

<H1> Additional Objective Questions

<H2> Single Correct Choice Type

1.(C) Bohr's theory is not applicable to He^{2+} as it has no electrons.

2.(C) Discovery of nucleus.

3.(A) Isotonic species are those who have same number of neutrons, that is, ${}^{14}_6\text{C}$ has 8 neutrons, ${}^{15}_7\text{N}$ has 8 neutrons, ${}^{17}_9\text{F}$ also has 8 neutrons.

4.(A) For Balmer series, $n_1 = 2$; therefore, the fourth line is $n_2 = 2 + 4 = 6$. Therefore, 6 to 2.

5.(C) We know

$$r_n = r_0 \times \frac{n^2}{Z},$$

where $Z = 1$.

For first three Bohr's orbit, we have

$$r_1 = r_0, r_2 = 4r_0, r_3 = 9r_0$$

Therefore, the ratio is 1:4:9

6.(B) It represents the probability of finding an electron at a point within the atom.

7.(D) Concept based.

8.(D) The change in the energy levels of electron is quantized instead of continuous.

9.(C) From the de Broglie hypothesis, we have

$$\lambda = \frac{h}{mv} \tag{1}$$

Substituting the values in Eq. (1), we get

$$\lambda = \frac{6.6 \times 10^{-34}}{\frac{0.2 \times 5}{60 \times 60}} = 2.37 \times 10^{-30} \text{ m}$$

10.(B) For hydrogen, Lyman series has $n_1 = 1$ and second line $n_2 = 1 + 2 = 3$

Since, second line of Lyman series of H coincides with the 6th line of Paschen series, therefore, wave number of both the line is same, we have

$$Z_{\text{H}}^2 \left(\frac{1}{1} - \frac{1}{3^2} \right) = Z_{\text{X}}^2 \left(\frac{1}{3^2} - \frac{1}{9^2} \right)$$

Sixth line of Paschen series = 9

$$\frac{8}{9} = Z_{\text{X}}^2 \left(\frac{1}{9} - \frac{1}{81} \right)$$

$$\Rightarrow \frac{8}{9} = Z_X^2 \left(\frac{8}{81} \right)$$

$$\Rightarrow Z_X^2 = 9$$

$$\Rightarrow Z_X = 3$$

Since, the atomic number of the ionic species X is 3, therefore, the species is Li^{2+} .

11.(A) We know

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

For ionization energy, $n_1 = 1$ and $n_2 = \infty$

$$\frac{1}{\lambda} = R_H Z^2 \left(\frac{1}{1^2} - \frac{1}{\infty} \right)$$

The energy is given by

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

Therefore,

$$E = \frac{R_H hc Z^2}{1}$$

12.(B) $E_2 = h\nu = (6.62 \times 10^{-34} \text{ Js})(880 \text{ s}^{-1}) = 5.831 \times 10^{-31} \text{ J}$

Now, $P = 1000 \text{ W} \Rightarrow E_1 = 1000 \text{ J s}^{-1}$

Therefore, the number of photons per second emitted = $\frac{E_1}{E_2} = \frac{1000}{5.831 \times 10^{-31}} = 1.715 \times 10^{30}$

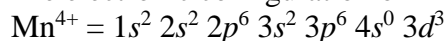
13.(B) Violates Hund's law.

14.(A) We know that $r_n = r_1' n^2$. Therefore,

$$9r_1 = r_1' n^2 \Rightarrow n^2 = 9 \Rightarrow n = 3$$

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

15.(D) The electronic configuration of $\text{Mn}(Z = 25)$ is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$



16.(C) For spin multiplicity = $(2s + 1) = 0$, the total spin (s) = $-\frac{1}{2}$

For electronic configuration $\boxed{\uparrow} \boxed{\downarrow} \boxed{\downarrow}$

