Chapter 2

Structure of Atom

Solutions

SECTION - A

Objective Type Questions

(Discovery of Fundamental Particles, Nature of Electromagnetic Radiation)

1. An isotone of $^{76}_{32}Ge$ is

(1) $^{77}_{32}Ge$ (2) $^{77}_{33}As$ (3) $^{77}_{34}Se$ (4) $^{78}_{74}Se$

Sol. Answer (2)

Isotone means same number of neutrons

$\boxed{\text{Number of neutrons} = \text{Mass number} - \text{Atomic number}}$

Number of neutron in Ge = 76 – 32 = 44

Number of neutron in As = 77 – 33 = 44

2. The ratio of specific charge of an electron to that of a proton is

(1) 1 : 1 (2) 1837 : 1 (3) 1 : 1837 (4) 2 : 1

Sol. Answer (2)

$\frac{e}{m}$ electron : $\frac{e}{m}$ proton

Both e$^-$ α protons have same charge

$\boxed{\text{Mass } e^- \text{ is } \frac{1}{1837}^{\text{th}} \text{ the mass of protons}}$

electron Proton

$\therefore \frac{e}{\frac{1}{1837}} : \frac{e}{1}$

$= \boxed{1837 : 1}$

3. Atomic number and mass number of an element M are 25 and 52 respectively. The number of electrons, protons and neutrons in M^{2+} ion are respectively

(1) 25, 25 and 27 (2) 25, 27 and 25 (3) 27, 25 and 27 (4) 23, 25 and 27

Sol. Answer (4)

Atomic number = 25

Mass number = 52

Number of proton = Atomic number = 25

Number of neutron = (Mass number – Atomic number)

52 – 25 = 27

Number of e^- = Number of protons,

but M^{2+} ion means $2e^-$ are removed

$\therefore$ Number of e^- = Number of protons – 2

= 25 – 2 = 23

4. The frequency of a wave is $6 \times 10^{15}\ s^{-1}$. Its wave number would be

(1) $10^5\ cm^{-1}$ (2) $2 \times 10^7\ m^{-1}$ (3) $2 \times 10^7\ cm^{-1}$ (4) $2 \times 10^5\ cm^{-1}$

Sol. Answer (2)

$$\text{Wave number } (\bar{\nu}) = \frac{1}{\text{Wavelength } (\lambda)} = \frac{\text{Velocity (c)}}{\text{Frequency } (\nu)}$$

$\boxed{c = \nu\lambda}$ $\boxed{\nu = \frac{c}{\lambda}}$ $\boxed{\nu = c \times \bar{\nu}}$ $\boxed{\bar{\nu} = \frac{\nu}{c}}$

$$\therefore \bar{\nu} = \frac{6 \times 10^{15}\ s^{-1}}{3.0 \times 10^8\ m/s} = 2 \times 10^{7\ m^{-1}}$$

5. The number of photons of light of wavelength 7000 Å equivalent to 1 J are

(1) 3.52×10^{-18} (2) 3.52×10^{18} (3) 50,000 (4) 10,0000

Sol. Answer (2)

$\boxed{E = \frac{nhc}{\lambda}}$ $n = \frac{\lambda \times E}{h \times c} = \frac{7000 \times 10^{-10}\ m \times 1J}{6.6 \times 10^{-34}\ J\text{-}s \times 3 \times 10^8\ m/s}$

6. The threshold energy is given as E_0 and radiation of energy E falls on metal, then K.E. is given as

(1) $\frac{E - E_0}{2}$ (2) $E - E_0$ (3) $E_0 - E$ (4) $\frac{E}{E_0}$

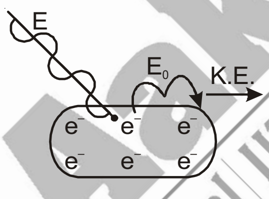
Sol. Answer (2)

E = Incident energy

E_0 = Threshold energy

$E = E_0 + K.E.$

$\boxed{K.E. = E - E_0}$



E = Incident energy

7. If threshold wavelength ($\lambda°$) for ejection of electron from metal is 330 nm, then work function for the photoelectric emission is

(1) 6×10^{-10} J (2) 1.2×10^{-18} J (3) 3×10^{-19} J (4) 6×10^{-19} J

Sol. Answer (4)

$\boxed{\text{Work function} = h\nu_0 = \frac{hc}{\lambda_0}}$ ν_0 = threshold frequency

λ_0 = threshold wavelength

$\lambda_0 = 330 \times 10^{-9}$ m Work function $= \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{330 \times 10^{-9}}$ J

8. A certain metal when irradiated with light ($\nu = 3.2 \times 10^{16}$ Hz) emits photo electrons with twice kinetic energy as did photo electrons when the same metal is irradiated by light ($\nu = 2.0 \times 10^{16}$ Hz). Calculate ν_0 of electron?

(1) 1.2×10^{14} Hz

(2) 8×10^{15} Hz

(3) 1.2×10^{16} Hz

(4) 4×10^{12} Hz

Sol. Answer (2)

K. E. = $h(\nu - \nu_0)$

K.E. of photoelectrons when $\nu = 3.2 \times 10^{16}$ Hz

K. $E_1 = h\,(3.2 \times 10^{16} - \nu_0)$

K. E. of photoelectron when $\nu = 2.0 \times 10^{16}$ Hz

K. $E_2 = h(2.0 \times 10^{16} - \nu_0)$

According to question $K \cdot E_1 = 2K \cdot E_2$

$\therefore \quad h(3.2 \times 10^{16} - \nu_0) = 2h(2.0 \times 10^{16} - \nu_0)$

$3.2 \times 10^{16} - \nu_0 = 4.0 \times 10^{16} - 2\nu_0$

$\nu_0 = 4.0 \times 10^{16} - 3.2 \times 10^{16} = 0.8 \times 10^{16}$ Hz $= 8 \times 10^{15}$ Hz $= 8 \times 10^{15}$ Hz

(Bohr's Model for Hydrogen atom)

9. According to Bohr's theory angular momentum of an electron in 6th orbit is

(1) $2.5\dfrac{h}{\pi}$ (2) $6\dfrac{h}{\pi}$

(3) $3\dfrac{h}{\pi}$ (4) $\dfrac{2.5h}{2\pi}$

Sol. Answer (3)

$mvr = \dfrac{nh}{2\pi}$ (n = number of shell)

Angular momentum

$\boxed{\text{for } 6^{th} \text{ shell} = \dfrac{6h}{2\pi} = \dfrac{3h}{\pi}}$

10. If r_1 is the radius of the first orbit of hydrogen atom, then the radii of second, third and fourth orbits in term of r_1 are

(1) r_1^2, r_1^3, r_1^4

(2) $4r_1, 9r_1, 16r_1$

(3) $8r_1, 27r_1, 64r_1$

(4) $2r_1, 6r_1, 8r_1$

Sol. Answer (2)

