STRUCTURE of ATOM

1. The angular momentum of electron of H−atom is proportional to

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

Answer: (c)

From Bohr's Model,

Centripetal force of electron = Columbic force of attraction on electron by nucleus

$$\frac{mv^2}{r} \propto \frac{e^2}{r^2}$$

$$\left(\frac{mv^2}{r}\right)(mr^2) \propto \frac{e^2 mr^2}{r^2}$$

$$(mvr)^2 \propto e^2 mr$$

$$(\text{Angular momentum})^2 \propto r$$

Angular momentum $\propto \sqrt{r}$

2. The total energy in 1st orbit of hydrogen atom is given by

(a) $\frac{2\pi^2 k^2 e^4 m}{h^3}$ (b) $-\frac{2\pi^2 k^2 e^2 m}{h^2}$

(c) $\frac{2\pi^2 k^2 e^4 m}{h^2}$ (D) $-\frac{2\pi^2 k^2 e^4 m}{h^2}$

Answer: (d)

- Energy of electron in Bohrs orbit $= -\frac{2\pi^2 k^2 z^2 e^4 m}{n^2 h^2}$

- for 1st orbit of hydrogen $n=1$, $z=1$
- $\therefore$ energy $= -\frac{2\pi^2 k^2 e^4 m}{h^2}$

3. If the radius of second Bohrs orbit of hydrogen atom is a_0 than the radius of third Bohrs orbit of Be^{3+} ion will be

   (a) $9a_0$ (b) $\frac{9a_0}{8}$

   (c) $\frac{9a_0}{16}$ (d) $\frac{9a_0}{4}$

   Answer: (c)

- $r_H = 0.529 \frac{n_H^2}{Z_H} Å \quad r_{Be^{3+}} = 0.529 \frac{n_{Be^{3+}}^2}{Z_{Be^{3+}}}$
- $\frac{r_H}{r_{Be^{3+}}} = \frac{n_H^2}{Z_H} \times \frac{Z_{Be^{3+}}}{n_{Be^{3+}}^2} = \frac{(2)^2}{1} \times \frac{4}{(3)^2}$
- $\frac{a_0}{r_{Be^{3+}}} = \frac{16}{9} \quad r_{Be^{3+}} = \frac{9a_0}{16}$

4. If the total energy of an electron in the 1stshell of H-atom is -13.6 eV then its potential energy in the 1stexcited state would be:

   (a) +6.8 eV (b)+20.4 eV (c) –6.8 eV (d)+ 3.4 eV

   Answer: (c)

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

   For Hydrogen atom, Z = 1

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

$E_1 = -13.6$ eV

$E_2 = -3.4$ eV

Potential energy of an electron = 2 ×Total energy of electron

$(P.E.)_2 = 2E_2 = -6.8$ eV

5. If the speed of the electron in the first Bohr orbit of hydrogen atom be 'x' then the speed of electron in the third Bohr orbit is

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

Answer: (b)

The speed of electron in Bohr's orbit for hydrogen atom is given by

$$V = \frac{2\pi e^2 Z}{nh} = \frac{2.188 \times 10^8 Z}{n} \text{ cms}^{-1}$$

For the first Bohr orbit of H−atom,

Z = 1, n = 1

$V_1 = 2.188 \times 10^8 \text{ cms}^{-1} = x$

$$V_3 = \frac{2.188 \times 10^8}{3} \text{ cms}^{-1} = \frac{x}{3}$$

6. If the radius of first Bohr orbit is 2x, then de Broglie wavelength of electron in 4thorbit is nearly

(a) 16πx (b) 8πx

(c) 4πx (d)none of these

Answer: (a)

 $2\pi r = n\lambda$

$2\pi 44 = 4\lambda$

$\lambda = \frac{\pi r_4}{2}$

$(r_4 = r_1 \times 42) = \frac{\pi \times 2x \times 16}{2} = 16\pi x$

7. If the lowest energy X-rays have λ=4.0×10−8m, estimating the minimum difference in energy between two Bohr orbit, where an electronic transition would correspond to the emission of an X-ray, at what minimum Z (atomic number) would a transition from the second energy level to the first result in the emission of an X-ray?

