\frac{27}{20}\lambda$ b) $\frac{20}{27}\lambda$ c) $\frac{27}{20}\lambda$ d) None of these

54. Energy required for the electron excitation in $Li^{2+}$ from the first to the third Bohr orbit is

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

55. The ionisation potential of mercury is 10.39 V. How far an electron must travel in an electric field of $1.5 \times 10^6$ $Vm^{-1}$ to gain sufficient energy to ionize mercury?

a) $\frac{10.39}{1.5 \times 10^6} \times 1.0 \times 10^{-19}$ m b) $\frac{10.39}{1.5 \times 10^6}$m

c) $1.39 \times 1.6 \times 10^{-19}$ m d) $\frac{10.39}{1.6 \times 10^{-19}}$m

56. Wavelength of light emitted from second orbit to first orbit in a hydrogen atom is

a) 6563 Å b) 4102 Å c) 4861 Å d) 1215 Å

57. White light is passed through a dilutee 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

58. The magnetic moment of the ground state of an atom whose open sub-shell is half-filled with five electrons is

a) $\sqrt{35}\sqrt{\mu_B}$ b) $35\,\mu_B$ c) $35\sqrt{\mu_B}$ d) $\mu_B\sqrt{35}$

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

a) Sizes of the two nuclei are different

b) Nuclear forces are different in the two cases

c) Masses of the two nuclei are different

d) Attraction between the electron and the nucleus is different in the two cases.

60. 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 $\lambda$ of that electron as

a) $(0.529)\,n\lambda$ b) $\sqrt{n}\,\lambda$ c) $(13.6)\lambda$ d) $n\lambda$

61. According to Bohr's theory of hydrogen atom, for the electron in the $n$th allowed orbit the

(i) Linear momentum is proportional to $1/n$

(ii)Radius is proportional to $n$

(iii)Kinetic energy is proportional to$1/ n^2$

(iv) Angular momentum is proportional to $n$

Choose the correct option from the codes given below.

a) (i),(iii),(iv) are correct b) (i) is correct

c) (i),(ii) are correct d) (iii) is correct

62. If elements with principal quantum number $n > 4$ not allowed in nature, the number of possible elements would be

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

63. In a hypothetical bohr hydrogen atom, the mass of the electron is doubled. The energy $E_o$and energy $r_o$ of the first orbit will be ($a_o$ is the Bohr radius)

a) $E_o = -27.2\text{eV}; r_o = a_o/2$ b) $E_o = -27.2\text{eV}; r_o = a_o$

c) $E_o = -13.6\text{eV}; r_o = a_o/2$ d) $E_o = -13.6\text{eV}; r_o = a_o$

64. The electric potential between a proton and an electron is given by $V = V_0 \text{ In} \frac{r}{r_0}$, 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) $r_n \propto \frac{1}{n}$ c) $r_n \propto n^2$ d) $r_n \propto \frac{1}{n^2}$

65. The product of linear momentum and angular momentum of an electron of the hydrogen atom is proportional to $n^x$, where $x$ is

a) 0 b) 1 c) $-2$ d) 2

66. If series limit of Balmer series is 6400 Å, then series limit of Paschen series will be

a) 6400 Å b) 18680 Å c) 14400 Å d) 2400 Å

67. The energy of an electron in $n$th orbit of the hydrogen atom is given by $E_n = \frac{-13.6}{n^2}$ eV The energy required to raise an electron from the first orbit to the second orbit will be

a) 10.2 eV b) 12.1 eV c) 13.6 eV d) 3.4 eV

68. 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

69. In the Bohr model of a hydrogen atom, the centripetal force is furnished by the coulomb attraction between the proton and the electron. If $a_o$is the radius of the ground state orbit, $m$ is the mass and $e$ is charge on the electron and $\varepsilon_o$ 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) $\sqrt{\frac{4\pi\varepsilon_0 a_0 m}{e}}$

70. The acceleration of electron in the first orbit of hydrogen atom is

a) $\frac{4\pi^2 m}{h^3}$ b) $\frac{h^2}{4\pi^2 mr}$ c) $\frac{h^2}{4\pi^2 m^2 r^3}$ d) $\frac{m^2 h^2}{4\pi^2 r^3}$

71. The figure indicates the energy levels of a certain atom. When the system moves from $2E$ level to$E$, a photon of wavelength $\lambda$ is emitted. The wavelength of photon produced during its transition from $\frac{4E}{3}$level to $E$ is

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

72. The ionisation potential of hydrogen atom is $-13.6$ eV. An electron in the ground state of a hydrogen atoms absorbs a photon of energy 12.75 eV. How many different spectral line can one expect when the electron make a downward transition?

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

73. If the shortest wavelength in the Lyman series is 911.6 Å, the longest wavelength in the same series will be

a) 1600 Å b) 2430Å c) 1215 Å d) ∞

74. The series limit wavelength of the Lyman series for the hydrogen atom is given by

a) $1/R$ b) $4/R$ c) $9/R$ d) $16/R$

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

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

76. In the Bohr model of hydrogen atom, the electron is pictured to rotate in a circular orbit of radius $5 \times 10^{-11}$ m, at a speed $2.2 \times 10^6$ ms$^{-1}$. What is the current associated with electron motion?

a) 1.12 mA b) 3 mA c) 0.75 mA d) 2.25 mA

77. If the atom $_{100}\text{Fm}^{257}$ follows the Bohr model and the radius of $_{100}\text{Fm}^{257}$ is $n$ times the Bohr radius, then find $n$.

a) 100 b) 200 c) 4 d) 1/4

78. The energy of electron in the $n$th orbit of hydrogen atom is expressed as $\text{En} = \frac{-14.6}{n^2}$ eV. The shortest and longest wavelength of Lyman series will be

a) 910Å, 1213 Å b) 5463 Å , 7858 Å c) 1315 Å, 1530 Å d) None of these

79. In hydrogen atom, the electron is moving round the nucleus with velocity $2.18 \times 10^6$ ms$^{-1}$ in an orbit of radius 0.528 Å. The acceleration of the electron is
a) $9 \times 10^{18}$ ms$^{-2}$ b) $9 \times 10^{22}$ ms$^{-2}$ c) $9 \times 10^{-22}$ ms$^{-2}$ d) $9 \times 10^{12}$ ms$^{-2}$

80. Rutherford's atomic model could account for
a) Concept of stationary orbits
b) The positively charged control core of an atom
c) Origin of spectra
d) Stability of atoms

81. The energy of an electron in an excited hydrogen atom is $-3.4$ eV. Its angular momentum is
a) $3.72 \times 10^{-34}$ Js b) $2.11 \times 10^{-34}$ Js c) $1.57 \times 10^{-34}$ Js d) $1.11 \times 10^{-34}$ Js

82. 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

83. If $\lambda_1$ and $\lambda_2$ are the wavelengths of the first members of the Lyman and Paschen series respectively, then $\lambda_1 : \lambda_2$ is
a) 1:3 b) 1:30 c) 7:50 d) 7:108

84. Which of the following lines of the H-atom spectrum belongs to the Balmer series?
a) 1025 Å b) 1218 Å c) 4861 Å d) 18751 Å

85. Continuous emission spectrum is produced by
a) Incandescent electric lamp
b) Mercury vapour lamp
c) Sodium vapour lamp
d) Polyatomic substances

86. The ionisation potential of hydrogen atom is 13.6 eV. The energy required to remove an electron from the second orbit of hydrogen will be
a) 27.4 eV b) 13.6 eV c) 3.4 eV d) None of these

87. In a hydrogen atom, the electron is making $6.6 \times 10^{15}$ revs$^{-1}$ around the nucleus in an orbit of radius 0.528 Å.The magnetic moment (Am$^2$) will be
a) $1 \times 10^{-15}$ b) $1 \times 10^{-10}$ c) $1 \times 10^{-23}$ d) $1 \times 10^{-27}$

88. The ratio of longest wavelength and the shortest wavelength observed in the fifth spectral series of emission spectrum of hydrogen is
a) 4/3 b) 525/376 c) 36/11 d) 960/11

89. In an atom, the 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) 1/4 b) 4/1 c) 8/1 d) 1/8

90. Which of the following transition gives the photon of minimum frequency?
a) $n$=2 to $n$=1 b) $n$ =3 to $n$=1 c) $n$ =3 to $n$=2 d) $n$ =4 to $n$=3

91. Let the potential energy of hydrogen atom in the ground state be regarded as zero. Then its potential energy in the first excited state will be
a) 20.4 eV b) 13.6 eV c) 3.4 eV d) 10.2eV

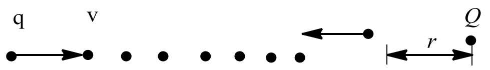
92. Of the following transition in the hydrogen atom, the one which gives an emission line of the highest frequency is
a) $n$ =1 to $n$=2 b) $n$ =2 to $n$=1 c) $n$ =3 to $n$=10 d) $n$ =10 to $n$=3

93. The acceleration of electron in the first orbit of hydrogen atom is
a) $\frac{4\pi^2 m}{h^3}$ b) $\frac{h^2}{4\pi^2 mr}$ c) $\frac{h^2}{2\pi^2 m^2 r^3}$ d) $\frac{m^2 h^2}{4\pi^2 r^3}$

94. The ratio of minimum wavelength of Lyman and Balmer series will be
a) 10 b) 5 c) 0.25 d) 1.25

95. The first excitation potential of a given atom is 10.2 V. Then ionisation potential must be
a) 20.4 V b) 13.6 V c) 30.6 V d) 40.8 V