$r_n = \dfrac{r_0 \times n^2}{z}$

z = 1

(for 2nd orbit) (for 3rd orbit) (for 4th orbit)

$\therefore\ r_2 = r_1 \times 2^2$ $\quad r_3 = r_1 \times 3^2$ $\quad r_4 = r_1 \times 4^2$

$= 4r_1, 9r_1, 16r_1$

11. Electronic energy is negative because

(1) Electron has negative charge

(2) Energy is zero near the nucleus and decreases as the distance from nucleus increases

(3) Energy is zero at infinite distance from the nucleus and decreases as the electron comes towards nucleus

(4) These are interelectronic repulsions

Sol. Answer (3)

At infinite distance energy of electron will be zero and it will decreases as the electron approaches towards nucleus

12. An electron jumps from lower orbit to higher orbit, when

(1) Energy is released (2) Energy is absorbed (3) No change in energy (4) It radiates energy

Sol. Answer (2)

When e^- jumps from lower to higher energy level absorbed.

When e^- comes from higher to lower energy level released.

13. If the energy difference between the ground state and excited state of an atom is 4.4×10^{-19} J. The wavelength of photon required to produce this transition is

(1) 4.5×10^{-7} m (2) 4.5×10^{-7} nm (3) 4.5×10^{-7} Å (4) 4.5×10^{-7} cm

Sol. Answer (1)

$\boxed{\Delta E = [\text{Excited state} - \text{ground state}] = 4.4 \times 10^{-19} J}$

According to Plank's quantum theory $\longrightarrow \boxed{\Delta E = \frac{nhc}{\lambda}}$ $\boxed{\lambda = \frac{hc}{\Delta E}}$

$$= \frac{6.6 \times 10^{-34} \text{ J-s} \times 3 \times 10^8 \text{ m/s}}{4.4 \times 10^{-19} \text{ J}} = 4.5 \times 10^{-7} \text{ m}$$

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

(1) 13.6, 6.8, 8.4 (2) 13.6, 10.2, 3.4 (3) 13.6, 27.2, 40.8 (4) 13.6, 3.4, 1.51

Sol. Answer (4)

$\boxed{\text{I. E.} = E_\infty - E_1}$

I.E. = 13.6 eV given

$E_\infty = 0$

$13.6 = 0 - E_1$

$E_1 = -13.6$ eV

$E_2 = \frac{E_1}{n^2} \times (1)^2 = -\frac{13.6}{4} = -3.4$ eV

$E_3 = \frac{E_1}{(3)^2} = \frac{-13.6}{9} = -1.51$ eV

$\therefore I \cdot E_1 = E_\infty - E_1 = 0 - (-13.6) = 13.6$ eV

$I \cdot E_2 = E_\infty - (E_2) = 0 - (-3.4) = 3.4$ eV

$I \cdot E_3 = E_\infty - E_3 = 0(-(-1.51 \text{ eV})) = 1.51$ eV

15. $E_n = -313.6/n^2$ kcal/mole. If the value of E = –34.84 kcal/mole, to which value does ‘n’ correspond?

(1) 4 (2) 3 (3) 2 (4) 1

Sol. Answer (2)

$\boxed{E_n = \frac{-313.6}{n^2}}$ E = – 34.84

$\therefore -34.84 = \frac{-313.6}{n^2}$ $n^2 = \frac{-313.6}{-34.84} = 9$

$n = \sqrt{9} = 3$

$\boxed{n = 3}$

16. Which transition of Li^{2+} is associated with same energy change as n = 6 to n = 4 transition in He^{+}?

(1) n = 3 to n = 1 (2) n = 8 to n = 6 (3) n = 9 to n = 6 (4) n = 2 to n = 1

Sol. Answer (3)

In $He^{\oplus}$; n = 6 the corresponding energy level in Li^{2+} ion will be

$$\begin{bmatrix}\text{For He}^{\oplus} \\ z = 2\end{bmatrix} \rightarrow E_6 = \frac{-1312}{(6)^2}\times(2)^2 = -\frac{1312}{36}\times 4 = \frac{-1312}{9}$$

Corresponding energy level for $\begin{matrix}Li^{2+} \\ (z=3)\end{matrix} = \boxed{-\frac{1312}{n^2}\times(3)^2 = -\frac{1312}{9}}$ $n^2 = 81$ $\boxed{n = 9}$

In $He^{\oplus}$ n = 4; the corresponding energy level in Li^{2+} ions

$$\begin{matrix}\text{For He}^{\oplus} \\ (z=2)\end{matrix} \quad E_4 = -\frac{1312}{(4)^2}\times 4 = -\frac{1312}{4}$$

Corresponding energy level for $\begin{matrix}Li^{\oplus} \\ (z=3)\end{matrix} = \frac{-1312}{n^2}\times(3)^2 = -\frac{1312}{4}$

$n^2 = 36$ $\boxed{n = 6}$

Shortcut

$$\frac{1}{\lambda_{He^{2+}}} = R\times(2)^2\left[\frac{1}{4^2} - \frac{1}{6^2}\right] \quad ......(1)$$

$$\frac{1}{\lambda_{Li^{2+}}} = R\times(3)^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] \quad ......(2)$$

For same energy equation (1) must be equal to equation (2) which only possible when

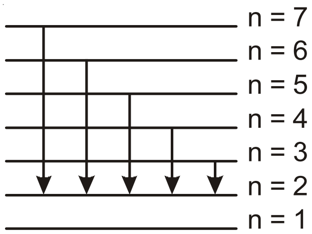
$n_1 = 6$ and $n_2 = 9$

17. Number of spectral lines in Balmer series when an electron return from 7th orbit to 1st orbit of hydrogen atom are

(1) 5 (2) 6 (3) 21 (4) 15

Sol. Answer (1)

As only visible lines have to be calculated i.e. Balmer lines



$\therefore$ Visible lines when ground state = 2

$n_1 = 2$

$\therefore$ Possible arrangements 7 $\rightarrow$ 2, 6 $\rightarrow$ 2, 5 $\rightarrow$ 2, 4 $\rightarrow$ 2, 3 $\rightarrow$ 2

Total number of spectral lines = 5

All have visible region because $\boxed{n_1 = 2}$

18. Zeeman effect refers to the

(1) Splitting of the spectral lines in a magnetic field

(2) Splitting up of the spectral lines in an electrostatic field

(3) Emission of electrons from metals when light falls on it

(4) Random scattering of α-particles by gold foil

Sol. Answer (1)

Splitting of line in magnetic field is known as **Zeeman effect**

(Towards Quantum Mechanical Model of the Atom (Dual behaviour of matter, Heisenberg's uncertainity Principle)

19. Assuming the velocity to be same, the wavelength of the waves associated with which of the following particles would be maximum?