(a) Z = 2 (b) Z = 3

(c) Z = 4 (d) Z = 5

Answer: (a)

$E = \frac{hc}{\lambda} = \frac{(6.63 \times 10{-}34)(3 \times 108)}{4.0 \times 1018} = 5 \times 10{-}18J$

$\Delta E_H = \frac{3}{4}(2.178 \times 10^{-18} J) = 1.63 \times 18^{-18} J$

$\Delta E = \Delta E_H z2$

or $z^2 = \frac{\Delta E}{\Delta En} = \frac{5.0 \times 10^{-18}}{1.63 \times 10^{-18}} = 3.06$

$z = 2$

8. Possible number of nodal planes present in the Mthshell of H−like species are:

(a)13 (b)14 (c)11 (d)9

Answer: (c)

Mth shell is n = 3

	3s	3px	3py	3pz	3dxy	3dyz	3dzx	$3d_{xy2-y2}$	$3d_{z2}$
Nodal Planes	0	1	1	1	2	2	2	2	0

Hence, Total no. of nodal planes

$= 0 + 1 + 1 + 1 + 2 + 2 + 2 + 2 + 0 = 11$

9. The no. of radial nodes for 3Px orbital is

(a)One (b)Two (c)Three (d)Infinite

Answer: (a)

No. of radial nodes = $n - l - 1 = 3 - 1 - 1 = 1$

10. Photoelectric emission is observed from a surface for frequencies ν_1 and ν_2 of incident radiations ($\nu_1>\nu_2$). If the maximum kinetic energy of photoelectrons in the two cases are in the ratio of 2 : 1, then threshold frequency ν_0 is given by

(a) $\frac{\nu_2-\nu_1}{2-1}$ (b) $\frac{2\nu_1-\nu_2}{2-1}$ (c) $\frac{2\nu_2-\nu_1}{2-1}$ (d) $\frac{\nu_2-\nu_1}{2}$

Answer: (c)

$h\nu = h\nu_0 + K.E.$

$KE_1 = h\nu_1 - h\nu_0$

$KE_2 = h\nu_2 - h\nu_0$

$\frac{KE_1}{KE_2} = \frac{h(\nu_1-\nu_0)}{h(\nu_2-\nu_0)}$; $\frac{2}{1} = \frac{\nu_1-\nu_0}{\nu_2-\nu_0}$; $\nu_0 = \frac{2\nu_2-\nu_1}{2-1}$.

11. The spin angular momentum for the 's' electron in H-atom is

(a) $\frac{\sqrt{3}h}{4\pi}$ (b) $\frac{h}{2\pi}$ (c) $\frac{h}{4\pi}$ (d) $\frac{\sqrt{3}h}{2\pi}$

Answer: (a)

Electronic configuration of Hydrogen atom is $1s^1$

Total spin of an unpaired electron, $S = \frac{1}{2}$

$\therefore$ Spin angular momentum $= \sqrt{S(S+1)}\frac{h}{2\pi} = \sqrt{\frac{1}{2}\left(\frac{1}{2}+1\right)}\frac{h}{2\pi} = \frac{\sqrt{3}h}{4\pi}$

12. If a dye absorbs a photon of wavelength λ and re-emits the absorbed energy into two photons of wavelengths λ_1 and λ_2 respectively. Then

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

Answer: (b)

$$E = E_1 + E_2$$

$$\frac{hc}{\lambda} = \frac{hc}{\lambda_1} + \frac{hc}{\lambda_2}$$

$$\frac{hc}{\lambda} = hc\left(\frac{\lambda_2+\lambda_1}{\lambda_1\lambda_2}\right)$$

$$\lambda = \frac{\lambda_1\lambda_2}{\lambda_1+\lambda_2}$$

13. An electron is allowed to move freely in a closed cubic box of length 10 cm. The minimum uncertainty in its velocity will be observed as

(a) 4×10^{-3} m/s (b) 5×10^{-4} m/s (c) 4×10^{-5} m/s (d) 4×10^{-6} m/s

Answer: (b)

$\Delta x = a\sqrt{3}$, $\Delta x = 10\sqrt{3}$, $\Delta x.\Delta p = \frac{h}{4\pi}$

$$\Delta V = \frac{h}{4\pi m.\Delta x} = \frac{6.62\times10^{-34}}{4\times 3.14\times9.1\times10^{-31}\times10\sqrt{3}\times10^{3}} \approx 5\times10^{-4}\ m / sec$$

14. If a_0 be the radius of first Bohr's orbit of H-atom, the de-Broglie's wavelength of an electron revolving in the third Bohr's orbit will be

(a) $6\pi a_0$
(b) $4\pi a_0$
(c) $2\pi a_0$
(d) πa_0

Answer: (a)