96. 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

97. The wavelength of the first spectral line of sodium is 5896 Å. The first excitation potential of sodium atom will be ($h = 6.63 \times 10^{-34}$Js)
a) 4.2 V b) 3.5 V c) 2.1 V d) None of these
98. The ratio of areas of the electron orbits for the first excited state and the ground state for the hydrogen atom is
a) 4:1 b) 16:1 c) 8:1 d) 2:1
99. The total energy of an electron in the first excited state of hydrogen is about −3.4eV. Its kinetic energy in this state is
a) − 3.4 eV b) − 6.8 eV c) 6.8 eV d) 3.4 eV
100. If $E_P$and $E_K$ are the potential energy and kinetic energy of the electron in stationary orbit in the hydrogen atom, the value of $\frac{E_P}{E_K}$ is
a) 2 b) −1 c) 1 d) −2
101. Assuming $f$to be frequency of first line in Balmer series, the frequency of the immediate next( *ie*, second) line is
a) 0.50 $f$ b) 1.35 $f$ c) 2.05 $f$ d) 2.70 $f$
102. A charged particle $q$ is shot towards another charged particle $Q$which is fixed, with a speed $v$. It approaches $Q$upto a closest distance $r$ and then returns. If $q$ was given a speed $2v$, the closest distance of approach would be


a) $r$ b) $2r$ c) $r/2$ d) $r/4$
103. Electrons in the atom are held to the nucleus by
a) Coulomb's forces b) Nuclear forces
c) Van der Waals' forces d) Gravitational forces
104. If the electron is a hydrogen atom jumps from an orbit with level $n_1 = 3$ to an orbit with level $n_1 = 2$, the emitted radiation has a wavelength given by
a) $\lambda = \frac{36}{5R}$ b) $\lambda = \frac{5R}{36}$ c) $\lambda = \frac{6}{R}$ d) $\lambda = \frac{R}{6}$
105. 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 from
a) $2 \rightarrow 1$ b) $3 \rightarrow 2$ c) $4 \rightarrow 2$ d) $5 \rightarrow 3$
106. Imagine an atom made up of proton and a hypothetical particle of double the mass of electron, but having the same charge as that of electron. Apply the Bohr 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 $\lambda$,(given in terms of Rydberg constant $R$ for hydrogen atom) equal to
a) $\frac{9}{5R}$ b) $\frac{36}{5R}$ c) $\frac{18}{5R}$ d) $\frac{4}{R}$
107. If the wavelength of the first line of the balmer series of hydrogen is 6561Å, the wavelength of the second line of the series should be
a) 13122 Å b) 3280 Å c) 4860 Å d) 2187 Å
108. 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
109. Number of neutrons in $C^{12}$ and $C^{14}$ are
a) 8 and 6 b) 6 and 8 c) 6 and 6 d) 8 and 8
110. Ionization energy of $He^+$ ion at minimum position is
a) 13.6 eV b) 27.2 eV c) 54.4 eV d) 68.0 eV
111. Suppose an electron is attracted towards the origin by a force $\frac{k}{r}$, where $k$ is constant and $r$ is the distance of the electron from the origin. By applying Bohr model to this system, the radius of the $n$th 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) $T_n \propto \frac{1}{n^2}, r_n \propto n^2$
b) $T_n$ independent of $n, r_n \propto n$
c) $T_n \propto \frac{1}{n}, r_n \propto n$
d) $T_n \propto \frac{1}{n}, r_n \propto n^2$

112. The angular speed of the electric in the $n$ th orbit of Bohr hydrogen atom is
a) Directly proportional to $n$
b) Inversely proportional to $\sqrt{n}$
c) Inversely proportional to $n^2$
d) Inversely proportional to $n^3$

113. 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

114. Ionization potential of hydrogen atom is13.6 eV. Hydrogen atoms in the ground state are excited by monochromatic radiation of photon energy 12.1 eV. According to Bohr's theory, the spectral lines emitted by hydrogen will be
a) Two
b) Three
c) Four
d) One

115. Solar spectrum is an example for
a) Line emission spectrum
b) Continuous emission spectrum
c) Band absorption spectrum
d) Line absorption spectrum

116. 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

117. The ionization energy of hydrogen atom is 13.6eV. Following Bohr's theory, the energy corresponding to a transition between 3rd and 4th orbit is
a) 3.40 eV
b) 1.51 eV
c) 0.85 eV
d) 0.66 eV

118. The nucleus of an atom consists of
a) Electrons and protons
b) Electrons, protons and neutrons
c) Electrons and Neutrons
d) Neutrons and protons

119. 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 orbits are in the ratio
a) 4:3
b) 3:4
c) 2:1
d) 1:2

120. Which of the following transition in Balmer series for hydrogen 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

121. In Raman effect, Stokes' 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

122. Which of the following atoms has the lowest ionization potential?
a) $^{14}_{7}N$
b) $^{133}_{55}Cs$
c) $^{40}_{18}Ar$
d) $^{16}_{8}O$

123. For hydrogen atom electron in $n$ th Bohr orbit, the ratio of radius of orbit to its de-Broglie wavelength is
a) $\frac{n}{2\pi}$
b) $\frac{n^2}{2\pi}$
c) $\frac{1}{2\pi n}$
d) $\frac{1}{2\pi n^2}$

124. If the electron in hydrogen atom jumps from the third to second orbit, the wavelength of the emitted radiation in terms of Rydberg constant R is given by
a) $\lambda = \frac{36}{5R}$
b) $\lambda = \frac{5R}{36}$
c) $\lambda = \frac{5}{R}$
d) $\lambda = \frac{R}{6}$

125. 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

126. In the Bohr's model of the hydrogen atom, the lowest orbit corresponds to
a) Infinite energy
b) Maximum energy
c) Minimum energy
d) Zero energy

127. The atomic number and the mass number of an atom remains unchanged when it emits

a) a photon b) a neutron c) $\beta$ −particle d) An $\alpha$ − particle

128. Band spectrum is also called

a) Molecular spectrum b) Atomic spectrum

c) Flash spectrum d) Line absorption spectrum

129. In a hydrogen atom, the electron moves around the nucleus in a circular orbit of radius $5 \times 10^{-11}$m. Its time period is $1.5 \times 10^{-16}$.The current associated with the electron motion is (charge of electron is $1.6 \times 10^{-16}$ C)

a) 1.00 A b) $1.066 \times 10^{-3}$ A c) $1.81 \times 10^{-3}$ A d) $1.66 \times 10^{-3}$ A

130. 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.

131. An electron of charge $e$ moves with a constant speed $v$ along a circle of radius $r$, its magnetic moment will be

a) $evr$ b) $evr/2$ c) $\pi r^2 ev$ d) $2\pi rev$

132. The ratio of the wavelengths for 2 → 1 transition in $Li^{2+}$, $He^+$ and H is

a) 1:2:3 b) $\frac{1}{9}:\frac{1}{4}:\frac{1}{1}$ c) 1:4:1 d) 3:2:1

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

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

134. The production of band spectra is caused by

a) Atomic nuclei b) Hot metals c) Molecules d) electrons

135. In Rutherford scattering experiment, what will be the correct angle for $\alpha$ scattering for an impact parameter $b$=0?

a) 90° b) 270° c) 0° d) 180°

136. According to Bohr's atomic model, the relation between principal quantum number($n$) and radius of orbit($r$) is

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

137. In the spectrum of hydrogen atom, the ratio of the longest wavelength in Lyman series to the longest wavelength in the Balmer series is

a) 5/27 b) 1/93 c) 4/9 d) 3/2

138. The wave number of the energy emitted when electron comes from fourth orbit to second orbit in hydrogen is 20,397 $cm^{-1}$. The wave number of the energy for the same transition in $He^+$is

a) 5,099 $cm^{-1}$ b) 20,497 $cm^{-1}$ c) 14400 Å d) 81,588 $cm^{-1}$

139. At the time of total solar eclipse, the spectrum of solar radiation will have

a) A large number of dark Fraunhofer lines

b) A smaller number of dark Fraunhofer lines

c) No lines at all

d) All Fraunhofer lines changed into bright coloured lines

140. What is the difference of angular momenta of an electron in two consecutive orbits in hydrogen atom?

a) $\frac{h}{2}$ b) $\frac{h}{\pi}$ c) $\frac{2\pi}{h}$ d) $\frac{h}{2\pi}$

141. The colour of the second line of Balmer series is

a) Blue b) Yellow c) red d) violet

142. An α −particle of energy 5MeV is scattered through 180° by a fixed uranium nucleus. The distance of closest approach is of the order of

a) 1 A° b) $10^{-10}$ cm c) $10^{-12}$cm d) $10^{-15}$cm

143. The wavelength of radiation emitted is $\lambda_0$ when an electron jumps from the third to the second orbit of hydrogen atom. For the electron jump from the fourth to the second orbit of hydrogen atom,the wavelength of radiation emitted will be

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

144. For light of wavelength 5000 Å, photon energy is nearly 2.5 eV. For $X$-rays of wavelength 1 Å, the photon energy will be close to

a) [2.5 ÷ 5000]eV b) $[2.5 \div (5000)^2]$eV c) [2.5 × 5000]eV d) $[2.5 \times (5000)^2]$eV

145. The ionisation energy of 10 time ionised sodium atom is

a) $\frac{13.6}{11}$eV b) $\frac{13.6}{112}$eV c) $13.6 \times (11)^2$eV d) 13.6 eV

146. What is the maximum wavelength of light emitted in Lyman series by hydrogen atom?

a) 691 nm b) 550 nm c) 380 nm d) 122 nm

147. 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) $R = \left(\frac{1}{4\pi\varepsilon_0}\right)\frac{2\pi^2 me^2}{ch^2}$

c) $R = \left(\frac{1}{4\pi\varepsilon_0}\right)^2\frac{2\pi^2 me^2}{c^2h^2}$ d) $R = \left(\frac{1}{4\pi\varepsilon_0}\right)^2\frac{2\pi^2 me^4}{ch^3}$

148. A photon collides with a stationary hydrogen atom in ground state inelastically. Energy of the colliding photon is 10.2 eV. After a time interval of the order of micro second another photon collides with same hydrogen atom inelastically with an energy of 15n eV. What will be observed by the detector?

a) 2 photon of energy 10.2 eV.

b) 2 photon of energy of 1.4 eV.

c) One photon of energy 10.2 eV and an electron of energy 1.4 eV

d) One photon of energy 10.2 eV and another photon of energy 1.4 eV

149. The ratio of kinetic energy and the total energy of the electron in the $n$th quantum state of Bohr's atomic model of hydrogen atom is

a) −2 b) −1 c) +2 d) +1

150. When an electron jumps from the orbit $n = 2$ to $n = 4$,then wavelength of the radiations absorbed will be ($R$ is Rydberg's constant)