The spin for first electron = $+\frac{1}{2}$

For second electron = $-\frac{1}{2}$

For third electron = $-\frac{1}{2}$

$$\text{The total spin} = 2\left(-\frac{1}{2}\right) + \left(+\frac{1}{2}\right) = -\frac{1}{2}$$

17.(D) Spin multiplicity is $2S + 1$. $l = 3$ corresponds to s , p , d , and f orbitals. Maximum multiplicity for the f orbitals (7 electrons) $= 2s + 1 = 2 \times \frac{7}{2} + 1 = 8$

Minimum multiplicity for the f orbital (1 electron) $= 2s + 1 = 2 \times \frac{1}{2} + 1 = 2$

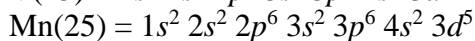
18.(B) $E_n = -13.6 \times \frac{z^2}{n^2}$. Therefore,

$$\frac{E_{n(\text{H})}}{E_{n(\text{Be}^{+3})}} = \frac{1}{\frac{4^2}{4}} = \frac{1}{4} = 1:4$$

19.(A) The electronic configuration of Rb ($Z = 37$) is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^1$. For outermost electron, that is, $5s^1$, the correct set of quantum number is:

$$n = 5, l = 0, m = 0, s = +\frac{1}{2}$$

20.(C) Number of unpaired electrons in V, Cr, and Mn is 3, 6, and 5.



21.(C) Number of nodes in double dumbbell shaped d -orbital in 4th principle shell is:

$$n - l - 1 = 4 - 2 - 1 = 1$$

22.(D) Charge/mass for $n = 0$, $\alpha = \frac{2}{4}$, $p = \frac{1}{1}$, $e = \frac{1}{1/1837}$

So, the order is $n < \alpha < p < e$.

23.(C) We know

$$h\nu_1 = h\nu_0 + \text{KE}_1$$

where, $h\nu_0 = \text{Work function}$.

$$h\nu'_1 = h\nu_0 + \text{KE}'_1,$$

$$2h\nu_1 = h\nu_0 + \text{KE}'_1,$$

$$[\text{Given, } \nu'_1 = 2\nu_1]$$

$$\text{KE}' = h(2\nu_1 - \nu_0)$$

The value of kinetic energy will increase but more than double of the previous KE.

24.(B) $N = \text{Number of lines emitted} = \frac{1}{2}n(n-1) = \frac{1}{2} \times 4(4-1) = 6$ (when electron falls from $m = n$ to

$n = 1$)

25.(B) Let the probability of finding an electron be 0. Then

$$\psi = \frac{1}{16\sqrt{4}} \left(\frac{1}{a_0} \right)^{3/2} [(x-1)(x^2 - 8x + 12)]e^{-r/2} = 0$$

or $(x-1)(x^2 - 8x + 12) = 0 \Rightarrow (x-1)(x-6)(x-2) = 0$

Therefore, the minimum value of x is 1 and maximum value is 6.

Given that $x = 2r/a_0$. Therefore, the minimum and maximum position of radial nodes from nucleus are:

$$\left(\frac{2r}{a_0} - 1 \right) = 0 \Rightarrow r = \frac{a_0}{2} \quad \text{and} \quad \left(\frac{2r}{a_0} - 6 \right) = 0 \Rightarrow r = 3a_0$$

26.(D) Since, the probability of finding an electron at nucleus is zero, therefore, the ratio of finding an electron at nucleus to first Bohr's orbit is zero.

27.(B) The radial nodes occur when the radial probability function = zero. Therefore, for 2s orbital, at radial node, $r = r_0$, and

$$\frac{1}{2\sqrt{2\pi}} \left(\frac{1}{a_0} \right)^{1/2} \left\{ 2 - \frac{r}{a_0} \right\} e^{-r/2a_0} = 0 \Rightarrow \frac{r_0}{a_0} = 2$$

28.(B) As $n_2 = 2, n_1 = 1$,

$$\frac{1}{\lambda} = R_H \times \left[\frac{1}{1^2} - \frac{1}{2^2} \right] = R_H = x \text{ \AA}$$

Therefore, $R_H = \frac{4/3}{x}$

29.(A) The probability of finding an electron residing in a p_x orbital is zero in plane perpendicular to x -axis, that is, yz -plane.