(1) An electron (2) A proton (3) An α-particle (4) A deutron

Sol. Answer (1)

$\lambda = \dfrac{h}{mv}$ $\lambda \propto \dfrac{1}{m}$ for same velocity

Mass of electron is minimum than proton, deutron and α-particle

i.e., $m_e = 9.1 \times 10^{-31}$ kg $m_p = 1.67 \times 10^{-27}$ kg $m_D = 1$ unit $m_{\alpha_{particle}} = 4$ unit

$\therefore$ e^- will have minimum mass and maximum wavelength

20. If the uncertainty in the position of electron is zero, the uncertainty in its momentum would be

(1) Zero (2) Greater than $\dfrac{h}{4\pi}$ (3) Less than $\dfrac{h}{4\pi}$ (4) Infinite

Sol. Answer (4)

$\boxed{\Delta x \times \Delta P = \dfrac{h}{4\pi}}$ if $\Delta x = 0$

$$\Delta P = \frac{h}{4\pi \times \Delta x} = \frac{h}{4\pi \times 0} = \infty$$

21. If kinetic energy of a proton is increased nine times, the wavelength of the de-Broglie wave associated with it would become

(1) 3 times (2) 9 times (3) $\dfrac{1}{3}$ times (4) $\dfrac{1}{9}$ times

Sol. Answer (3)

$\dfrac{1}{2}mv^2 = K.E. \Rightarrow \dfrac{1}{2}m^2v^2 = m \cdot K \cdot E$

$m^2v^2 = 2m \cdot K \cdot E$ $\lambda = \dfrac{h}{mv}$ substitute the value of mv

$mv = \sqrt{2m \cdot K \cdot E}$ $\lambda = \dfrac{h}{\sqrt{2m \cdot K \cdot E}}$ $\therefore \boxed{\lambda \propto \dfrac{1}{\sqrt{K \cdot E}}}$ ...... (1)

From equation (1) when K.E. of the electron increased 9 times. The de-Broglie wavelength decreased by $\dfrac{1}{3}$ times.

$$\lambda \propto \frac{1}{\sqrt{9}} = \frac{1}{3}$$

22. The de-Broglie wavelength of an electron travelling with 10% of velocity of light is equal to

(1) 242.4 pm (2) 24.2 pm

(3) 2.42 pm (4) 2.424 pm

Sol. Answer (2)

v = 10% of velocity of light

$$= \frac{10}{100} \times 3.0 \times 10^{8} \text{ m/s} = 3.0 \times 10^{7} \text{ m/s}$$

$$m = 9.1 \times 10^{-31} \text{ kg}$$

$$\boxed{\lambda = \frac{h}{mv}} = \frac{6.6 \times 10^{-34} \text{ J-s}}{9.1 \times 10^{-31} \times 3 \times 10^{7}} = 24.2 \times 10^{-12} \text{ m} = 24.2 \text{ pm}$$

23. The wavelength associated with a ball of 200 g and moving with a speed of 5 m/hour is of the order of

(1) 10^{-10} m (2) 10^{-20} m (3) 10^{-30} m (4) 10^{-40} m

Sol. Answer (3)

$$v = 5 \text{ m/hour} = \frac{5}{3600} \text{ m/s}$$

m = 200 g = 0.2 kg

$$\lambda = \frac{6.6 \times 10^{-34} \text{ J-s} \times 3600}{0.2 \times 5}$$

$= 23760 \times 10^{-34}$

$= 2.3 \times 10^{-30}$ m

$$= \boxed{10^{-30} \text{m}}$$

24. The momentum of a particle which has a de-Broglie wavelength of 0.1 nm is

(1) 3.2×10^{-24} kg ms^{-1} (2) 4.3×10^{-22} kg ms^{-1}

(3) 5.3×10^{-22} kg ms^{-1} (4) 6.62×10^{-24} kg ms^{-1}

Sol. Answer (4)

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

momentum P = mv

$$\therefore P = \frac{h}{\lambda} = \frac{6.6 \times 10^{-34} \text{ kgm}^2\text{s}^{-1}}{0.1 \times 10^{-9} \text{ m}}$$

$$\boxed{P = 6.6 \times 10^{-24} \text{ kg ms}^{-1}}$$

25. The uncertainty in velocity of an electron present in the nucleus of diameter 10^{-15}m hypothetically should be approximately

(1) 10^{-11} m/s (2) 10^{8} m/s (3) 10^{11} m/s (4) 10 Å/s

Sol. Answer (3)

$\Delta x = 10^{-15}$ m

$m = 9.1 \times 10^{-31}$ kg $\boxed{\Delta x \times m\Delta v = \frac{h}{4\pi}}$

$$\Rightarrow \Delta v = \frac{6.6 \times 10^{-34} \text{ kg m}^2\text{s}^{-1}}{10^{-15} \times 9.1 \times 10^{-31} \times 4 \times 3.14} = \frac{6.6}{114.296} \times 10^{12} \text{ m/s}$$

$$= 0.05 \times 10^{12} \text{ m/s}$$

$$\boxed{\text{App.} = 0.5 \times 10^{11} \text{ m/s}}$$

(Quantum Mechanical Model of the Atom)

26. The set of quantum numbers not applicable to an electron

(1) $1, 1, 1, +\frac{1}{2}$ (2) $1, 0, 0, +\frac{1}{2}$ (3) $1, 0, 0, -\frac{1}{2}$ (4) $2, 0, 0, +\frac{1}{2}$

Sol. Answer (1)

The value of l can never be equal to n

$\therefore$ n = 1, l = 1 which is not possible

27. The principal and azimuthal quantum number of electrons in 4*f* orbitals are

(1) 4, 2 (2) 4, 4 (3) 4, 3 (4) 3, 4

Sol. Answer (3)

For 4f electron $\begin{bmatrix} \text{Principal quantum number (n) = 4} \\ \text{Azimuthal quantum number (l) = 3} \end{bmatrix}$

$$\begin{bmatrix} l = 0 & s \\ l = 1 & p \\ l = 2 & d \\ l = 3 & f \end{bmatrix}$$

28. How many 3*d* electrons can have spin quantum number $-\frac{1}{2}$?

(1) 5 (2) 7 (3) 8 (4) 10

Sol. Answer (1)

For 3d number of electrons will be 10

↿⇂	↿⇂	↿⇂	↿⇂	↿⇂

5 e⁻ have **clockwise** $= +\frac{1}{2}$

5 e⁻ have **anti clockwise** $= -\frac{1}{2}$

For l = 2 m = –2, –1, 0, +1, +2

$-\frac{1}{2}$ $+\frac{1}{2}$ $-\frac{1}{2}$ $+\frac{1}{2}$ $-\frac{1}{2}$ $+\frac{1}{2}$ $-\frac{1}{2}$ $+\frac{1}{2}$ $-\frac{1}{2}$ $+\frac{1}{2}$