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

151. Assuming the mass of earth as $6.64 \times 10^{24}$ kg and the average mass of the atoms that makes up earth as 40 u (atomic mass unit), the number of atoms in the earth is approximately

a) $10^{30}$ b) $10^{40}$ c) $10^{50}$ d) $10^{60}$

152. The shortest wavelength which can be obtained in hydrogen spectrum is ($R = 10^7\ m^{-1}$)

a) 1000 Å b) 800 Å c) 1300 Å d) 2100 Å

153. The $K_\alpha$ line of singly ionised calcium has a wavelength of 393.3nm as measured on earth. In the spectrum of one of the observed galaxies, the spectral line is located at 401.8 nm. The speed with which this galaxy is moving away from us, will be

a) 7400 $ms^{-1}$ b) $32.4 \times 10^2\ ms^{-1}$ c) 6480$kms^{-1}$ d) None of these

154. The binding energy of the electron in the lowest orbit of the hydrogen atom is 13.6 eV. The energies required in eV to remove an electron from the three lowest orbits of the hydrogen atom are

a) 13.6, 6.8, 8.4 b) 13.6, 10.2, 3.4 c) 13.6, 27.2, 40.8 d) 13.6, 3.4, 1.5

155. What is the radius of Iodine atom? (Atomic no.53, mass no.126)

a) $2.5 \times 10^{-11}$m b) $2.5 \times 10^{-9}$m c) $7 \times 10^{-9}$m d) $7 \times 10^{-11}$m

156. Hydrogen atom from excited state comes to the ground state by emitting a photon of wavelength $\lambda$. 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) $\sqrt{\frac{\lambda R}{\lambda - 1}}$

157. The spectrum of an oil flame is an example for

a) Line emission spectrum
b) Continuous emission spectrum
c) Line absorption spectrum
d) Band emissionspectrum

## : ANSWER KEY :

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1) | b | 2) | b | 3) | b | 4) | b |
| 5) | c | 6) | b | 7) | b | 8) | a |
| 9) | b | 10) | a | 11) | a | 12) | a |
| 13) | b | 14) | a | 15) | a | 16) | d |
| 17) | a | 18) | d | 19) | b | 20) | d |
| 21) | c | 22) | c | 23) | c | 24) | a |
| 25) | c | 26) | b | 27) | a | 28) | d |
| 29) | c | 30) | d | 31) | a | 32) | c |
| 33) | d | 34) | a | 35) | c | 36) | a |
| 37) | c | 38) | b | 39) | d | 40) | b |
| 41) | a | 42) | b | 43) | c | 44) | b |
| 45) | d | 46) | c | 47) | a | 48) | a |
| 49) | a | 50) | c | 51) | b | 52) | d |
| 53) | b | 54) | b | 55) | b | 56) | d |
| 57) | c | 58) | d | 59) | c | 60) | d |
| 61) | a | 62) | a | 63) | a | 64) | a |
| 65) | a | 66) | c | 67) | a | 68) | d |
| 69) | c | 70) | c | 71) | d | 72) | d |
| 73) | c | 74) | a | 75) | b | 76) | a |
| 77) | d | 78) | a | 79) | b | 80) | b |
| 81) | b | 82) | b | 83) | d | 84) | c |
| 85) | a | 86) | c | 87) | c | 88) | c |
| 89) | d | 90) | d | 91) | d | 92) | b |
| 93) | c | 94) | c | 95) | b | 96) | c |
| 97) | c | 98) | b | 99) | d | 100) | d |
| 101) | b | 102) | d | 103) | a | 104) | a |
| 105) | d | 106) | c | 107) | c | 108) | b |
| 109) | b | 110) | c | 111) | a | 112) | d |
| 113) | a | 114) | b | 115) | d | 116) | a |
| 117) | d | 118) | d | 119) | a | 120) | c |
| 121) | d | 122) | b | 123) | a | 124) | a |
| 125) | c | 126) | c | 127) | a | 128) | a |
| 129) | d | 130) | d | 131) | b | 132) | b |
| 133) | c | 134) | c | 135) | d | 136) | a |
| 137) | a | 138) | d | 139) | d | 140) | d |
| 141) | a | 142) | c | 143) | b | 144) | c |
| 145) | c | 146) | d | 147) | d | 148) | c |
| 149) | b | 150) | d | 151) | c | 152) | a |
| 153) | c | 154) | d | 155) | a | 156) | a |
| 157) | b | | | | | | |

# : HINTS AND SOLUTIONS :

1 **(b)**
As $E_1 > E_2$
$\therefore$ $v_1 > v_2$
*ie*, photon oh higher frequency will be emitted if transition takes place from $n$=2 to $n$=1.

2 **(b)**
Radius of Bohr orbit is given by

$$r_n = \left(\frac{\varepsilon_0 h^2}{\pi m e^2}\right) n^2$$

The quantities in the bracket are constant
$\therefore$ $r_n \propto n^2$
The expression gives the radius of the nth Bohr orbit

$$\frac{r_1}{r_2} = \frac{n_1^2}{n_2^2}$$
$$\frac{a}{r_2} = \frac{1}{3^2}$$
$$r_2 = 9\,a$$

3 **(b)**
The energy taken by hydrogen atom corresponds to its transition from
$n$ =1 to $n$ =3 state.
$\Delta E$ (given to hydrogen atom)

$$= 13.6\left(1 - \frac{1}{9}\right)$$
$$= 13.6 \times \frac{8}{9} = 12.1 \text{ eV}$$

4 **(b)**
Energy released $= E_4 - E_1$

$$= -\frac{13.6}{4^2} - \left(-\frac{13.6}{1^2}\right) = 1.75\text{eV}$$

5 **(c)**
The excitation energy in the first excited state is

$$E = RhcZ^2\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = (13.6 \text{ eV}) \times Z^2 \times \frac{3}{4}$$

$\therefore$ $40.8 = 13.6 \times Z^2 \times \frac{3}{4}$
$\Rightarrow$ $Z = 2$
So, the ion in problem is $He^+$. The energy of the ion in the ground state is

$$E = \frac{RhcZ^2}{1^2} = 13.6 \times 4 = 54.4 \text{ eV}$$

Hence, 54.4 eV is required to remove the electron from the ion.

6 **(b)**

| | |
|---|---|
| Ultraviolet region | Lyman series |
| Visible region | Balmer series |
| Infrared region | Paschen series, Brackett series Pfund series |

From the above chart it is clear that Balmer series lies in the visible region of the electromagnetic spectrum.

7 **(b)**
At distance of closest approach relative velocity of two particles is $v$. Here target is considered as stationary, so $\alpha$-particle comes to rest instantaneously at distance of closest approach. Let required distance is $r$, then from work energy-theorem.

$$0 - \frac{mv^2}{2} = -\frac{1}{4\pi\varepsilon_0}\frac{Z_e \times Z_e}{r}$$
$$\text{r} \propto \frac{1}{m}$$
$$\propto \frac{1}{v^2}$$
$$\propto Ze^2$$

8 **(a)**
As $r \propto n^2$, therefore, radius of 2nd Bohr's orbit $= 4a_0$

9 **(b)**

$$\text{KE} = \frac{1}{2}\frac{e^2}{r}$$

10 **(a)**

$$E = -Z^2\frac{13.6}{n^2}\text{eV}$$

For first excited state,

$$E_2 = -3^2 \times \frac{13.6}{4}$$
$$= -30.6 \text{ eV}$$

Ionisation energy for first excited state of $Li^{2+}$ is 30.6 eV.

11 **(a)**
For maximum wavelength of Balmer series

$$\frac{1}{\lambda_{\max}} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = \frac{R \times 5}{36} \quad \text{...(i)}$$

For minimum wavelength of Balmer series,

$$\frac{1}{\lambda_{\min}} = R\left(\frac{1}{2^2} - \frac{1}{\infty}\right) = \frac{R}{4} \quad \text{...(ii)}$$

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

$$\therefore \quad \frac{\lambda_{\min}}{\lambda_{\max}} = \frac{R \times 5}{36} \times \frac{4}{R} = \frac{5}{9}$$

12 **(a)**
Frequency, $v = RC\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$$v_1 = RC\left[1 - \frac{1}{\infty}\right] = RC$$
$$v_2 = RC\left[1 - \frac{1}{4}\right] = \frac{3}{4}RC$$

$$v_3 = RC\left[\frac{1}{4} - \frac{1}{\infty}\right] = \frac{RC}{4}$$

$\Rightarrow$ $v_1 - v_2 = v_3$

13 **(b)**

Time period of electron, $T = \frac{4\varepsilon_0^2 n^3 h^3}{mZ^2e^4}$

$\therefore$ $T \propto n^3$

$\therefore$ $\frac{1}{\text{frequency }(f)} \propto n^3$

or $f \propto n^{-3}$

14 **(a)**

$$E = E_2 - E_1 = -\frac{13.6}{2^2} - \left(-\frac{13.6}{1^2}\right) = 10.2 \text{ eV}$$

15 **(a)**

$$\frac{1}{\lambda_{\min}} = R\left[\frac{1}{2^2} - \frac{1}{3^2}\right] = \frac{R \times 5}{36}$$

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

$$\frac{\lambda_{\min}}{\lambda_{\max}} = \frac{R \times 5}{36} \times \frac{4}{R} = \frac{5}{9}$$

16 **(d)**

Radius of orbit of electron in $n$th excited state of hydrogen

$$r = \frac{\varepsilon_0 h^2 n^2}{\pi m Z e^2}$$

$\therefore$ $r \propto \frac{n^2}{Z}$ ... (i)

$\therefore$ $\frac{r_1}{r_2} = \frac{n_1^2}{n_2^2} \times \frac{Z_2}{Z_1}$

But $r_1 = r_2$

So, $n_2^2 = n_1^2 \times \frac{Z_2}{Z_1}$

Here,

$n_1 = 1$(ground state of hydrogen),

$Z_1 = 1$(atomic number of hydrogen),

$Z_2 = 4$(atomic number of beryllium)

$\therefore$ $\sqrt{n_2^2} = (1)^2 \times \frac{4}{1}$

or $n_2^2 = 4$

or $n_2 = 2$

17 **(a)**

For spin-orbit interaction, only the case of$l \geq 1$ is important since spin orbit interaction vanishes for $l$=0.