30.(A) The maximum electron population of a shell is $2n^2$. For example, for $n = 2$, subshells are 2s and 2p with maximum electron population $2 + 6 = 8 = 2(2)^2$.

31.(B) Absorption line in the spectra arises when energy is absorbed, that is, electron shifts from lower to higher orbit out of a and b ; b will have the maximum wavelength as this falls in the Paschen series.

32.(C) $-PE = 2KE = 2 \times (+13.6) = 27.2 \text{ eV}$.

Therefore, $PE = -27.2 \text{ eV}$

PE with respect to ground state = 27.2 eV, which we assume to be zero.

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

For the first excited state, $n = 2$. Therefore,

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

$$\text{Total energy} = (27.2 - 3.4) \text{ eV} = 23.8 \text{ eV}$$

33.(C) Most electronegative element is F (i.e., halogens). Therefore, electronic configuration: $ns^2 np^5$.

34.(B) According to Aufbau principle, the correct sequence for filling up orbitals when $n = 6$ is $6s, 4f, 5d, 6p$.

35.(D) We know

$$h\nu = h\nu_0 + \text{KE}$$

For zero velocity, the $\text{KE} = 0$

where $h\nu_0$ is work function. So, $h\nu = h\nu_0$.

Given that $h\nu = 4 \text{ eV}$. Therefore,

$$\frac{hc}{\lambda} = 4 \text{ eV} \Rightarrow \lambda = \frac{h \times c}{4 \text{ eV}} = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{4 \times 1.6 \times 10^{-19}} = 3100 \text{ \AA}$$

36.(C) $\lambda = \frac{h}{\sqrt{2m\text{KE}}}$; where KE is in eV.

Given that the mass is same, but charges are in the ratio 1:2, therefore, $\text{KE}_2 > \text{KE}_1$. Now,

$$\frac{\lambda_1}{\lambda_2} = \frac{\sqrt{\text{KE}_2}}{\sqrt{\text{KE}_1}} \Rightarrow \lambda_1 > \lambda_2$$

37.(B) Total energy = $\frac{e^2}{2r_n} = -3.4 \text{ eV} = \frac{E_1}{n^2}$

$$\text{Therefore, } n^2 = \frac{13.6}{-3.4} = 4 \Rightarrow n = 2$$

The velocity in second orbit $\frac{U_1}{2} = \frac{2.18 \times 10^8}{2} \text{ (cm sec}^{-1}\text{)}$

$$\lambda = \frac{h}{mu} = \frac{6.626 \times 10^{-27} \times 2}{9.1 \times 10^{-28} \times 2.18 \times 10^8} = 6.6 \times 10^{-10} = 6.6 \text{ \AA}$$

38.(B) Required energy = $10^{-17} \text{ J} = n \times \frac{hc}{\lambda} \Rightarrow n \times \frac{6.625 \times 10^{-34} \times 3 \times 10^8}{550 \times 10^{-9}} \text{ J}$

$$\text{Therefore, } n = \frac{10^{-17}}{\frac{6.626 \times 10^{-34} \times 3 \times 10^8}{550 \times 10^{-9}}} = 27.8 \approx 28$$

39.(A) The total energy is given by

$$E = \text{KE} + \text{PE} = \frac{1}{2}mv^2 - \frac{Ze^2}{r} \quad (1)$$

For an electron to stay in an orbital, the centripetal force must be balanced by the columbic force of the nucleus, therefore,

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

$$\Rightarrow v = e\sqrt{\frac{Z}{mr}}$$

Substituting expression of v in Eq. (1), we get

$$E = \frac{1}{2}m \left(\frac{Ze^2}{mr} \right) + \frac{Ze^2}{r} = -\frac{1}{2} \frac{Ze^2}{r}$$

Therefore, $\text{KE} = -E = 13.6 \text{ eV}$.