$\begin{bmatrix} \text{5 orbital = 10e}^- \\ \text{half are clockwise} \\ \text{and half are anticlockwise} \end{bmatrix}$

29. The correct order of increasing energy of atomic orbital is

(1) $5p < 4f < 6s < 5d$ (2) $5p < 6s < 4f < 5d$

(3) $4f < 5p < 5d < 6s$ (4) $5p < 5d < 4f < 6s$

Sol. Answer (2)

More the $(n + l)$ value ; more will be the energy

	$5p$	$4f$	$6s$	$5d$
$(n + l) \rightarrow$	(5 + 1)	(4 + 3)	(6 + 0)	(5 + 2)
	6	7	6	7

According to Aufbau principle

Smaller the $(n + l)$; smaller will be energy

For same $(n + l)$; smaller the value of n ; lesser will be energy

$\therefore$ increasing order $\boxed{5p < 6s < 4f < 5d}$

30. Which shell would be the first to have 'g' sub-shell?

(1) L (2) M (3) N (4) O

Sol. Answer (4)

For g-subshell l = 4; the value of n will be = (l + 1) = 5

K,	L,	M,	N,	O
n = 1	n = 2	n = 3	n = 4	n = 5

$\therefore$ For n = 5 corresponding is 'o' shell and it contain 'g' subshell.

31. For which one of the following set of quantum numbers an electron will have the highest energy?

(1) $3, 2, 1, \frac{1}{2}$ (2) $4, 2, -1, \frac{1}{2}$ (3) $4, 1, 0, -\frac{1}{2}$ (4) $5, 0, 0, \frac{1}{2}$

Sol. Answer (2)

Larger the value of (n + l) ; larger will be the energy

(1) $3, 2, 1, \frac{1}{2}$ (n + l) = 3 + 2 = 5

(2) $4, 2, -1, \frac{1}{2}$ (n + l) = 4 + 2 = 6 **(Max energy)**

(3) $4, 1, 0, -\frac{1}{2}$ (n + l) = 4 + 1 = 5

(4) $5, 0, 0, \frac{1}{2}$ (n + l) = 5 + 0 = 5

32. The energies of orbitals of H-atom are in the order

(1) $3s < 3p < 4s < 3d < 4p$ (2) $3s < 3p < 3d < 4s < 4p$

(3) $3s = 3p = 3d < 4s = 4p$ (4) $3s = 3p = 3d < 4s < 4p$

Sol. Answer (3)

As 'H' have 1 electron

$\therefore$ Orbitals are not degenerated

$\therefore \underbrace{3s = 3p = 3d}_{\text{same energy}} < \underbrace{4s = 4p}_{\text{same energy}}$

33. Which of the following set of quantum number is possible?

(1) $n = 4, l = 2, m = -2, s = -2$ (2) $n = 4, l = 4, m = 0, s = \frac{1}{2}$

(3) $n = 4, l = 3, m = -3, s = \frac{1}{2}$ (4) $n = 4, l = 0, m = 0, s = 0$

Sol. Answer (3)

Option 1 not possible because s can never have –2 value

Option 2 not possible because n and l cannot have same value

Option 4 not possible because s cannot have zero value

$\therefore$ Correct answer = 3

n = 4 l = 3 m = –3 $s = \frac{1}{2}$

34. The maximum number of electrons in an atom which can have n = 4 is

(1) 4 (2) 8 (3) 16 (4) 32

Sol. Answer (4)

Number of electrons = $2n^2$ (n = shell number)

For 4th shell = $2 \times (4)^2 = 32$ electrons

35. In the presence of magnetic field, the possible number of orientations for an orbital of azimuthal quantum number 3, is

(1) Three (2) One (3) Five (4) Seven

Sol. Answer (4)

When magnetic field is applied subshell will give orbital *i.e.*,

l = 3 $m = \underbrace{-3, -2, -1, 0, +1, +2, +3}$

(Total 7 orbitals are possible)

36. For a 'p' electron, the orbital angular momentum is

(1) $\sqrt{6}\hbar$ (2) $\sqrt{2}\hbar$ (3) $\hbar$ (4) $2\hbar$

Sol. Answer (2)

$$\boxed{\text{Orbital angular momentum} = \sqrt{l(l+1)}\frac{h}{2\pi} = \sqrt{l(l+1)}\ \hbar}$$

For *p*-electron value of $l = 1$

$\therefore$ Orbital angular momentum $= \sqrt{l(l+1)}\ \hbar = \sqrt{2}\ \hbar$

37. Which of the following electronic level would allow the hydrogen to absorb a photon but not emit a photon?

(1) 3*s* (2) 2*p* (3) 2*s* (4) 1*s*

Sol. Answer (4)

1*s*-orbital is the ground state

Further emission is not possible *i.e.* de excitation not possible

38. Which of the following transition will emit maximum energy in hydrogen atom?

(1) $4f \rightarrow 2s$ (2) $4d \rightarrow 2p$

(3) $4p \rightarrow 2s$ (4) All have same energy

Sol. Answer (4)

Transition energy depends upon the shell number i.e. value of principle quantum number 'n' in all the case transition is between 4th energy level to 2nd level

$\therefore$ All have same energy

39. In an atom, which has 2K, 8L, 18M and 2N electrons in the ground state. The total number of electrons having magnetic quantum number, $m = 0$ is

(1) 6 (2) 10 (3) 7 (4) 14

Sol. Answer (4)

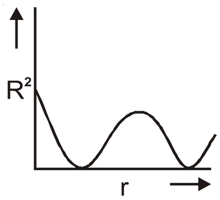
Total number of e^- = 30. Therefore, e^- configuration will be

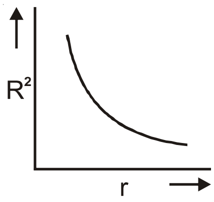
$1s^2$	$2s^2$	$2p^6$	$3s^2$	$3p^6$	$4s^2$	$3d^{10}$
n = 1	n = 2	n = 2	n = 3	n = 3	n = 4	n = 3
l = 0	l = 0	l = 1	l = 0	l = 1	l = 0	l = 2
m = 0	m = 0	m = –1, 0, +1	m = 0	m = 0, –1, +1	m = 0	m = –2, –1, 0, +1, +2

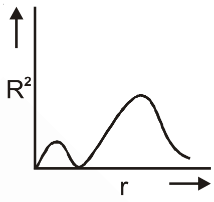
For	s-subshell 1 orbital have	m = 0
For	p-subshell 1 orbital have	m = 0
For	d-subshell 1 orbital have	m = 0