19 **(b)**

Hydrogen atom normally stays in lowest energy state ($n$=1), where its energy is

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

On being ionized its energy becomes zero. Thus, ionization of hydrogen atom is

= energy after ionisation – energy before ionisation

$= 0 - (-Rhc) = Rhc$

$= (1.097 \times 10^7 \text{ m}^{-1})\ (6.63 \times 10 - 34 \text{ J} - \text{s})(3 \times 108 \text{ ms}^{-1})$

$= 21.8 \times 10^{-19}$ J

$= \frac{21.8 \times 10^{-19}}{1.6 \times 10^{-19}} = 13.6$ eV

20 **(d)**

In ground state TE=−13.6 eV

In first excited state, TE=−3.4 eV, *ie*,

10.2 eV above the ground state.

If ground state energy is taken as zero, the total energy in

First excited state = 10.2 eV

21 **(c)**

Given, ground state energy of hydrogen atom

$E_1 = -13.6$ eV

Energy of electron in first excited state (*ie*, $n$=2)

$E_2 = -\frac{13.6}{(2)^2}$ eV

Therefore ,excitation energy

$\Delta E = E_2 - E_1$

$= -\frac{13.6}{4} - (-13.6) = -3.4 + 13.6 = 10.2$ eV

22 **(c)**

Given, $E_2 - E_1 = 2.3$ eV

Or $v = \frac{E2 - E1}{h} = \frac{2.3 \times 1.6 \times 10^{-19}}{6.6 \times 10^{-34}}$

$= 0.55 \times 10^{15}$

$= 5.5 \times 10^{14}$ Hz

23 **(c)**

The Spectrum of light emitted by a luminous source is called the emission Spectrum. Neon bulb gives an emission Spectrum. The spectrum of the neon light has several bright lines. The red lines are bright. The emission Spectrum of an element is the exact opposite of its absorption Spectrum, that is, the frequencies emitted by a material when heated are the only frequencies that will be absorbed when it is lighted with a white light. Hence, neon sign does not produce an absorption Spectrum.

24 **(a)**

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

$$\frac{v_L}{v_B} = \frac{27}{5}$$

25 **(c)**

In Balmer series, $n = 2$

$$E = \frac{13.6}{2^2} = 3.4 \text{ eV}$$

26 **(b)**

$$r \propto n^2$$

$$\frac{r_f}{r_i} = \left(\frac{n_f}{n_i}\right)^2$$

$$\frac{21.2 \times 10^{-11}}{5.3 \times 10^{-11}} = \left(\frac{n}{1}\right)^2$$

$$n^2 = 4$$

$$n = 2$$

27 **(a)**

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

$$E_{(4\to3)} = Rhc\left[\frac{1}{3^2} - \frac{1}{4^2}\right]$$

$$= Rhc\left[\frac{7}{9 \times 16}\right] = 0.05\ Rhc$$

$$E_{(4\to2)} = Rhc\left[\frac{1}{2^2} - \frac{1}{4^2}\right]$$

$$= Rhc\left[\frac{3}{16}\right] = 0.2\ Rhc$$

$$E_{(2\to1)} = Rhc\left[\frac{1}{(1)^2} - \frac{1}{(2)^2}\right]$$

$$= Rhc\left[\frac{3}{4}\right] = 0.75\ Rhc$$

$$E_{(1\to3)} = Rhc\left[\frac{1}{(3)^2} - \frac{1}{(1)^2}\right]$$

$$= -\frac{8}{9}\ Rhc = -0.9\ Rhc$$

Thus, transition III gives most energy. Transition I represents the absorption of energy.

28 **(d)**

For ground state, $n = 1$

For first excited state, $n = 2$

As $r \propto n^2$

$\therefore$ radius becomes 4 times.

29 **(c)**

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

$$= 3 \times 10^8 \times 10^7\left(\frac{1}{2^2} - \frac{1}{4^2}\right) = \frac{9}{16} \times 10^{15}\text{Hz}$$

30 **(d)**

Number of spectral lines obtained due to transition of electrons from $n$th orbit to lower orbit is,

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

I case $\quad 6 = \frac{n_1(n_1-1)}{2}$

$\Rightarrow \quad n_1 = 4$

II case $\quad 3 = \frac{n_2(n_2-1)}{2}$

$\Rightarrow \quad n_2 = 3$

Velocity of electron in hydrogen atom in $n$th orbit

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

$$\frac{v_n}{v'_n} = \frac{n_2}{n_1}$$

$$\Rightarrow \quad \frac{n_6}{n_3} = \frac{3}{4}$$

31 **(a)**

Ionization energy $= RchZ^2$

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

$\therefore$ Ionization energy $=(3)^2 Rch = 9Rch$

32 **(c)**

According to law of conservation of energy, kinetic energy of $\alpha$-particle

= potential energy of $\alpha$-particle at distance of closest approach

*ie*, $\quad \frac{1}{2}mv^2 = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r}$

$\therefore \quad 5\text{MeV} = \frac{9\times 10^9 \times (2e) \times (92e)}{r}$

$$\left(\because \frac{1}{2}mv^2 = 5 \text{ MeV}\right)$$

$$\Rightarrow \quad r = \frac{9\times10^9\times2\times92\times(1.6\times10^{-19})^2}{5\times10^6\times1.6\times10^{-19}}$$

$\therefore \quad r = 5.3 \times 10^{-14}\text{ m} \approx 10^{-12}\text{cm}$

33 **(d)**

As $R \propto n^2; V \propto \frac{1}{n}$ and $E \propto \frac{1}{n^2}$

$\therefore VR \propto \left(\frac{1}{n} \times n^2\right)$ *ie*, $VR \propto n$

34 **(a)**

$$E_5 = -\frac{13.6}{5^2}\text{eV} = -0.54 \text{ eV}$$

35 **(c)**

These photons will be emitted when electron makes transitions in the shown way.
So, these transitions is possible from two or three atoms.
From three atoms separately.

36 **(a)**
Radius of Bohr's orbit

$$R_n = \frac{A_0 n^2}{Z}$$

$\Rightarrow \quad R_n \propto n^2 \qquad$ (Z=constant)

$\therefore \quad R_3 = 3^2 R = 9R$

37 **(c)**
We have, $r \propto A^{1/3}$

$$\Rightarrow \quad \frac{r_2}{r_1} = \left[\frac{A_2}{A_1}\right]^{1/3} = \left[\frac{206}{4}\right]^{1/3}$$

$$\therefore \quad r_2 = 3\left[\frac{206}{4}\right]^{1/3} = 11.16 \text{ fermi}$$

38 **(b)**

$$E_m = -\frac{13.6}{(3)^2} = 1.51$$

Minimum energy required by electron should be + 1.51 eV.

39 **(d)**
Electrostatic force = centripetal force

$$\frac{1}{4\pi\varepsilon_0}\frac{Ze^2}{r^2} = \frac{mv^2}{r}$$

$$\therefore \quad v = \sqrt{\left(\frac{1}{4\pi\varepsilon_0}\frac{Ze^2}{mr}\right)}$$

$$= \sqrt{\frac{9\times10^9 \times (1.6\times10^{-19})^2}{(9.1\times10^{-31})\times(0.1\times10^{-9})}}$$

$$= 1.59 \times 10^6 \text{ms}^{-1}$$

40 **(b)**
Least energy of photon of Balmer series is obtained when an electron jumps to 2nd orbit from 3rd orbit.

$$E = E_3 - E_2 = \left[\frac{-13.6}{3^2} - \left(\frac{-13.6}{2^2}\right)\right] \text{eV}$$

$$= 13.6\left[\frac{1}{4} - \frac{1}{9}\right] = \frac{13.6\times5}{36}\text{eV}$$

$$= 1.89 \text{ eV}$$

41 **(a)**
Angular momentum $= \frac{nh}{2\pi} ie,$

$L \propto n \propto \sqrt{r} \qquad (\because r \propto n^2)$

42 **(b)**
Number of spectral lines $= \frac{n(n-1)}{2} = \frac{4(4\ 3)}{2} = 6$

43 **(c)**
According to Bohr, the wavelength emitted when an electron jumps from $n_1$th to $n_2$th orbit is

$$E = \frac{hc}{\lambda} = E_2 - E_1$$

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

For first line in Lyman series

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

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)

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

$$\therefore \quad \lambda_B = \frac{27}{5}\lambda \qquad (\because \lambda_L = \lambda)$$

44 **(b)**
When electric discharge is passed through mercury vapour lamp, eight to ten lines from red to violet are seen in its spectrum. In some line spectra there are only a few lines, while in many of them there are hundreds of them. Hence, mercury vapour lamp gives line spectra.

45 **(d)**
The moment of linear momentum is angular momentum

$$L = mvr = \frac{nh}{2\pi}$$

Here, $n$=2

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

46 **(c)**
For an electron to remain orbiting around the nucleous, the angular momentum ($L$) should be an integral multiple of $h/2\pi$.

*ie*, $\quad mvr = \frac{nh}{2\pi}$

where $n$ = principle quantum number of electron, and $h$= Planck's constant

47 **(a)**
The wavelength ($\lambda$) of lines is given by

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

For Lyman series, the shortest wavelength is for $n$=∞ and longest is for $n$=2.

$$\therefore \quad \frac{1}{\lambda_s} = R\left(\frac{1}{1^2}\right) \qquad \text{... (i)}$$

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

Dividing Eq.(ii) by Eq. (i) , we get

$$\frac{\lambda_L}{\lambda_s} = \frac{4}{3}$$

Given, $\quad \lambda_s$=91.2 nm

$$\Rightarrow \quad \lambda_L = 91.2 \times \frac{4}{3} = 121.6\text{nm}$$

48 **(a)**

According to kinetic interpretation of temperature

$$Ek = \left(=\frac{1}{2}mv^2\right) = \frac{3}{2}\ kT$$

Given : $E_i = 10.2\ \text{eV} = 10.2 \times 1.6 \times 10^{-19}$ J

So, $\frac{3}{2}\ kT = 10.2\ \times 1.6\ \times\ 10^{-19}$ J

Or $T = \frac{2}{3} \times \frac{10.2 \times 1.6 \times 10^{-19}}{k}$

$= \frac{2}{3} \times \frac{10.2 \times 1.6 \times 10^{-19}}{1.38 \times 10^{-23}} = 7.9\ \times 10^4$ K

49 **(a)**

1st excited state corresponds to $n = 2$

2nd excited state corresponds to $n = 3$

$$\frac{E_1}{E_2} = \frac{n_3^2}{n_2^2} = \frac{3^2}{2^2} = \frac{9}{4}$$

50 **(c)**

For wavelength

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

Here, transition is same

So, $\lambda \propto \frac{1}{Z^2}$

$$\frac{\lambda_H}{\lambda_{Li}} = \frac{(Z_{Li})^2}{(Z_H)^2} = \frac{(3)^1}{(1)^2} = 9$$

$$\lambda_{Li} = \frac{\lambda_H}{9} = \frac{\lambda}{9}$$

51 **(b)**

$\Delta\lambda = 706 - 656 = 50\ \text{nm} = 50 \times 10^{-9}\text{m}, v = ?$

As $\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$

$$\therefore\ v = \frac{\Delta\lambda}{\lambda} \times c = \frac{50 \times 10^{-9}}{656 \times 10^{-9}} \times 3 \times 10^8$$

$= 2.2 \times 10^7\,\text{ms}^{-1}$

52 **(d)**

PE= 2 × total energy

$= 2(-1.5)\ \text{eV} = -3.0\ \text{eV}$

53 **(b)**

The wavelength of series for $n$ is given by

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

were $R$ is Rydberg's constant.