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

deBroglie equation = $P = \frac{h}{\lambda} = mv$ ...(ii)

placing the value of mv from (ii) and (i) for 3rd orbit

$$\frac{h}{\lambda} r_3 = \frac{3h}{2\pi}$$

$$\Rightarrow \lambda = \frac{hr_3}{} \frac{2\pi}{3h}$$

$$\lambda = \frac{2\pi r_3}{3}$$

or $r = n^2 a_0 = 9a_0$

so $\lambda = \frac{2\pi . 9a_0}{3} = 6\pi a_0$

15. The probability of finding an electron residing in a px orbital is zero

(a) in yz plane
(b) in xy plane
(c) in the y direction
(d) in the z direction

Answer: (a)

Nodal plane of Px orbital is yz-plane.

16. In a single hydrogen atom, the electron is excited to its 6th orbit. The maximum no. of distinct lines possible, when it comes to the ground state is:

(a)12 (b)15 (c)5 (d)22

Answer: (c)

Maximum number of spectral lines (or distinct lines) if an electron jumps from n2to n1monoelectronic species =n2−n1.

If an electron jumps from n2=6to n1=1in a Hydrogen atom, then maximum number of spectral lines = 6−1 = 5

17. The difference between nthand (n t+1)hBohr's radius of H-atom is equal to (n)th−1Bohr's radius. Hence the value of 'n' is:

(a)5 (b)2 (c)6 (d)4

Answer: (c)

Bohr's radius of n th orbit ,rn $= \frac{0.529\ n2}{Z}$ Å

rn+1−rn=rn−1

$$\frac{0.529(n+1)2}{Z} - \frac{0.529(n2)}{Z} = \frac{0.529(n-1)2}{Z}$$

0.529[(n+1)2−(n)2]=0.529(n−1)2

(n+1)2−n2=(n−1)2

n2+1+2n−n2=n2+1−2n

On solving, n = 4

18. Consider one He+ion in excited state (n = 5). Which of the following observations will hold true as per the Bohr's model?

(a)10 emission spectral lines will be seen

(b)The ionization energy needed is less than 2 eV

(c)The longest emitted wavelength is less than 10/R (R = Rydberg's constant)

(d)The electronic separation from the centre of nucleus is more than 6oA

Answer: (d)

(a) A multitude of He+will produce 10 possible emission spectral lines. However, a single He+can produce maximum 4 lines (not more)

5→4→3→2→1

(b) $E_n = -\frac{2}{n} = -13.6 \times \frac{2}{5} = -13.6 \times \frac{4}{25} = -2.176 \text{eV}.$

∴ 1E = + 2.176 eV > 2 eV

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

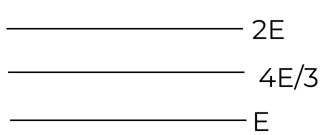
(c) $\frac{1}{\lambda} = R.4\left(\frac{1}{4^2} - \frac{1}{5^2}\right)$

$\frac{1}{\lambda} = 4R\left(\frac{9}{16 \times 25}\right)$

$\lambda = \frac{16 \times 25}{4 \times 9 \times R} = \frac{100}{9R} > \frac{10}{R}$

(d) $r_n = 0.53\frac{n^2}{Z} = 0.53 \times \frac{5^2}{Z} = 6.625\,\mathring{A} > 6\,\mathring{A}$

19. The given diagram indicates the energy levels of certain atom. When an electron moves from 2E level to E level, a photon of wavelength λ is emitted. The wavelength of photon emitted during its transition from $\frac{4E}{3}$ level to E level is:



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

Answer: (d)

$h\nu = 2E - E$

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

When the electron jumps from $\frac{4E}{3}$ level to E level, a photon of wavelength λ1 is emitted. Thereby,

$$\frac{hc}{\lambda_1} = \frac{4E}{3} - E = \frac{E}{3}$$

λ1=3λ

20. Total number of electrons in Cu2+for which the summation of azimuthal quantum number and magnetic quantum number is zero is

(a)4 or 8 (b)11 or 12 (c)5 or 6 (d)10 or 11

Answer: (b)

Electronic configuration of Cu2+is 1s22s22p63s23p63d9

Electrons

$1s^2$	$\ell + m = 0$	2 [For s-subshell, l = 0 and m = 0]
$2s^2$	$\ell + m = 0$	2
$2p_x^2 2p_y^2 2p_z^2$	$\ell + m = 0$	2 [For p-subshell, l = 1 and m = –1]
$3s^2$	$\ell + m = 0$	2
$3p_x^2 3p_y^2 3p_z^2$	$\ell + m = 0$	2
$3d^9$	$\ell + m = 0$	1 or 2 [For d-subshell, l = 2 and m = –2]