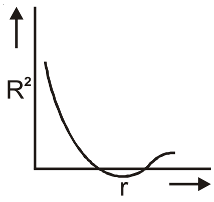
∴ Total 7 orbital have m = 0 in above configuration. Therefore, total number of electron = 7 × 2 = 14

40. The probability density curve for 2*s* electron appears like

(1) 

(2) 

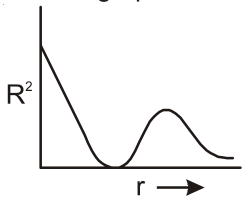
(3) 

(4) 

Sol. Answer (1)

Graph is not correct [because 2s have only one node]

Correct graph will be



41. A *p*-orbital can accommodate upto

(1) Four electrons (2) Six electrons (3) Two electrons (4) Eight electrons

Sol. Answer (3)

In any orbital maximum two electrons can accommodate

[A p-orbital can accommodate upto two electrons]

42. The number of radial nodes in 4*s* and 3*p* orbitals are respectively

(1) 2, 0 (2) 3, 1 (3) 2, 2 (4) 3, 2

Sol. Answer (2)

$\boxed{\text{Number of radial nodes} = (n-l-1)}$

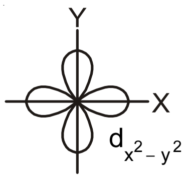
$$\begin{cases}\text{For } \;\; 4s \;\; n=4 \;\; l=0 \;\; (4-0-1)=3 \\ \text{For } \;\; 3p \;\; n=3 \;\; l=1 \;\; (3-1-1)=1\end{cases}$$

43. Which of the following orbital is with the four lobes present on the axis?

(1) d_{z^2} (2) d_{xy} (3) d_{yz} (4) $d_{x^2-y^2}$

Sol. Answer (4)

$d_{x^2-y^2}$ (all the lobes are present on axis)



44. Which of the following statement concerning the four quantum number is incorrect?

(1) *n* gives the size of an orbital

(2) *l* gives the shape of an orbital

(3) *m* gives the energy of the electron in orbital

(4) *s* gives the direction of spin of electron in the orbital

Sol. Answer (3)

m = represents the orientation of orbital in magnetic field.

m = orbitals

45. Which of the following has maximum number of unpaired electrons?

(1) Mg^{2+} (2) Ti^{3+} (3) Fe^{2+} (4) Mn^{2+}

Sol. Answer (4)

					Number of unpaired	
Mg^{2+}	=	10	=	$1s^2, 2s^2, 2p^6$	0	
Ti^{3+}	=	19	=	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^0, 3d^1$	1	
Fe^{2+}	=	24	=	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^0, 3d^6$	4	
Mn^{2+}	=	23	=	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^0, 3d^5$	5	maximum number

46. Two electrons in K shell will not have

(1) Same principal quantum number (2) Same azimuthal quantum number

(3) Same magnetic quantum number (4) Same spin quantum number

Sol. Answer (4)

As K shell is the 1st shell and have maximum two electron. Therefore, to Pauli's exclusion principal two electrons can't have the same value of all the four quantum number.

Therefore, can't have same spin quantum number

47. Which of the following electronic configuration is not possible?

(1) $2p^3$ (2) $2d^5$ (3) $4s^1$ (4) $5f^8$

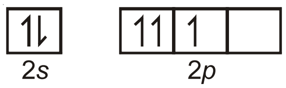
Sol. Answer (2)

Value of l cannot be greater or equal to n.

For 2d n = 2, l = 2 not possible

48. The orbital diagram in which both Pauli's exclusion principle and Hund's rule are violated is

Sol. Answer (1)



According to Pauli number two electrons have same value of all the four quantum numbers *i.e.* pair in 2*p* orbital have same spin not possible.

According to Hund's rule electrons are firstly clockwise arranged then pairing is done which is not in 2*p* subshell.

49. Which of the following electronic configuration is incorrect?

(1) $1s^2, 2s^2, 2p_x^2, 2p_y^2, 2p_z^2, 3s^2, 3p_x^1$
(2) $1s^2, 2s^1, 2p_x^1, 2p_y^1, 2p_z^1$
(3) $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^5, 4s^2$
(4) $1s^2, 2s^2, 2p^6, 3s^2, 3p_x^1, 3p_y^1, 3p_z^1$

Sol. Answer (2)

Before 2s completely filled electrons are not further added into higher energy level.

Therefore Option 2 incorrect.

50. The number of waves in the third orbit of H atom is

(1) 1 (2) 2 (3) 4 (4) 3

Sol. Answer (4)

Number of waves = Number of shell

Number of waves = $-\dfrac{\text{Circumference}}{\text{de Broglie } \lambda}$

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

Number of waves $= \dfrac{2\pi r \times mv}{h}$

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

Number of waves = n

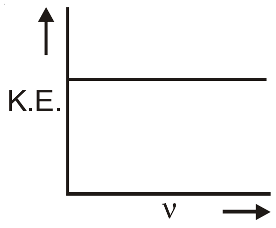
Number of waves in third orbit = 3

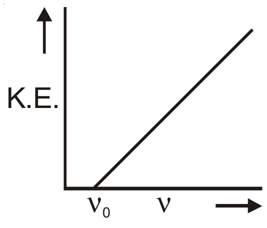
SECTION - B

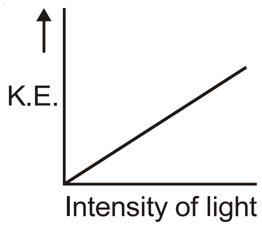
Objective Type Questions

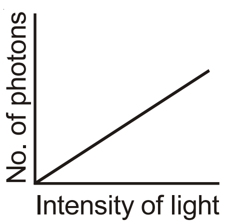
(Discovery of Fundamental Particles, Nature of Electromagnetic Radiation)

1. Which is the correct graphical representation based on photoelectric effect?

I. 

II. 

III. 

IV. 

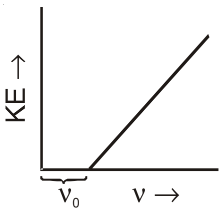
(1) I & II (2) II & III (3) III & IV (4) II & IV

Sol. Answer (4)

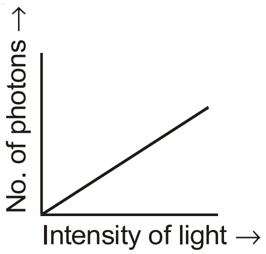
For photoelectric effect

KE = $h(\nu - \nu_0)$

KE = $h\nu - h\nu_0$



(II)



(IV)

ν_0 = Threshold frequency

∴ [KE of e^- increases after crossing. Threshold frequency]

(Bohr's Model for Hydrogen atom)

2. What will be the longest wavelength line in Balmer series of spectrum of H-atom?

(1) 546 nm (2) 656 nm (3) 566 nm (4) 556 nm

Sol. Answer (2)

All the wavelength are in visible region i.e. between 400 nm to 760 nm. Therefore maximum wavelength line will be 656 nm.