For Balmer series $n$=3 gives the first member of series and $n$=4 gives the second member of series. Hence,

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

$$\frac{1}{\lambda_1} = R\left(\frac{5}{36}\right) \quad \text{...(i)}$$

$$\frac{1}{\lambda_2} = R\left(\frac{1}{2^2} - \frac{1}{4^2}\right)$$

$$= R\left(\frac{12}{16 \times 4}\right) = \frac{3R}{16} \quad \text{...(ii)}$$

$$\Rightarrow \quad \frac{\lambda_2}{\lambda_1} = \frac{16}{3} \times \frac{5}{36} = \frac{20}{27}$$

$$\lambda_2 = \frac{20}{27}\lambda \qquad (\because\ \lambda_1 = \lambda)$$

54 **(b)**

$$\Delta E = 13.6Z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$= 13.6\ (3)^2\left[\frac{1}{1^2} - \frac{1}{3^2}\right]$$

$= 108.8\ eV$

55 **(b)**

Electric field E $= \frac{V}{d}$

$$d = \frac{V}{E}$$

$$= \frac{10.39}{1.5 \times 10^6}\ \text{m}$$

56 **(d)**

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

$$\Rightarrow\ \frac{1}{\lambda} = 1.097\ \times 10^7 \times \frac{3}{4}$$

$\therefore\ \lambda = 1.215\ \times 10^{-7}\text{m} = 1215$ Å

58 **(d)**

The magnetic moment of the ground state of an atom is

$$\mu = \sqrt{n(n+2)\mu_B}$$

Where, $\mu_B$ is gyromagnetic moment. Here, open sub-shell is half-filled with 5 electrons. *ie*, $n$=5

$$\therefore \quad \mu = \sqrt{5(5+2).\,\mu_B}$$

$$= \mu_B\sqrt{35}$$

60 **(d)**

Circumference of $n$th Bohr orbit $= n\ \lambda$

61 **(a)**

According to Bohr's theory of hydrogen atom , angular momentum is quantized *ie*,

$$L = mv_n r_n = n\left(\frac{h}{2\pi}\right)$$

Or $\qquad L \propto n$

Radius of the orbit $r_n \propto \frac{n^2}{Z}$

Kinetic Energy $= \frac{kZ^2e^2}{2n^2}$ *ie*, $k \propto \frac{1}{n^2}$

62 **(a)**

Number of possible elements

$= 2(1^2 + 2^2 + 3^2 + 4^2)$

$= 2(1 + 4 + 9 + 16) = 60$

63 **(a)**

As $r \propto \frac{1}{m}$

$\therefore r_0 = \frac{1}{2} a_0$

As $E \propto m$

$\therefore E_0 = 2(-13.6) = -27.2$ eV

64 **(a)**

$$U = eV = eV_0 \ln\left(\frac{r}{r_0}\right)$$

$\therefore$ $$|F| = \left|-\frac{dU}{dr}\right| = \frac{eV_0}{r}$$

This force will provide the necessary centripetal force. Hence

$$\frac{mv^2}{r} = \frac{eV_0}{r}$$

or $$v = \sqrt{\frac{eV_0}{m}} \quad ....(i)$$

Moreover

$$mvr = \frac{nh}{2\pi} \quad .....(ii)$$

Dividing Eq. (ii) by Eq. (i), we have

$$mr = \left(\frac{nh}{2\pi}\right)\sqrt{\frac{m}{eV_0}}$$

Or $r_n \propto n$

65 **(a)**

Linear momentum $= mv = \frac{mcZ}{137\,n}$

Angular momentum $= \frac{nh}{2\,\pi}$

Given,

Linear momentum $\times$ angular momentum $\propto n^x$

$\therefore$ $$\frac{mcZ}{137\,n} \times \frac{nh}{2\pi} \propto n^x$$

$$n^0 \propto n^x$$

$\Rightarrow$ $$x = 0$$

66 **(c)**

Series limit of Balmer series is given by

$$\frac{1}{\lambda_{\min}} = R\left(\frac{1}{2^2} - \frac{1}{\infty}\right) = \frac{R}{4}$$

$$R = \frac{4}{\lambda_{\min}} = \frac{4}{6400} = \frac{1}{1600}\text{Å}^{-1}$$

Series limit of Paschen series would be

$$\frac{1}{\lambda_{\min}} = R\left(\frac{1}{3^3} - \frac{1}{\infty}\right) = \frac{R}{9}$$

$$\lambda_{\min} = \frac{9}{R} = \frac{9}{1/1600} = 14400\text{Å}$$

67 **(a)**

$$E = E_2 - E_1 = -\frac{13.6}{2^2} - \left(-\frac{13.6}{1^2}\right) = 10.2 \text{ eV}$$

68 **(d)**

Given , $E_n = \frac{13.6}{n^2}$ eV

Energy of photon ejected when electron jumps from $n$=3 state to $n$=2 state is given by

$$\Delta E = E_3 - E_2$$

$\therefore$ $$E_3 = -\frac{13.6}{(3)^2} \text{ eV} = -\frac{13.6}{9} \text{ eV}$$

$$E_2 = -\frac{13.6}{(2)^2} \text{ eV} = -\frac{13.6}{4} \text{ eV}$$

So, $\Delta E = E_3 - E_2 = -\frac{13.6}{9} - \left(-\frac{13.6}{4}\right)$

$= 1.9$ eV

(approximately)

69 **(c)**

Centripetal force=force of attraction of nucleus on electron

$$\frac{mv^2}{a_0} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{a_0^2}$$

$$v = \frac{e}{\sqrt{4\pi\varepsilon_0 m a_0}}$$

70 **(c)**

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

Acceleration, $a = \frac{v^2}{r} = \frac{n^2h^2}{4\pi^2m^2r^2(r)} = \frac{h^2}{4\pi^2m^2\mu^3}$

71 **(d)**

In the first case, energy emitted,

$$E_1 = 2E - E = E$$

In the second case, energy emitted

$$E_2 = \frac{4E}{3} - E = \frac{E}{3}$$

As $E_3$ is $\frac{1}{3}$ rd, $\lambda_2$ must be 3 times, *ie*, $3\lambda$

72 **(d)**

$E = E_1/n^2$

Energy used for excitation is 12.75 eV

*ie*, $(-13.6 + 12.75)$ eV $= -0.85$ eV

Energy levels of H-atom

The photon of energy 12.75 eV can excite the fourth level of H-atom

Therefore, six lines will be emitted.

$\left(n\frac{(n-1)}{2} \text{ lines}\right)$.

73 **(c)**

$$\frac{\lambda_l}{\lambda_s}=\frac{R\left(\frac{1}{1^2}-\frac{1}{\infty}\right)}{R\left(\frac{1}{1^2}-\frac{1}{2^2}\right)}=\frac{4}{3}$$

$$\lambda_l=\frac{4}{3}\lambda_s=\frac{4}{3}\times 911.6=1215.4\text{ Å}$$

74 **(a)**

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

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

75 **(b)**

The series end of Lyman series corresponds to transition from $n_i=\infty$ to $n_f=1$, corresponding to the wavelength

$$\frac{1}{(\lambda_{\min})_{\mathrm{L}}}=R\left[\frac{1}{1}-\frac{1}{\infty}\right]=R$$

$\Rightarrow \quad (\lambda_{\min})_{\mathrm{L}}=\frac{1}{R}=912\text{ Å}$ ...(i)

For last line of Balmer series

$$\frac{1}{(\lambda_{\min})_{\mathrm{B}}}=R\left[\frac{1}{(2)^2}-\frac{1}{(\infty)^2}\right]=\frac{R}{4}$$

$\Rightarrow \quad (\lambda_{\min})_{\mathrm{B}}=\frac{4}{R}=3636\text{ Å}$ ...(ii)

Dividing Eq.(i) by Eq. (ii) .we get

$$\frac{(\lambda_{\min})_{\mathrm{L}}}{(\lambda_{\min})_{\mathrm{B}}}=0.25$$

76 **(a)**

Frequency of revolution of electron,

$$f=\frac{v}{2\pi r}=\frac{2.2\times 10^6}{2\pi(5\times 10^{-11})}=7.0\times 10^{15}\text{ Hz}$$

Current associated, $i=q\,f$

$$=(1.6\times 10^{-19})(7.0\times 10^{15})$$
$$=11.2\times 10^{-4}\text{ A}=1.12\text{ mA}$$

77 **(d)**

$$(r_m)=\left(\frac{m^2}{z}\right)(0.53\text{Å})=(n\times 0.3)\text{Å}$$

$\therefore \quad \frac{m^2}{z}=n$

$m=5$ for $_{100}Fm^{257}$ (the outermost shell) and $z=100$

$\therefore \quad n=\frac{(5)^2}{100}=\frac{1}{4}$

78 **(a)**

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

$\Rightarrow \quad \lambda_{\max}=\frac{4}{3R}\approx 1213\text{ Å}$

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

$\Rightarrow \quad \lambda_{\min}=\frac{1}{R}\approx 910\text{ Å}$

79 **(b)**

Given, $v=2.18\times 10^6\text{ ms}^{-1}, r=0.528\times 10^{-10}\text{m}$

Acceleration of electron moving round the nucleus

$$a=\frac{(2.18\times 10^6)^2}{0.528\times 10^{-10}}\approx 9\times 10^{22}\text{ ms}^{-2}$$

81 **(b)**

Energy of electron in $n$th energy level in hydrogen atom

$$=\frac{-13.6}{n^2}\text{ eV}$$

Here, $\frac{-13.6}{n^2}=-3.4\text{ eV}$

So, $n=2$

Angular momentum from Bohr's principle

$$=n\frac{h}{2\pi}=\frac{2\times 6.626\times 10^{-34}}{2\times 3.14}$$
$$=2.11\times 10^{-34}\text{ Js}$$

82 **(b)**

The series in U-V region is Lyman series. Longest wavelength corresponds to, minimum energy which occurs in transition from $n$=2 to $n$=1.