40.(A) Ψ_{321} means $n = 3$ and $l = 2$, $m = 1$ therefore, the angular momentum = $\frac{\sqrt{l(l+1)}h}{2\pi} = \frac{\sqrt{6}h}{2\pi}$,
spherical nodes = $n - l - 1 = 3 - 2 - 1 = 0$ and angular nodes = $l = 2$. Hence, the sum is

$$\frac{\sqrt{6}h}{2\pi} + 2 = \frac{\sqrt{6}h + 4\pi}{2\pi}$$

41.(D) Given that de Broglie wavelength is

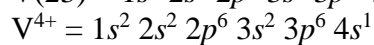
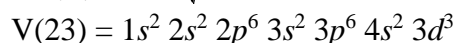
$$\lambda = \frac{h}{mv} \Rightarrow v = \frac{h}{m\lambda}$$

$$E = \frac{1}{2}mv^2 = \frac{1}{2} \times m \times \frac{h^2}{m^2\lambda^2} = \frac{h^2}{2m\lambda^2}$$

Therefore,

$$E = \frac{3}{2}kT \Rightarrow T = \frac{2E}{3k} = \frac{1}{3k} \times \frac{h^2}{m\lambda^2} = 2 \text{ K}$$

42.(C) $1.73 = \sqrt{n(n+2)} \Rightarrow n = 1$



So, oxidation state is +4.

43.(C) The d_{xy} orbital has yz and xz nodal planes.

44.(A) We know that $v \propto \frac{1}{n}$ and $n =$ principal quantum number. Therefore, vn will be independent of the principal quantum number, that is, n .

45.(D) We know

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

For Balmer Series; $n_1 = 2$ because it is the first emission line and $n_2 = 2 + 1 = 3$. Hence,

$$\frac{1}{\lambda} = R_H \times 1^2 \left[\frac{1}{2^2} - \frac{1}{3^2} \right] = \frac{R_H 5}{36} \text{ cm}^{-1}$$

46.(C) $t = \frac{2\pi R_n}{u_n} \Rightarrow t \propto \frac{R_n}{u_n} \Rightarrow t \propto \frac{1/n^2}{n} \Rightarrow t \propto n^3$

Hence, the ratio of the time taken by them to complete one revolution is

$$\frac{t_1}{t_2} = \frac{(n_1)^3}{(n_2)^3} = \frac{(\sqrt{R_1})^3}{(\sqrt{R_2})^3} = \frac{(\sqrt{R})^3}{(\sqrt{4R})^3} = \frac{1}{8}$$

47.(B) The electronic configuration of Cr ($Z = 24$) is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$
 $\text{Cr}^{3+} = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^0 3d^3$

Number of unpaired electrons in $\text{Cr}^{3+} = 3$

48.(D) After the removal of first electron, helium ion becomes a hydrogen like species, so the energy required to remove the second electron can be calculated as

$$E_n = \frac{13.6Z^2}{n^2} = 13.6 \times 4 = 54.4 \text{ eV}$$

Therefore, the energy to remove both the electrons is $24.6 + 54.4 = 79.0 \text{ eV}$.

49.(C) The energy change for the transitions is given by

$$\Delta E = 2.17 \times 10^{-18} \left(\frac{1}{(n_1)^2} - \frac{1}{(n_2)^2} \right) \text{ J atom}^{-1}$$

For the given transitions, the energy changes are

For $5 \rightarrow 3$

$$\Delta E = 2.17 \times 10^{-18} \left(\frac{1}{(3)^2} - \frac{1}{(5)^2} \right) \text{ J atom}^{-1} = 2.17 \times 10^{-18} \times \frac{16}{225} \text{ J atom}^{-1}$$