3. In hydrogen atom, energy of first excited state is –3.4 eV. Then find out KE of same orbit of hydrogen atom

(1) +3.4 eV (2) +6.8 eV (3) –13.6 eV (4) +13.6 eV

Sol. Answer (1)

$$\frac{KE}{E_{Total}} = -1$$

Total energy = –3.4 eV (Given)

∴ KE = –(–3.4 eV) = +3.4 eV

4. Total number of spectral lines in UV region, during transition from 5th excited state to 1st excited state

(1) 10 (2) 3 (3) 4 (4) Zero

Sol. Answer (4)

As 1st excited state means $n_1 = 2$

For 5th excited state means $n_2 = 6$

∴ e^- will transit between 6th level to 2nd level

No transition will be upto 1st level. Because no line will appear in Lyman series i.e. UV region.

5. The first emission line in the atomic spectrum of hydrogen in the Balmer series appears at

(1) $\frac{5R}{36}\text{cm}^{-1}$ (2) $\frac{3R}{4}\text{cm}^{-1}$ (3) $\frac{7R}{144}\text{cm}^{-1}$ (4) $\frac{9R}{400}\text{cm}^{-1}$

Sol. Answer (1)

$\boxed{1^{st} \text{ line in the Balmer series means } n_1 = 2, n_2 = 3}$

$$\bar{v} = \frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]z^2 \quad \text{for H} \quad z = 1$$

$$\bar{v} = \frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{3^2}\right]\times 1^2 = R\left[\frac{1}{4} - \frac{1}{9}\right] = \frac{5R}{36}\ \text{cm}^{-1}$$

6. In a hydrogen atom, if the energy of electron in the ground state is –x eV., then that in the 2nd excited state of He^+ is

(1) –x eV (2) $-\frac{4}{9}$x eV (3) +2x eV (4) $-\frac{9}{4}$x eV

Sol. Answer (2)

$$\boxed{E_n = \frac{E_{\text{ground state}}}{n^2}\times z^2} \qquad \begin{cases} E_{\text{ground}} = x\text{ eV} & \text{given} \\ n = 3 & \text{because } 2^{nd} \text{ excited state} \\ z = 2 & \text{because} \end{cases}$$

$$= -\frac{x}{(3)^2}\times(2)^2 = \boxed{-\frac{4}{9}x\text{ eV}}$$

7. The wavelength of radiation emitted, when in He^+ electron falls from infinity to stationary state would be ($R = 1.097 \times 10^7\ m^{-1}$)

(1) 2.2×10^{-8} m (2) 22×10^{-9} m (3) 120 m (4) 22×10^7 m

Sol. Answer (1)

$n_1 = 1$ For $He^{\oplus}$ z = 2

$n_2 = \alpha$ given

$$\frac{1}{\lambda_{He^{\oplus}}} = R\left[\frac{1}{1^2} - \frac{1}{\alpha^2}\right]\times(2)^2$$

$$\boxed{\frac{1}{\lambda_{He^{\oplus}}} = 109678\times 4\ \text{cm}^{-1}}$$

$$\lambda_{He^{\oplus}} = \frac{1}{109678\times 4} = \frac{1}{438712} = 2.2\times 10^{-6}\ \text{cm}$$

$$\boxed{= 2.2\times 10^{-8}\ \text{m}}$$

8. In Bohr series of lines of hydrogen spectrum, the third line from the red end corresponds to which one of the following inter-orbit jumps of the electron for Bohr orbits in an atom of hydrogen?

(1) $3 \rightarrow 1$ (2) $5 \rightarrow 2$ (3) $2 \rightarrow 5$ (4) $3 \rightarrow 2$

Sol. Answer (2)

Third line means third excited state

i.e. $n_1 = 2$ Balmer series (visible region)

$n_2 = 5$ Third line

$\therefore$ Third line will appear when electron comes from 5th energy level to 2nd level.

9. The correct order of energy difference between adjacent energy levels in H atom

(1) $E_2 - E_1 > E_3 - E_2 > E_4 - E_3$ (2) $E_2 - E_1 > E_4 - E_3 > E_3 - E_2$

(3) $E_4 - E_3 > E_3 - E_2 > E_2 - E_1$ (4) $E_3 - E_2 > E_4 - E_3 > E_2 - E_1$

Sol. Answer (1)

In H atom

$$E_1 = \frac{-1312}{12} \qquad E_2 = \frac{-1312}{4} \qquad E_3 = \frac{-1312}{9} \qquad E_4 = \frac{-1312}{25} \qquad E_5 = \frac{-1312}{36}$$

$\therefore (E_2 - E_1) > (E_3 - E_2) > (E_4 - E_3)$ ....

[Alternatively as the distance from the nucleus increases the value of ΔE (energy difference between two shell) decreases]

10. Which of the following electronic in a transition hydrogen atom will require the largest amount of energy?

(1) $n = 1$ to $n = 2$ (2) $n = 2$ to $n = 3$ (3) $n = 1$ to $n = \infty$ (4) $n = 3$ to $n = 5$

Sol. Answer (3)

Largest amount of energy is required for the transition between $1 \rightarrow \infty$

$\Delta E = hc \times \frac{1}{\lambda} \quad \Rightarrow hcR\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$ [Large the difference between n_1 and n_2 large will be the value of DE]

11. The time taken by the electron in one complete revolution in the n^{th} Bohr's orbit of the hydrogen atom is

(1) Inversely proportional to n^2 (2) Directly proportional to n^3

(3) Directly proportional to $\frac{h}{2\pi}$ (4) Inversely proportional to $\frac{n}{h}$

Sol. Answer (2)

$$\text{Time period} = \frac{\text{circumference}}{\text{velocity}} = \frac{2\pi r}{v_n} = \frac{n^3}{z^2} \times 1.5 \times 10^{-16} \text{ seconds}$$

Time period $\propto n^3$

12. What will be the ratio of the wavelength of the first line to that of the second line of Paschen series of H atom?

(1) 256 : 175 (2) 175 : 256 (3) 15 : 16 (4) 24 : 27

Sol. Answer (1)

First time of paschen series $n_1 = 3$, $n_2 = 4$

$$\frac{1}{\lambda_1} = R\left[\frac{1}{9} - \frac{1}{16}\right]$$

$$\frac{1}{\lambda_1} = \frac{7R}{144} \qquad \lambda_1 = \frac{144}{7R}$$

Second line of paschen series $n_1 = 3$, $n_2 = 5$

$$\frac{1}{\lambda_2} = R\left[\frac{1}{9} - \frac{1}{25}\right]$$

$$\frac{1}{\lambda_2} = \frac{16R}{225} \qquad \lambda_2 = \frac{225}{16R}$$

$$\boxed{\frac{\lambda_1}{\lambda_2} = \frac{144}{7R} \times \frac{16R}{225} = \frac{2304}{1575} = \frac{256}{175}}$$