$\therefore \quad 122=\frac{\frac{1}{R}}{\left(\frac{1}{1^2}-\frac{1}{2^2}\right)}$ ... (i)

The smallest wavelength in the infrared region corresponds to maximum energy of Paschen series.

$\therefore \quad \lambda=\frac{\frac{1}{R}}{\left(\frac{1}{3^2}-\frac{1}{\infty}\right)}$ ... (ii)

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

$$\lambda=823.5\text{ nm}$$

83 **(d)**

For first line of Lyman series,

$n_1$=1 and $n_2$=2

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

For first line of Paschen Series

$n_1$=3 and $n_2$=4

$\therefore \quad \frac{1}{\lambda_2}=R\left(\frac{1}{3^2}-\frac{1}{4^2}\right)=R\left(\frac{1}{9}-\frac{1}{16}\right)=\frac{7R}{144}$

$\therefore \quad \frac{\lambda_1}{\lambda_2}=\frac{7R}{144}\times\frac{4}{3R}=\frac{7}{108}$

84 **(c)**

The wavelength of different members of Balmer series are given by

$$\frac{1}{\lambda}=R_{\mathrm{H}}\left[\frac{1}{2^2}-\frac{1}{n_i^2}\right], \text{ where } n_i=3,4,5,....$$

The first member of Balmer series ($H_\alpha$) corresponds to $n_i$=3.It has maximum energy and hence the longest wavelength. Therefore ,wavelength of $H_\alpha$ line (or longest wavelength )

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

$$= 1.097 \times 10^7\left(\frac{5}{36}\right)$$

or $\lambda_1 = \frac{36}{5 \times 1.097 \times 10^7} = 6.563 \times 10^{-7}$ m

$n = 6563$ Å

The wavelength of the Balmer series limit corresponds to $n_i = \infty$ and has got shortest wavelength.

Therefore , wavelength of Balmer series limit is given by

$$\frac{1}{\lambda_\infty} = R_H\left[\frac{1}{2^2} - \frac{1}{\infty^2}\right] = 1.097 \times 10^7 \times \frac{1}{4}$$

or $\lambda_\infty = \frac{4}{1.097 \times 10^7} = 3.646 \times 10^{-7}$ m

$= 3646$Å

Only 4861 Å is between the first and last line of the Balmer series.

85 **(a)**

Incandescent electric lamp produces continuous emission spectrum whereas mercury and sodium vapour give line emission spectrum. Polyatomic substances such as $H_2$, $CO_2$ and $KMnO_4$ produces band absorption spectrum.

86 **(c)**

The potential energy of hydrogen atom

$$E_n = \frac{13.6}{n^2}\text{ eV}$$

So, the potential energy in second orbit is

$$E_2 = -\frac{13.6}{2^2}\text{ eV}$$

$$E_2 = -\frac{13.6}{4}\text{eV} = -3.4\text{ eV}$$

Now, the energy required to remove an electron from second orbit to infinity is

$U = E_\infty - E_2$ [From work-energy theorem and $E_\infty = 0$]

$\Rightarrow$ $U = 0 - (-3.4)$ eV

Or $U = 3.4$ eV

Hence, the required energy is 3.4 eV.

87 **(c)**

Current , $I = 6.6 \times 10^{15} \times 1.6 \times 10^{-19}$

$= 10.5 \times 10^{-4}$ A

Area $A = \pi R^2 = 3.142 \times (0.528)^2 \times 10^{-20}$ m$^2$

So, magnetic moment $M = IA = 10.5 \times 10^{-4} \times 3.142$

$\times (0.528)^2 \times 10^{-20}$

$= 10 \times 10^{-24} = 10^{-23}$ units

88 **(c)**

For Pfund series, $\frac{1}{\lambda_s} = R\left(\frac{1}{5^2} - \frac{1}{(\infty)^2}\right) = \frac{R}{25}$

$$\lambda_s = 25/R$$

$$\frac{1}{\lambda_l} = R\left(\frac{1}{5^2} - \frac{1}{6^2}\right) = R\left(\frac{36-25}{25 \times 36}\right)$$

$$\lambda_l = \frac{25 \times 36}{11R}$$

$$\therefore \frac{\lambda_l}{\lambda_s} = \frac{25 \times 36}{11R} \times \frac{R}{25}$$

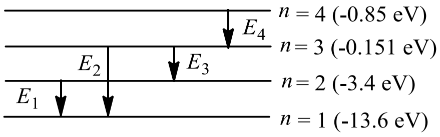
$$= \frac{36}{11}$$

89 **(d)**

$$\frac{R_1}{R_2} = \frac{n_1^2}{n_2^2} = \frac{1}{4} \therefore \frac{n_1}{n_2} = \frac{1}{2}$$

$$\frac{T_1}{T_2} = \left(\frac{n_1}{n_2}\right)^3 = \left(\frac{1}{2}\right)^3 = \frac{1}{8}$$

90 **(d)**




$E_1 = -13.6 - (-3.4) = -10.2$ eV

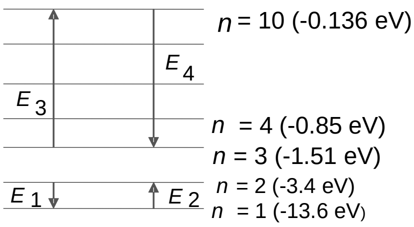
$E_2 = -13.6 - (-1.51) = -12.09$ eV

$E_3 = -3.4 - (-1.5) = -1.89$ eV

$E_4 = -1.51 - (-0.85) = -0.66$ eV

$E_4$ is least *ie*, frequency is lowest.

92 **(b)**




$E_1 = -13.6 - (-3.4) = -10.2$ eV

$E_2 = -3.4 - (-13.6) = +10.2$ eV

$E_3 = -0.136 - (-1.51) = -1.374$ eV

$E_4 = -1.51 - (-0.136) = -1.374$ eV

When an electron makes transition from higher energy level having energy $E_2(n_2)$ to lower energy level having energy$E_1(n_1)$, then a photon of frequency $v$ is emitted.

Here, for emission line $E_1$ is maximum hence, it will have the highest frequency emission line.

93 **(c)**

From $mvr = \frac{nh}{2\pi}$

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

Acceleration, $a = \frac{v^2}{r} = \frac{n^2h^2}{4\pi^2m^2r^3}$

$$= \frac{h^2}{4\pi^2m^2r^3} \qquad (n = 1)$$

94 **(c)**

$\lambda \propto n^2$

$\therefore \quad \frac{\lambda_{\text{Lyman}}}{\lambda_{\text{Balmer}}} = \left(\frac{1}{2}\right)^2 = \frac{1}{4} = 0.25$

95 **(b)**

The minimum energy needed to ionise an atom is called ionisation energy. The potential difference through which an electron should be accelerated to acquire this much energy is called ionisation potential.

$$(E_2)_H - (E_1)_H = 10.2 \text{ eV}$$

or $\frac{(E_1)_H}{4} - (E_1)_H = 10.2 \text{ eV}$

$\therefore \quad (E_1)_H = -13.6 \text{ eV}$

Hence ,ionisation potential energy is

$$= (E_\infty)_H - (E_1)_H = 13.6 \text{ eV}$$

$\therefore$ Ionisation potential = 13.6 V

96 **(c)**

As $U = 2E, K = -E$

Also, $E = -\frac{13.6}{n^2}$ eV

Hence, $K$ and $U$ change as four fold each.

97 **(c)**

The energy of first excitation of sodium is

$$E = hv = \frac{hc}{\lambda}$$

Where $h$ is Planck's constants, $v$ is frequency, $c$ is speed of light and $\lambda$ is wavelength.

$$E = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{5896 \times 10^{-10}}$$

$$E = 3.37 \times 10 - 19 \text{ J}$$

Also since $1.6 \times 10 - 19 \text{ J} = 1\text{eV}$

$\therefore \quad E = \frac{3.37 \times 10^{-19}}{1.6 \times 10^{-19}}$ eV

$$E = 2.1 \text{ eV}$$

Hence ,corresponding first excitation potential is 2.1 V.

98 **(b)**

The radius of the orbit of the electron in the $n$th excited state

$$r_e = \frac{n^2 4\pi\varepsilon_0 h^2}{4\pi^2 mZe^2}$$

For the first excited state

$$n = 2, Z = 1$$

$\because \quad r' = \frac{4\varepsilon_0 h^2}{\pi me^2}$

For the ground state of hydrogen atom

$$n = 1, Z = 1$$

$\because \quad r'' = \frac{h^2\varepsilon_0}{\pi me^2}$

The ratio of radius

$$\frac{r'}{r''} = \frac{4}{1}$$

The ratio of area of the electron orbit for hydrogen atom

$$\frac{A'}{A''} = \frac{4\pi(r')^2}{4\pi(r'')^2}$$

$$\frac{A'}{A''} = \frac{16}{1}$$

99 **(d)**

Kinetic energy of electron

$$K = \frac{Ze^2}{8\pi\varepsilon_0 r}$$

Potential energy of electron

$$U = \frac{1}{4\pi\varepsilon_0 r}\frac{Ze^2}{r}$$

$\therefore$ Total energy

$E = K + U = \frac{Ze^2}{8\pi\varepsilon_0 r} - \frac{Ze^2}{4\pi\varepsilon_0 r}$

Or $\quad E = \frac{Ze^2}{8\pi\varepsilon_0 r}$

Or $\quad E = -K$

Or $\quad K = -E = -(-3.4)$

Or $\quad = 3.4$ eV

100 **(d)**

As is known,

PE = −2KE

$ie, \ E_P = -2E_K$ or $\frac{E_p}{E_k} = -2$

101 **(b)**

For Balmer series, $n_f = 2$ and $n_i = 3,4,5,....$

Frequency, of 1st spectral line of Balmer series

$$f = RZ^2 \, c\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$$

or $\quad f = RZ^2 \, c \times \frac{5}{36} \qquad$ ...(i)

Frequency, of 2nd spectral line of Balmer series

$$f' = RZ^2 \, c\left(\frac{1}{2^2} - \frac{1}{4^2}\right)$$

or $\quad f' = RZ^2 \, c \times \frac{3}{16} \qquad$ ....(ii)

Form eqs. (i) and (ii), we have

$$\frac{f}{f'} = \frac{20}{27}$$

$\therefore \quad f' = \frac{27}{20} f = 1.35 f$

102 **(d)**

Let a particle of change $q$ having velocity $v$ approaches Q upto a closest distance $r$ and if the velocity becomes $2v$, the closest distance will be $r.'$

The law of conservation of energy yields,
Kinetic energy of particle=electric potential energy between them at closest distance of approach.