For $4 \rightarrow 1$

$$\Delta E = 2.17 \times 10^{-18} \left(\frac{1}{(1)^2} - \frac{1}{(4)^2} \right) \text{ J atom}^{-1} = 2.17 \times 10^{-18} \times \frac{15}{16} \text{ J atom}^{-1}$$

For $3 \rightarrow 1$

$$\Delta E = 2.17 \times 10^{-18} \left(\frac{1}{(1)^2} - \frac{1}{(3)^2} \right) \text{J atom}^{-1} = 2.17 \times 10^{-18} \times \frac{8}{9} \text{J atom}^{-1}$$

For $5 \rightarrow 4$

$$\Delta E = 2.17 \times 10^{-18} \left(\frac{1}{(4)^2} - \frac{1}{(5)^2} \right) \text{J atom}^{-1} = 2.17 \times 10^{-18} \times \frac{9}{400} \text{J atom}^{-1}$$

50.(C) If electron is accelerated by V volt,

$$\text{KE} = eV = \frac{1}{2}mv^2$$

$$\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2eVm}}$$

But $\lambda = 1 \text{ \AA}$, so

$$\frac{h}{\lambda} = \sqrt{2eVm} \Rightarrow V = \frac{h^2}{2em\lambda^2} = \frac{(6.626 \times 10^{-34})^2}{2 \times 1.6 \times 10^{-19} \times 9.1 \times 10^{-31} \times (1 \times 10^{-10})^2} = 150.7 \text{ V}$$

51.(A) For the $3p$ orbital, $n = 3$, $l = 1$. $n - l - 1$ for p orbital $l = 1$.

The number of spherical nodes = $n - l - 1 = 3 - 1 - 1 = 1$

52.(B) Orbital angular momentum = $\sqrt{l(l+1)} \frac{h}{2\pi} = \sqrt{0(0+1)} \frac{h}{2\pi} = 0$ (for s orbital, $l = 0$).

53.(D) We know

$$r_n = \frac{0.529 \times n^2}{2} \text{ \AA}$$

$$r_{\text{Be}^{3+}} = \frac{0.529 \times (2)^2}{4} = 0.529 \text{ \AA}$$

54.(A) With principle quantum number 3 and azimuthal quantum number 2, the orbital is $3d$. As there are five atomic orbitals in $3d$ and each orbital can have a maximum of 2 electrons, so the maximum number of electrons that maybe present in all atomic orbitals of $3d$ is 10.

<H2>Multiple Correct Choice Type

1.(A, C) Concept based.

2.(A, B, C) Angular nodes being directional only depend on θ and ϕ but not on the radial wave function (R).

3.(A, B) For electrons in 3s-orbital, the three set of quantum number is same and only spin quantum number is different. Same for all electrons in 3p-orbital.

4. (A, B, C) The area enclosed by nth orbit in hydrogen atom is $A_n = \pi r_n^2$

Now, r_n is related to Bohr's radius as $r_n = n^2 r_0$. Substituting in the above equation, we get

$$A_n = \pi (n^2 r_0)^2$$

Now, $A_1 = \pi (r_0)^2$. Substituting, we get $A_n = n^4 A_1$. On rearranging and taking log on both sides,

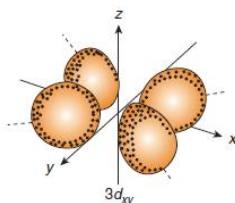
we get $\ln \left(\frac{A_n}{A_1} \right) = 4 \ln n$, which is of the form $y = mx$, and hence is a straight line passing through origin with slope 4 and is a monotonically increasing non-linear curve.

5.(A, B, C) Except spin quantum number, remaining all quantum numbers are derived from solution of Schrodinger's wave equation.

6.(A, B, C, D) All statements are correct.

7.(B, C, D) Angular nodes are only associated with direction orbitals.

8.(B, C) The d_{xy} -orbital is



Therefore, the nodal plane for the d_{xy} -orbital is xz and yz plane.