21. Photons having energy equivalent to binding energy of 4th state of He+ ion is used on the metal surface of work function 1.4 eV. If electrons are further accelerated through

the potential difference of 4V then the minimum value of de-Broglie wavelength associated with the electron is

(a)1.1 Å (b)9.15 Å (c)5 Å (d)11 Å

Answer: (c)

Binding energy of He+= $\frac{13.6 \times 2^2}{4^2} = \frac{13.6}{4}$ =3.4eV

Total K.E. of electron = 3.4 – 1.4 + 4 eV = 6 eV

$\lambda = \frac{h}{\sqrt{2meV}} = \frac{h}{\sqrt{2me \times 6}} = 5$ Å

22. If Rutherford would have used β–particlesinstead of α–particles in his Gold-leaf experiment, which of the following observations would definitely not have been made:

(a)β–particlesscattering beyond the gold foil.

(b)Majority of β–particles passing undeflected through the foil.

(c)Very few β–particlesgetting absorbed.

(d)Wave nature of electron

Answer: (a)

α–particlesare scattered by positively charged nucleus; β–particleswill converge while passing through atom as they bear negative charge.

23. A 1-kW radio transmitter operates at a frequency of 880 Hz. How many quantas per second does it emit?

(a) 1.71×10^{21} (b) 1.71×10^{30} (c) 6.02×10^{23} (d) 2.85×10^{26}

Answer: (b)

A 1kW radio transmitter emits 1000 Joules of radio waves per second.

Energy of one quanta, E=hν

$=6.626\times 10^{-34}\times 880\times 10^{3}$

$=5.83\times 10^{-28}J$

Number of quantas emitted per second = $\frac{\text{Energy emitted per sec}}{\text{Energy of one quanta}}$ = $\frac{1000}{5.83\times 10^{-28}} = 1.71\times 10^{30}$

24. The ratio of the e/m values of a proton and an α−particle is

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

Answer: (a)

For a proton $(H^+), \frac{e}{m} = \frac{1.6\times 10^{-19} C}{1.67\times 10^{-27} Kg}$.

For an α-particle $(He^{2+}) \frac{e}{m} = \frac{2\times 1.6\times 10^{-19} C}{4\times 1.67\times 10^{-27} Kg}$

$\frac{(e/m)_p}{(e/m)_\alpha} = \frac{4}{2} = \frac{2}{1}$

25. For sets of values of quantum numbers (n, l, m and s) are given below. Which of these does not provide a permissible solution of the wave equation?

(a) $3, 2, -2, \frac{1}{2}$ (b) $3, 3, 1, -\frac{1}{2}$ (c) $3, 2, 1, \frac{1}{2}$ (d) $3, 1, 1, -\frac{1}{2}$

Answer: (b)

n = l is not permissible.

Value of l is always less than the value of n.

26. Angular momentum of an electron in a Bohr's orbit of He+ is 3.1652×10^{-34} kg.m2/sec The wave number of the spectral line emitted when an electron falls from this level to the first excited state is.

(a) 3R (c) $\frac{3R}{4}$ (b) $\frac{5R}{9}$ (d) $\frac{8R}{9}$

Answer: (b)

$$3.1652 = \frac{nh}{2\pi}$$

$$3.1652 = \frac{n \times 6.626 \times 10^{-34}}{2 \times \frac{22}{7}}$$

n = 3

$$\bar{\nu} = R.Z^2\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$$

$$\bar{\nu} = R \times 2^2\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = \frac{5R}{9}$$

27. The electronic configuration of Fe^{3+} is

(a) $[Ar]3d^5 4s^1$ (b) $[Ar]3d^6 4s^0$ (c) $[Ar]3d^5 4s^0$ (d) $[Ar]3d^6 4s^2$

Answer: (c)

$Fe(Z=26)=[Ar]3d^6As^2$

Fe^{3+}(23electrons)$=[Ar]3d^5$

28. The value of the magnetic moment of a particular ion is 2.83 Bohr magneton. The ion is

(a) Fe^{2+} (b) Ni^{2+} (c) Mn^{2+} (d) Co^{3+}

Answer: (b)

The spin only magnetic moment is given by ,

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

Where ‘n’ is no. of unpaired electrons.

$2.83 = \sqrt{(n)(n+2)} \Rightarrow n = 2$

The value of μ=2.83BMcorresponds to the presence of two unpaired electrons. So the ion is $Ni^{2+}(3d^8)$.