Or $\frac{1}{2}mv^2 = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r}$

Or $\frac{1}{2}mv^2 = k\frac{Qq}{r}$ ...(i)

$\left(\text{k} = \text{constant} = \frac{1}{4\pi\varepsilon_0}\right)$

and $\frac{1}{2}m(2v)^2 = k\frac{Qq}{r'}$ ...(ii)

Dividing Eq. (i) by Eq.(ii),

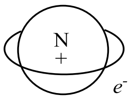
$$\frac{\frac{1}{2}mv^2}{\frac{1}{2}m(2v)^2} = \frac{\frac{kQq}{r}}{\frac{kQq}{r'}}$$

$\Rightarrow$ $$\frac{1}{4} = \frac{r'}{r}$$

$\Rightarrow$ $$r' = \frac{r}{4}$$

103 **(a)**

The positively charged nucleus, has electrons revolving around it in stationary orbits. The Coulomb's force provides the necessary centripetal force attraction to keep the electrons is orbits.




104 **(a)**

Wavelength emitted $(\lambda)$is given by

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = \frac{5R}{36}$$

$$\lambda = \frac{36}{5R}$$

105 **(d)**

Infrared radiation corresponds to least value of $\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$ ,*ie*, from Paschen, Brackett and Pfund series. Thus the transition corresponds to 5 → 3.

106 **(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 the mass of an electron. Therefore, this hypothetical atom, energy is $n$th orbit will be given by

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

The longest wavelength (or minimum energy) photon will correspond to the transition of particle from $n = 3$to $n = 2$

$$\Rightarrow \frac{hc}{\lambda_{\max}} = E_3 - E_2 = 2Rhc\left[\frac{1}{2^2} - \frac{1}{3^2}\right] = 2Rhc \times \frac{5}{36}$$

$$\therefore \lambda_{\max} = \frac{hc}{\frac{5}{18}Rhc} = \frac{18}{5R}$$

107 **(c)**

For Balmer series, $n_1 - 2, n_2 = 3$ for 1st line and $n_2 = 4$ for second line

$$\frac{\lambda_1}{\lambda_2} = \left(\frac{\frac{1}{2^2} - \frac{1}{4^2}}{\frac{1}{2^2} - \frac{1}{3^2}}\right) = \frac{3/16}{5/16} = \frac{3}{16} \times \frac{36}{5} = \frac{27}{20}$$

$$\lambda_2 = \frac{20}{27}\lambda_1 = \frac{20}{27} \times 6561 = 4860 \text{ Å}$$

108 **(b)**

Number of spectral lines $= \frac{n(n-1)}{2} = \frac{3(3-1)}{2} = 3$

109 **(b)**

No. of neutrons in $C^{12} = 12 - 6 = 6$

No. of electrons in $C^{14} = 14 - 6 = 8$

110 **(c)**

Energy of helium ions.

$$E_n = -\frac{13.6\,Z^2}{n^2} \text{ eV}$$

In minimum position, $n$=1

For $He^+, Z = 2$

$$E = \frac{-13.6 \times (2)^2}{1} \text{ eV}$$

$$E = 54.4 \text{ eV}$$

111 **(a)**

Radius of orbit

$$r_n = \frac{n^2h^2}{4\,\pi^2\,k^2 m_e^2}$$

$$r_n \propto n^2$$

Energy $E = -Rch\frac{Z^2}{n^2}$

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

113 **(a)**

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

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

114 **(b)**

Ionization energy corresponding to ionization potential

$= -13.6$ eV

Photon energy incident = 12.1 eV

So,the energy of electron in excited state

$= -13.6 + 12.1 = -1.5$ eV

*ie*, $E_n = -\frac{13.6}{n^2}$ eV

$$-1.5 = -\frac{-13.6}{n^2}$$

$\Rightarrow \quad n^2 = \frac{-13.6}{-1.5} \approx 9$

$\therefore \quad n = 3$

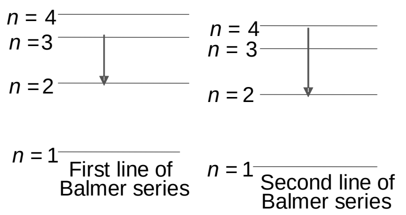
*ie*, energy of electron in excited state corresponds to third orbit.

The possible spectral lines are when electron jumps from orbit 3rd to 2nd; 3rd to 1st and 2nd to 1st. Thus, 3 spectral lines are emitted.

115 **(d)**

Solar Spectrum is an example of line absorption Spectrum.

116 **(a)**




For hydrogen or hydrogen type atoms

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

In the transition from $ni \rightarrow nf$

$$\therefore \quad \lambda \propto \frac{1}{Z^2\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)}$$

$$\therefore \quad \frac{\lambda_2}{\lambda_1} = \frac{Z_1^2\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)_1}{Z_2^2\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)_2}$$

$$\lambda_2 = \frac{\lambda_1 Z_1^2\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)_1}{Z_2^2\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)_2}$$

Substituting the values, we have

$$= \frac{(6561)(1)^2\left(\frac{1}{2^2} - \frac{1}{3^2}\right)}{(2)^2\left(\frac{1}{2^2} - \frac{1}{4^2}\right)} = 1215 \text{ Å}$$

117 **(d)**

$E = E_4 - E_3$

$$= -\frac{13.6}{4^2} - \left(-\frac{13.6}{3^2}\right) = -0.85 + 1.51$$

$= 0.66$ eV

118 **(d)**

Nucleus Contains only the neutrons and protons.

119 **(a)**

Number of emitted spectral lines

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

Case I

$N = 3$

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

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

$(n_1 - 3)(n_1 + 2) = 0$

$n_1 = 3$

Case II

$N = 6$

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

$n_2^2 - n_2 - 12 = 0$

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

$n_2 = 4, n_2 = -3$

Again , as $n_2$ is always positive

$\therefore \quad n_2 = 4$

Velocity of electron $v = \frac{Ze^2}{2\varepsilon_0 hn}$

$$\therefore \quad \frac{v_1}{v_2} = \frac{n_2}{n_1}$$

$$\Rightarrow \quad \frac{v_1}{v_2} = \frac{4}{3}$$

120 **(c)**

According to the Bohr's theory the wavelength of radiations emitted from hydrogen atom given by

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

For maximum wavelength if$n_1 = n$,then

$n_2 = n + 1$

$\therefore \ \lambda \ is$ maximumfor$n_2 = 3$ and $n_1 = 2$.

121 **(d)**

In Raman effect, Stokes' lines are spectral lines having lower frequency or greater wavelength than that of the original line.

122 **(b)**

As $_{55}Cs^{133}$ has larger size among the four atoms given, thus, 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 electrons from outer orbit will be minimum in case of$_{55}Cs^{133}$.

123 **(a)**

For $n$th Bohr orbit,

$$r = \frac{\varepsilon_0 n^2 h^2}{\pi m Z e^2}$$

de-Broglie wavelength

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

Ratio of both $r$ and $\lambda$, we have

$$\frac{r}{\lambda} = \frac{\varepsilon_0 n^2 h^2}{\pi m Z e^2} \times \frac{mv}{h}$$

$$= \frac{\varepsilon_0 n^2 h v}{\pi Z e^2}$$

But $v = \frac{Ze^2}{2h\varepsilon_0 n}$ for $n$th orbit

Hence, $\frac{r}{\lambda} = \frac{n}{2\pi}$

124 **(a)**

From Bohr's model of atom, the wave number is given by

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

where$R$ is Rydberg's constant and $n_1$ and $n_2$ the energy levels.

Given, $n_1$=2, $n_2$=3

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

$$\frac{1}{\lambda} = R\left[\frac{5}{36}\right]$$

$$\Rightarrow \quad \lambda = \frac{36}{5R}$$

This gives corresponding wavelength of Balmer series.

125 **(c)**

According to Bohr's theory of atom electrons can revolve only in those orbits in which their angular momentum is an integral multiple of$\frac{h}{2\pi}$, where $h$ is Planck's constant.

Angular momentum $= mvr = \frac{2h}{2\pi}$

Hence, angular momentum is quantized.

The energy of electron in $n$th orbit of hydrogen atom,

$$E = \frac{Rhc}{n^2} \text{ joule}$$

Thus, it is obvious that the hydrogen atom has some characteristics energy state. In fact this is true for the atom of each element, *ie*, each atom has its energy quantized.

Hence, both energy and angular momentum are quantised.

126 **(c)**

In hydrogen atom, the lowest orbit corresponds to minimum energy.

127 **(a)**

When a $\gamma -$ ray photon is emitted then atomic number and mass number remains unchanged.