<H2>Assertion-Reasoning Type

1.(A) The electronic configuration of H ($Z = 1$) is $1s^1$. Since, the value of l and m_l is zero for s -orbital.

2.(C) Number of radial nodes = $n - l - 1$

3.(C) Energy of the electron is quantized in the energy level or energy shell; hence, possible number of electrons in any energy level is fixed.

Total number of electrons in a shell = $2n^2$

4.(A) Due to the presence of many excited levels for only electron in hydrogen atom, it produces several spectral lines.

5.(C) Photoelectric effect is easily pronounced by the metals having low ionization enthalpy.

<H2>Comprehension Type

Read the paragraphs and answer the questions that follow.

Paragraph I

1.(B) We know

$$\Delta x = \frac{h}{4\pi m \Delta v}$$

Therefore,

$$\Delta x = \frac{6.6 \times 10^{-27}}{4 \times 3.14 \times 9.1 \times 10^{-28} \times 0.3} = 1.92 \text{ cm}$$

2.(D) $\Delta x = 2\Delta p$ and $\Delta x \cdot \Delta p = \frac{h}{4\pi}$

3.(D) When $\Delta x = 0, \Delta p = \infty$, so

$$\Delta x \times \Delta p = \frac{h}{4\pi} \Rightarrow 2(\Delta p)^2 = \frac{h}{4\pi} \Rightarrow \Delta p = \frac{1}{\sqrt{2} \times 2} \sqrt{\frac{h}{\pi}}$$

Therefore,

$$\Delta v = \frac{1}{2\sqrt{2}m} \sqrt{\frac{h}{\pi}}$$

Paragraph II

4.(B) We know

$$\frac{1}{\lambda} = \bar{\nu} = R_H Z^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right]$$

For lowest energy transition of He^+ ion in Lyman series $\bar{\nu} = R_H 2^2 \left[\frac{1}{1^2} - \frac{1}{1^2} \right] = 3R_H$

5.(A) Lyman series, $n_1 = 1$

$$\frac{1}{\lambda_1} = \bar{\nu}_1 = R_H \times 1^2 \left[\frac{1}{1^2} - \frac{1}{n_2^2} \right]$$

Balmer series, $n_2 = 1$

$$\frac{1}{\lambda_2} = \bar{\nu}_2 = R_H \times 1^2 \left[\frac{1}{2^2} - \frac{1}{n_2^2} \right]$$

For highest energy transition,

For Lyman series $n_2 = \infty$

For Balmer series $n_2 = \infty$

Therefore,

$$\frac{\bar{\nu}_1}{\bar{\nu}_2} = \frac{4}{1}$$

Paragraph III

6.(B) Total number of radial and angular nodes = n

7.(D) Number of radial nodes = $n - l - 1$

$$8.(A) \Psi_{2s} = \left(\frac{Z}{2a_0}\right)^{1/2} \left(2 - \frac{Zr}{a_0}\right) e^{-\frac{Zr}{a_0}} = 0 \Rightarrow \left(2 - \frac{Zr}{a_0}\right) = 0$$

Therefore,

$$r = \frac{2a_0}{Z} = \frac{2a_0}{3}$$

<H2>Integer Answer Type

1.(2) Since, the wave function of an orbital is represented as ψ_{nlm} . Therefore, the value of azimuthal quantum number is 2.

2.(5) The electronic configuration of Cu ($Z = 29$) is $[\text{Ar}]4s^1 3d^{10}$



Five d -electrons have $+\frac{1}{2}$ spin

Five d -electrons have $-\frac{1}{2}$ spin

3.(2) For a radial node $\psi_2 = 0$; thus, on solving the equation we have

$$a_0 x^2 = 4a_0 \Rightarrow x^2 = 4 \Rightarrow x = 2$$

4.(6) $n = 4, l = 1$ represents $4p$ subshell containing six electrons. Thus, there will be six elements having $4p^1$ to $4p^6$ electronic configuration.