13. For the transition from n = 2 → n = 1, which of the following will produce shortest wavelength?

(1) H atom (2) D atom (3) He^+ ion (4) Li^{2+} ion

Sol. Answer (4)

$$\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]z^2 \text{ as } n_1 \propto n_2 \text{ are constant}$$

$\therefore \lambda \propto \frac{1}{z^2}$ more the nuclear charge smaller will be the λ

H = z = 1

D = z = 1 ∴ Li^{2+} have shorter wavelength

$He^{\oplus}$ = z = 2

Li^{2+} = z = 3

(Towards Quantum Mechanical Model of the Atom (Dual behaviour of matter, Heisenberg's uncertainity Principle)

14. The uncertainty in momentum of an electron is 1 × 10^{-5} kg-m/s. The uncertainty in its position will be (h = 6.62 × 10^{-34} kg-m^2/s)

(1) 5.27 × 10^{-30} m (2) 1.05 × 10^{-26} m (3) 1.05 × 10^{-28} m (4) 5.25 × 10^{-28} m

Sol. Answer (1)

$\Delta P = 10^{-5}$ kgms^{-1}

$$\Delta x \times \Delta P = \frac{h}{4\pi}$$

$$\boxed{\Delta x = \frac{6.6 \times 10^{-34}\ \text{J}}{10^{-5} \times 4 \times 3.14} = 5.2 \times 10^{-30}\,\text{m}}$$

15. Two particles *A* and *B* are in motion. If the wavelength associated with particle *A* is 5 × 10^{-8} m; calculate the wavelength associated with particle *B* if its momentum is half of *A*.

(1) 5 × 10^{-8} m (2) 10^{-5} cm (3) 10^{-7} cm (4) 5 × 10^{-8} cm

Sol. Answer (2)

$$\boxed{\lambda_A = \frac{h}{P_A} \qquad \lambda_B = \frac{h}{P_B} \qquad P_B = \frac{1}{2}P_A}$$ (Given)

$$\frac{\lambda_A}{\lambda_B} = \frac{\frac{h}{P_A}}{\frac{h}{P_B}} = \frac{P_B}{P_A}$$ Putting $P_B = \frac{1}{2}P_A$

$$\boxed{\frac{\lambda_A}{\lambda_B} = \frac{1}{2}\frac{P_A}{P_A}}$$

$\lambda_B = 2\lambda_A$ [λ_A = 5 × 10^{-8}m]

λ_B = 2 × 5 × 10^{-8}

= 10 × 10^{-8} m ∵ 1 m = 100 cm

= 10^{-7} m = 10^{-5} cm

(Quantum Mechanical Model of the Atom)

16. Maximum number of electrons in a subshell with l = 3 and n = 4 is

(1) 10 (2) 12 (3) 14 (4) 16

Sol. Answer (3)

$\boxed{n = 4, l = 3 \text{ means } 4f}$

for l = 3, m = –3, –2, –1, 0, 1, 2, 3 = 7 orbital

Therefore, maximum 14 electrons are present.

17. The total number of subshells in fourth energy level of an atom is

(1) 4 (2) 8 (3) 16 (4) 32

Sol. Answer (1)

18. For which of the following sets of four quantum numbers, an electron will have the highest energy?

	n	*l*	*m*	*s*
(1)	3	2	1	+1/2
(2)	4	2	–1	+1/2
(3)	4	1	0	–1/2
(4)	5	0	0	–1/2

Sol. Answer (2)

Energy of an electron depends upon (n + l) value

More the (n + l) value more will be the energy

	n	*l*	*m*	*s*	(n + l)
(1)	3	2	1	+1/2	5
(2)	4	2	–1	+1/2	6 Max. (n + l). max. energy
(3)	4	1	0	–1/2	5
(4)	5	0	0	–1/2	5

19. A transition element X has a configuration (Ar)3d^4 in its +3 oxidation state. Its atomic number is

(1) 22 (2) 19 (3) 25 (4) 26

Sol. Answer (3)

Total number of e^- in X^{+3} = [Ar] $3d^4$

= 18 + 4 = 22

∴ $\boxed{\text{Number of electrons in X} = 22 + 3 = 25}$

Atomic number = 25

20. Among the following which one is not paramagnetic? [Atomic numbers; Be = 4, Ne = 10, As = 33, Cl = 17]

(1) Ne^{2+} (2) Be^{+} (3) Cl^{-} (4) As^{+}

Sol. Answer (3)

Ions having all the electron paired will be non-paramagnetic or diamagnetic

Ne^{+2}	=	8	=	$1s^2, 2s^2, 2p^4$	$\boxed{\uparrow\downarrow}\boxed{\uparrow}\boxed{\uparrow}$ $2p$	2 unpaired e^-
$Be^{\oplus}$	=	3	=	$1s^2, 2s^1$	$\boxed{\uparrow}$ $2s$	1 unpaired e^-
Cl^{-}	=	18	=	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6$	$\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}$ $3p$	0 unpaired e^-
$As^{\oplus}$	=	33	=	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^{10}, 4p^3$	$\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}$	3 unpaired e^-

21. Isoelectronic species are

(1) CO, CN^-, NO^+, C_2^{2-}

(2) CO^-, CN, NO, C_2^-

(3) CO^+, CN^+, NO^-, C_2

(4) CO, CN, NO, C_2

Sol. Answer (1)

Isoelectronic species have same number of electrons

$$\begin{bmatrix} CO = 14\ e^- & NO^{\oplus} = 14\ e^- \\ CN^- = 14\ e^- & C_2^{2-} = 14\ e^- \end{bmatrix}$$ [All have same number of electrons]

22. Consider the following sets of quantum number

	n	l	m	s
(i)	3	0	0	+1/2
(ii)	2	2	1	+1/2
(iii)	4	3	–2	–1/2
(iv)	1	0	–1	–1/2
(v)	3	2	3	+1/2

Which of the following sets of quantum number is not possible?

(1) (i), (ii), (iii) and (iv) (2) (ii), (iv) and(v) (3) (i) and (iii) (4) (ii), (iii) and (iv)

Sol. Answer (2)

(ii), (iv), and (v) are not possible

(ii)	n = 2	l = 2	m = 1	s = +1/2	l not equal to n not possible
(iii)	n = 1	l = 0	m = –1	s = –1/2	Not possible because m = –1 where l = 0
(iv)	n = 3	l = 2	m = 3	s = +1/2	Not possible because m = 3 is not for l = 2

23. Any *f*-orbital can accommodate upto
    (1) 2 electrons with parallel spin
    (2) 6 electrons
    (3) 2 electrons with opposite spin
    (4) 14 electrons

Sol. Answer (3)

Any orbital have maximum of two electrons with opposite spin.