131 **(b)**

Here ,area of circular orbit of electron A $= \pi r^2$,current due to motion of electron

$$i = \frac{e}{t} = \frac{e}{2\pi r/v} = \frac{ev}{2\pi r}$$

Magnetic moment $= iA$

$$= \frac{eV}{2\pi r} \times \pi r^2$$

$$= \frac{evr}{2}$$

132 **(b)**

From Bohr's formula , the wave number $\left(\frac{1}{\lambda}\right)$ is given by

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

where $Z$ is atomic number, $R$ the Rydberg's constant and $n$ the quantum number.

$$\Rightarrow \quad \lambda \propto \frac{1}{Z^2}$$

Atomic number of lithium is 3, of helium is 2 and of hydrogen is 1.

$$\therefore \quad \lambda_{Li^{2+}} : \lambda_{He^+} : \lambda_H = \frac{1}{(3)^2} : \frac{1}{(2)^2} : 1$$

$$= \frac{1}{9} : \frac{1}{4} : 1$$

133 **(c)**

Total energy of electron in excited state $= -13.6 + 12.1 = -1.5$ eV, which corresponds to third orbit. The possible spectral lines are when electron jumps from orbit 3rd to 2nd; 3rd to 1st and 2nd to 1st

134 **(c)**

The given type of spectrum has coloured bands of light on a dark-ground. One end of each band is sharp and bright and the brightness gradually decreases towards the other end. Band spectrum is obtained from the molecules in the gaseous state of matter. For example, when discharge is passed through oxygen, nitrogen or carbon dioxide, the light emitted from these gases give band spectrum.

135 **(d)**

Impact parameter b $\propto \cot\frac{\theta}{2}$

Here $b$=0, hence, $\theta = 180^0$

136 **(a)**

Electron angular momentum about the nucleus is an integer multiple of$\frac{h}{2\pi}$ , where $h$ is Planck's constant.

$$I\omega = mvr$$

$$= \frac{nh}{2\pi}$$

$$r \propto n$$

137 **(a)**

When an atom comes down from some higher energy level to the first energy level then emitted lines form of Lyman series.

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

where $R$ is Rydberg's constant.

When an atom comes from higher energy level to the second level, then Balmer series are obtained.

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

For maximum wavelength

$$n=2, \frac{1}{\lambda_L} = R\left(1 - \frac{1}{(2)^2}\right) = R\left(1 - \frac{1}{4}\right) = \frac{3R}{4} \quad \ldots.(i)$$

$$n = 3, \frac{1}{\lambda_B} = R\left(\frac{1}{(2)^2} - \frac{1}{(3)^2}\right) = R\left(\frac{5}{36}\right) \quad \ldots(ii)$$

Dividing Eq. (ii) by Eq. (i), we get

$$\frac{\lambda_L}{\lambda_B} = \frac{5}{27}$$

138 **(d)**

$$\bar{\upsilon} = R\left[\frac{1}{2^2} - \frac{1}{4^2}\right] = \frac{3R}{4} = 20397\text{cm}^{-1}$$

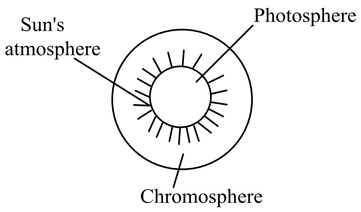
For the same transaction in He atom ($Z = 2$)

$$\bar{\upsilon} = RZ^2\left[\frac{1}{2^2} - \frac{1}{4^2}\right] = \frac{3R \times 2^2}{4}$$

$$= 20397 \times 4 = 81588 \text{ cm}^{-1}$$

139 **(d)**

Fraunhofer lines are certain dark lines observed in the otherwise continuous spectrum of the sum. According to Fraunhofer, these dark lines represent the absorption spectrum of the vapours surrounding the sun. The sun consists of a hot central core called photosphere, which is at an extremely high temperature = $1.4 \times 10^7$ K. it is surrounded by less dense, luminous and highly compressed gases. They are said to form sun's atmosphere. A continuous spectrum




containing radiations of all wavelengths is emitted by the sun's atmosphere . surrounding this , is another sphere of vapours and gases at a comparatively lower temperature (6000 K). At the time of total solar eclipse, photosphere is covered. Emission lines from vapours of elements in chromosphere appear as bright lines. So, all Fraunhofer lines are changed into bright coloured lines.

140 **(d)**

The angular momenta of an electron is

$$mvr = \frac{nh}{2\pi}$$

141 **(a)**

When an atom comes down from some higher energy level to the second energy ($n$=2), then the lines of spectrum are obtained in visible part and give the Balmer series.

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

For second line $n = 4$

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

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

$$R = 1.097 \times 10^7 \text{ m}^{-1}$$

$$\lambda = \frac{16}{3 \times 1.097 \times 10^7}$$

$$= 4860 \times 10^{-10} \text{ m}$$

$$\Rightarrow \quad \lambda = 4860 \text{ Å}$$

which corresponds to colour blue.

142 **(c)**

$$r_0 = \frac{(Ze)(2e)}{4\pi\varepsilon_0(E)} = \frac{2 \times 92(1.6 \times 10^{-19})^2 \times 9 \times 10^9}{5 \times 1.6 \times 10^{-13}}$$

$$= 0.53 \times 10^{-14}\text{m} \approx 10^{-12}\text{cm}$$

143 **(b)**

Wavelength ($\lambda$) during transition from $n_2$to $n_1$ is given by

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

$$\Rightarrow \frac{1}{\lambda_{3\to2}} = R\left[\frac{1}{2^2} - \frac{1}{3^2}\right] = \frac{5R}{36}$$

$$\text{and} \frac{1}{\lambda_{4\to2}} = r\left[\frac{1}{2^2} - \frac{1}{4^2}\right] = \frac{3R}{16}$$

$$\therefore \quad \frac{\lambda_{4\to2}}{\lambda_{3\to2}} = \frac{20}{27}$$

$$\Rightarrow \lambda_{4\to2} = \frac{20}{27}\lambda_0$$

144 **(c)**

As energy $\propto \frac{1}{\lambda}$,

Therefore, energy corresponding to 1 Å = 2.5 × 5000 eV

145 **(c)**

The energy of $n$th orbit of hydrogen like atom is,

$$E_n = -13.6 \frac{Z^2}{n^2}$$

Here, $Z = 11$ for Na atom. 10 electrons are removed already. For the last electron to be removed $n$=1.

$$\therefore E_n = \frac{-13.6 \times (11)^2}{(1)^2} \text{ eV}$$

$$= -13.6 \times (11)^2 \text{ eV}$$

146 **(d)**

In Lyman series, wavelength emitted is given by

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

where, $n$ =2,3,4……

and $R$ =Rydberg's constant

$= 1.097 \times 10^7 \text{m}^{-1}$

For maximum wavelength $n$=2

$$\therefore \quad \frac{1}{\lambda_{\max}} = 1.097 \times 10^7 \left[\frac{1}{1^2}-\frac{1}{2^2}\right]$$

$$\frac{1}{\lambda_{\max}} = 1.097 \times 10^7 \left[\frac{1}{1}-\frac{1}{4}\right]$$

$$= 1.097 \times 10^7 \times \frac{3}{4}$$

$$\Rightarrow \quad \lambda_{\max} = \frac{4}{3.291 \times 10^7}$$

$= 1216$ Å $= 121.6$ m

$\therefore \quad \lambda_{\max}$ =122nm

147 **(d)**

$$R = \frac{2\pi^2 mk^2e^4}{ch^3} = \left(\frac{1}{4\pi\varepsilon_o}\right)^2 \frac{2\pi^2 me^4}{ch^3}$$

148 **(c)**

The first photon will excite the hydrogen atom (in ground state) in first excited state (as $E_2 - E_1 - 10.2$ eV). Hence, during de-excitation a photon of 10.2 eV will be released. The second photon of energy 15 eV can ionize the atom. Hence the balance energy *ie*, $(15 - 13.6)$ eV = 1.4 eV is retained by the electron.

Therefore, by the second photon an electron of energy 1.4 eV will be released.

149 **(b)**

The Kinetic energy of the electron in the $n$th state

$$K = \frac{mZ^2e^4}{8\varepsilon_0^2 h^2 n^2}$$

The total energy of the electron in the $n$th state

$$T = -\frac{mZ^2e^4}{8\varepsilon_0^2 h^2 n^2}$$

$$\therefore \quad \frac{K}{T} = -1$$

150 **(d)**

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

$n_1$=2, $n_2$=4

$$\frac{1}{\lambda} = R\left[\frac{1}{4}-\frac{1}{16}\right]$$

$$= R\left[\frac{4-1}{16}\right] = \frac{3R}{16}$$

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

151 **(c)**

1amu (or 1 u)=$1.6 \times 10^{-27}$ kg

40 u=$40 \times 1.6 \times 10^{-27}$ kg

Number of atoms in earth

$$= \frac{6.64 \times 10^{24}}{40 \times 1.6 \times 10^{-27}} = 10^{50}$$

152 **(a)**

For minimum wavelength $n_2 = \infty$ , $n_1 = n$.

So, $\lambda_{\min} = \frac{n^2}{R} = \frac{1}{10^7} = 1000$ Å

153 **(c)**

From Hubble 's law

$$Z \propto r$$

Where $Z \to$ red shift, $r \to$distance of the galaxy

Also, $Z = \frac{d\lambda}{\lambda} = \frac{v}{c} = \frac{\text{speed of galaxy}}{\text{speed of light}}$

Given $d\lambda = 401.8 - 393.3 = 8.5$ nm,

$\lambda = 393.3$ nm,

$Z = \frac{8.5}{393.3} = 0.0216$

Also $v = cZ$

$= 3 \times 10^8 \times 0.0216$

$= 64.8 \times 10^5 \text{ms}^{-1}$

Since 1km $= 10^3$m , therefore

$v = 6480 \text{ kms}^{-1}$

154 **(d)**

Lowest orbit is $n = 1$. Three lower orbits correspond to $n = 1.2.3$

$$\therefore E_1 = \frac{13.6}{1^2} = 13.6 \text{ eV},$$

$$E_2 = \frac{13.6}{2^2} = 3.4 \text{ eV}, E_3 = \frac{13.6}{3^2} = 1.5 \text{ eV}$$

155 **(a)**

$\therefore n = 5$

$$r_n = (0.53 \times 10^{-10})\frac{n^2}{Z}$$

$$= \frac{0.53 \times 10^{-10} \times 5^2}{53} = 2.5 \times 10^{-11}\text{m}$$

156 **(a)**

Here, $n_f = 1, n_i = n$

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

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

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

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

157 **(b)**

Since spectrum of an oil flame consists of continuously varying wavelength in a definite wavelength range, it is an example for continuous emission spectrum.