5.(1) Number of radial nodes = $n - l - 1 = 2 - 0 - 1 = 1$.

6.(6) Number of spherical lines produced if electron falls from n_2 to n_1 .

$$\begin{aligned} &= \frac{(n_2 - n_1)(n_2 - n_1 + 1)}{2} \\ &= \frac{(5 - 2)(5 - 2 + 1)}{2} = 6 \end{aligned}$$

7.(2) We know

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

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

8.(2) Number of waves $n = \frac{\text{Circumference}}{\text{Wavelength}}$, where $2\pi r = n\lambda$

$$n = \frac{400}{200} = 2$$

So, $n\lambda = 2\pi r \Rightarrow n \times 200 = 400 \Rightarrow n = 2$.

9.(5) $l = 2$, and the number of d -electrons = 5

10.(3) $E_n = -13.6 + 12.09 = -1.51 E_n = \frac{E_1}{n^2}$

Therefore, $n^2 = \frac{-13.6}{-1.51} = 9 \Rightarrow n = 3$

<H2>Matrix–Match Type

1.A → (r, t); B → (p), C → (q, s), D → (q)

- (A) Lyman series is ($n_1 = 1$) and falls in UV region.
- (B) Balmer series is ($n_1 = 2$) and falls in visible region.
- (C) Paschen series is ($n_1 = 3$) and falls in infrared region.
- (D) Bracket series is ($n_1 = 4$) and falls in infrared region.

2.A → (r); B → (q), C → (p, t), D → (s)

- (A) For H, radius of 2nd orbit = $0.53 \times \frac{2^2}{1} = 0.53 \times 4 \text{ \AA}$
- (B) For He^+ , energy of 2nd orbit = $-13.6 \times \frac{2^2}{2^2} = -13.6 \text{ eV}$
- (C) For Be^{2+} , radius of 4th orbit = $0.53 \times \frac{4^2}{4} = 0.53 \times 4 \text{ \AA}$

Also, energy of 4th orbit = $-13.6 \times \frac{4^2}{4^2} = -13.6 \text{ eV}$

- (D) For Li^{3+} , velocity of electron in 3rd orbit = $2.18 \times 10^8 \times \frac{2}{3} = 2.18 \times 10^8 \text{ \AA}$

3.A → (p); B → (p), C → (q, r, s), D → (p)

- (A) For $2p$ orbital, number of spherical nodes = $n - l - 1 = 2 - 1 - 1 = 0$; nodal planes $\neq 0$; $l = 1$; $m = 1, 0, -1$.
- (B) For $3d$ orbital, number of spherical nodes = $n - l - 1 = 3 - 2 - 1 = 0$; nodal planes $\neq 0$; $l = 2$; $m = 2, 1, 0, -1, -2$.

(C) For $4f$ orbital, number of spherical nodes $= n - l - 1 = 4 - 3 - 1 = 0$; nodal planes $\neq 0$; $l = 3$; $m = 3, 2, 1, 0, -1, -2, -3$.

(D) For $2s$ orbital, number of spherical nodes $= n - l - 1 = 2 - 0 - 1 = 1$; nodal planes $\neq 0$; $l = 0$; $m = 0$.

4.(A) \rightarrow (q); (B) \rightarrow (s), (C) \rightarrow (p), (D) \rightarrow (r)

If θ is the angle between the angular momentum vector and z -axis then

$$\sqrt{l(l+1)} \cos \theta = m$$

m = magnetic quantum number

For p_x atomic orbital $l = 1, m = 1$.

For p_z atomic orbital $l = 1, m = 0$.

For p_y atomic orbital $l = 1, m = -1$.

For $d_{x^2-y^2}$, $l = 2, m = \pm 2$

5. A \rightarrow (s); B \rightarrow (r), C \rightarrow (p), D \rightarrow (q)

Concept based.