29. The ratio of the radii of the first three Bohr orbits is :

(a) 1:05:0.33 (b) 1:2:3 (c) 1:4:9 (d) 1:8:27

Answer: (c)

$r_n \times r_1 \times n^2$

For first orbit r1=r1

For second orbit, $r_2 = r_1 \times 2^2 = 4r_1$

For third orbit, $r_3 = r_1 \times 3^2 = 9r_1$

Hence the ratio of radii of Bohr's orbits is 1:4:9.

30. Atomic number of chromium is 24, then Cr3+will be:

(a) diamagnetic (b) paramagnetic

(c) ferromagnetic (d) none of these

Answer: (b)

Electronic configuration of Cr3+ $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$

Cr3+has three unpaired 3d electrons. Hence Cr^{3+} will be paramagnetic.

31. Find the incorrect set of quantum number.

(a) $n=2, \ell=1, m=0, s=1/2$ (b) $n=4, \ell=3, m=1, s=+1/2$

(c) $n=5, \ell=3, m=2, s=+1/2$ (d) $n=3, \ell=2, m=3, s=+1/2$

Answer: (d)

If the angular momentum quantum number of an electron =3 , which means (n-1) values are possible for ℓ, so the possible values of ℓ = 0,1,2. The possible values of m will be $\pm\ell$ that are -2,-1,0,1,2 and s will always be $\pm\frac{1}{2}$

The value of m will never more than ℓ, thus this is not the valid set of quantum numbers .

32. If x is the speed of electron in the Bohr's first orbit of hydrogen atom, then find the speed of electron in the fourth Bohr's orbit

(a) 8x (b) x/4

(c) 4x (d) x/8

Answer: (c)

According to Bohr's model the velocity of an electron for hydrogen and hydrogen like atoms is quantised and is equals $\frac{2.18\times10^6\times Z}{n}$.

Here, n and Z are orbit number and atomic number respectively. For H atom Z = 1. The velocity of electron in hydrogen atom's 1 orbit = $2.18\times10^6 = x$

The velocity of electron in hydrogen atom's 4 orbit = $2.18\times10^6\times4 = 4x$

Hence, the velocity in fourth bohr orbit is 4x.

33. Choose the correct set of quantum number for the Ne atom's electron of second excited state

(a) 2,0,0,±1/2 (b) 3,2,1,±1/2

(c) 3,0,0,±1/2 (d) 3,1,2,±1/2

Answer: (c)

Ground sate electronic configuration of Ne atom is $1s^2,2s^2,2p^6$.

Electronic Configuration for its first excitation state $1s^2,2s^2,2p^5,3s^1$.

Electronic Configuration for its second excitation state $1s^2,2s^2,2p^4,3s^2$.

Quantum numbers for3selectrons will be 3,0,0,$\pm\frac{1}{2}$.

34. Select the one among the following transitions in hydrogen atom, which gives an absorption line of lowest frequency

(a) n =1 to n = 3 (b) n = 2 to n = 3

(c) n = 4 to n = 6 (d) n= 3 to n = 4

Answer: (c)

When energy is absorbed, electron shifts from lower to higher orbit and the absorption line in the spectra arises. n= 4 to n = 6 will have the lowest frequency as this falls in the bracket series.

35. An electron is moving with a kinetic energy of 4.55×10−25J. What will be the de Broglie wave length for this electron?

(a) 5.28×10−7m (b) 7.28×10−7m

(c) 2×10−10m (d) 3×10−5m

Answer: (b)

$KE = \frac{1}{2}mv2 = 4.55 \times 10^{25}$

$v^2 = \frac{2 \times 4.55 \times 10^{35}}{9.1 \times 10^{-31}} = 1 \times 106$

$v = 103 m/s$

De Broglie wave length $\lambda = \frac{h}{m} = \frac{6.626\times10^{-34}}{9.11\times10^{-31} \times 10^{3}} = 7.28\times10^{-7}m$

36. Suppose 10^{-17}J of energy is needed by the interior of human eye to see an object. How many photons of green light (λ=550nm) are needed to generate this minimum amount of energy?

(a) 14 (b) 28

(c) 39 (d) 42

Answer: (b)

Let the number of photons required be n.

$$\frac{nhc}{\lambda} = 10^{-17}$$

$$n = \frac{10^{-17} \times \lambda}{hc} = \frac{10^{-17}\times550\times10^{-9}}{6.626\times10^{-34}\times3\times10^{8}} = 27.6 \approx 28 \text{ photons}$$

37. Threshold frequency of a metal is fo. When light of frequency v = 2fo is incident on the metal plate, maximum velocity of e– emitted is v1, when frequency of incident radiation is 5fo, maximum velocity of emitted e– is v2. then the ratio of v1/v2 is (a) 1:4 (c) 2:1

(b) 1:2

(d) 3:2

Answer: (b)

From Einstein's equation for photoelectric effect

$h\nu = h\nu_0 + 1/2mv^2$

$\Rightarrow 1/2mv^2 = h\nu - h\nu_0$

$\Rightarrow 1/2mv_1^2 = 2hf_0 - hf_0 = hf_0$ -----(1)

$1/2mv_2^2 = 5hf_0 - hf_0 = 4hf_0$ -----(2)

$\frac{Eqn(1)}{Eqn(2)} \Rightarrow \left(\frac{v_1}{v_2}\right)^2 = \frac{1}{4} \Rightarrow \frac{v_1}{v_2} = \frac{1}{2}$

38. Number of waves in the third Bohr's orbit of hydrogen will be

(a) 3 (b) 6

(c) 9 (d) 12

Answer: (a)

Number of waves $= \frac{\text{circumference}}{\text{wavelength}} = \frac{2\pi r}{\lambda}$

$= \frac{2\pi r}{h/mv} = \frac{2\pi}{h}(mvr)$

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

n = 3

39. The binding energy of an electron in the ground state of the He atom is equal to 24.6 eV. The energy required to remove both the electrons from the atom will be

(a) 59 eV
(b) 81 eV
(c) 79 eV
(d) None of these

Answer: (c)

Ionization energy of He+ (Second IP of He)

$= \frac{Z^2}{n^2} \times 13.6 = \frac{2^2}{1^2} \times 13.6 = 54.4 eV$

Energy required to remove both the electrons

= First IP of He + Second IP of He

= Binding energy of first electron + Ionization energy of He+

= 24. 6 + 54.4 = 79 eV

40. The spectral line of the shortest wavelength in Balmer series of atomic hydrogen will be

(a) 4215Å
(b) 1437Å
(c) 3942Å
(d) 3647Å

Answer: (d)

Shortest wavelength means maximum energy.

Therefore, the electronic transition involved should be

$n_2=\infty \rightarrow n_1=2$ (as it belongs to the Balmer series)

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

$$\frac{1}{\lambda_{shortest}}=109678\times 1^2\times\left(\frac{1}{2^2}-\frac{1}{\infty^2}\right)$$

$\lambda=3.647\times10^{-5}$ cm

$=3647$ Å

41. For a d–electron, the orbital angular momentum is:

(a) $\sqrt{6}\hbar$ (B) $\sqrt{2}\hbar$ (C) $\hbar$ (D) $2\hbar$

Answer: (a)

For d–electron, $l=2$, orbital angular momentum

$=\sqrt{l(l+1)}\hbar=\sqrt{2(2+1)}\hbar=\sqrt{6}\hbar$

Hence, (a) is the correct answer.

42. The electronic configuration of an element is $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^5, 4s^1$. This represents its

(A) excited state (B) ground state

(C) cationic form (D) anionic from

Answer: (b)

The given electronic configuration is ground state for chromium.

Hence, (B) is the correct answer.

43. Which of the following pairs of ions have the same electronic configuration?

(A) Cr^{3+}, Fe^{3+} (B) Fe^{3+}, Mn^{2+} (C) Fe^{3+}, Co^{3+} (D) Se^{3+}, Cr^{3+}

Answer: (b)

Fe^{3+} and Mn^{2+} have same electronic configuration

Hence (B) is the correct answer.

44. Principal, azimuthal and magnetic quantum numbers are respectively related to

(A) size, orientation and shape

(B) size shape and orientation

(C) shape, size and orientation

(D) none of these

Answer: (b)

Principal gives, i.e. azimuthal gives shape and magnetic quantum number gives the orientation

Hence, (B) is the correct answer.

45. Number of waves in third Bohr's orbit of hydrogen will be

(A) 3 (B) 6 (C) 9 (D) 12

Answer: (a)

Number of waves $= \frac{\text{Circumference}}{\text{Wavelength}}$

$$\frac{2\pi r}{\lambda} = \frac{2\pi r}{h/mv} = \frac{2\pi}{h}(mvr)$$

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

$$\therefore n = 3$$

Hence, (A) is the correct answer.