24. For principal quantum number $n = 5$, the total number of orbitals having $l = 3$ is
    (1) 7 (2) 14 (3) 9 (4) 18

Sol. Answer (1)

For l = 3 m = –3, –2, –1, 0, +1, +2, +3

i.e., 7 orbitals are present

25. The four quantum numbers of valence electron of potassium are
    (1) $4, 0, 1, \frac{1}{2}$ (2) $4, 1, 0, \frac{1}{2}$ (3) $4, 0, 0, \frac{1}{2}$ (4) $4, 1, 1, \frac{1}{2}$

Sol. Answer (3)

K = 19 = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1$ last e^-

Last electron $4s^1$

$\therefore$ n = 4 l = 0 m = 0 $s = +\frac{1}{2}$

26. In the ground state, an element has 13 electrons in its M-shell. The element is
    (1) Manganese (2) Cobalt (3) Nickel (4) Iron

Sol. Answer (1)

M shell means 3rd orbit

Mn = 25 = $1s^2, 2s^2, 2p^6, \underbrace{3s^2, 3p^6}_{8}, 4s^2, \underbrace{3d^5}_{5}$ total 13 e^- in 3 orbit

Co = 27 = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^7$ total 15 e^- in 3 orbit

Ni = 28 = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^8$ total 16 e^- in 3 orbit

Fe = 26 = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^6$ total 14 e^- in 3 orbit

27. Which combinations of quantum numbers *n*, *l*, *m* and *s* for the electron in an atom does not provide a permissible solutions of the wave equation?
    (1) $3, 2, -2, \frac{1}{2}$ (2) $3, 3, 1, -\frac{1}{2}$ (3) $3, 2, 1, \frac{1}{2}$ (4) $3, 1, 1, -\frac{1}{2}$

Sol. Answer (2)

n = 3 l = 3 [Not possible because value of l can never be equals to n]

28. The orbital angular momentum of electron in 4*s* orbital is
    (1) $\frac{1}{2}.\frac{h}{2\pi}$ (2) Zero (3) $\frac{h}{2\pi}$ (4) $(2.5)\frac{h}{2\pi}$

Sol. Answer (2)

Orbital angular momentum = $\sqrt{l(l+1)}\frac{h}{4\pi}$

For 4s electron the value of l = 0 $\therefore$ [orbital angular momentum = zero]

29. Radial nodes present in 3*s* and 3*p*-orbitals are respectively

(1) 0, 2 (2) 2, 1 (3) 1, 1 (4) 2, 2

Sol. Answer (2)

Radial nodes = (n – l – 1)

for 3*s* (3 – 0 – 1) = 2 ; For 3*p* (3 – 1 – 1) = 1

30. Quantum numbers for some electrons are given below

A : $n = 4$, $l = 1$ B : $n = 4$, $l = 0$ C : $n = 3$, $l = 2$ D : $n = 3$, $l = 1$

The correct increasing order of energy of electrons

(1) A < B < C < D (2) D < C < B < A (3) D < B < C < A (4) C < B < A < D

Sol. Answer (3)

Energy = $(n + l)$

A = n = 4 l = 1 = 4 + 1 = 5

B = n = 4 l = 0 = 4 + 0 = 4

C = n = 3 l = 2 = 3 + 2 = 5

D = n = 3 l = 1 = 3 + 1 = 4

According to Pauli exclusion principle

(1) Larger the (n + l); larer will be energy

(2) Same value of (n + l) ; smaller n ; more will be energy

$\therefore$ $\boxed{D < B < C < A}$

31. The number of lobes in most of the *d*-orbitals are

(1) 6 (2) 8 (3) 10 (4) 4

Sol. Answer (4)

32. For which of the following options m = 0 for all orbitals?

(1) $2s, 2p_x, 3d_{xy}$ (2) $3s, 2p_z, 3d_{z^2}$ (3) $2s, 2p_z, 3d_{x^2-y^2}$ (4) $3s, 3p_x, 3d_{yz}$

Sol. Answer (2)

Value of m = 0 for $3s$, $2P_z$ and $3d_{z^2}$

33. In any sub-shell, the maximum number of electrons having same value of spin quantum number is

(1) $\sqrt{l(l+1)}$ (2) $l + 2$ (3) $2l + 1$ (4) $4l + 2$

Sol. Answer (3)

Total number of electron in subshell = 2(2l + 1) l = angular quantum number

Number of electrons having same spin $= \dfrac{2(2l+1)}{2} = (2l+1)$

[Because half e^- have clockwise and half e^- have anti clockwise spin]

34. If each orbital can hold a maximum of 3 electrons. The number of elements in 2nd period of periodic table (long form) is

(1) 27 (2) 9 (3) 18 (4) 12

Sol. Answer (4)

For 2nd period electronic configuration = $2s^2, 2p^6$

If each orbital have $3e^-$ then electronic configuration = $2s^3, 2p_x^3, 2p_y^3, 2p_z^3$

Total 12 e^- will present

SECTION - C

Previous Years Questions

1. Which one is the wrong statement? **[NEET-2017]**

(1) de-Broglie's wavelength is given by $\lambda = \frac{h}{mv}$, where m = mass of the particle, v = group velocity of the particle

(2) The uncertainty principle is $\Delta E \times \Delta t \geq \frac{h}{4\pi}$

(3) Half-filled and fully filled orbitals have greater stability due to greater exchange energy, greater symmetry and more balanced arrangement

(4) The energy of 2*s* orbital is less than the energy of 2*p* orbital in case of Hydrogen like atoms

Answer (4)

Sol. Energy of 2*s*-orbital and 2*p*-orbital in case of hydrogen like atoms is equal.

2. How many electrons can fit in the orbital for which n = 3 and l = 1? **[NEET-Phase-2-2016]**

(1) 2 (2) 6 (3) 10 (4) 14

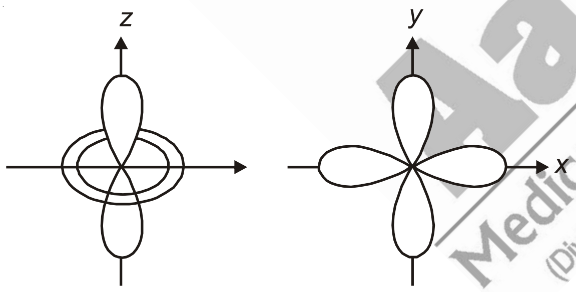
Sol. Answer (1)

An orbital can accommodate maximum of 2 electrons with anti-parallel spins.

3. Which of the following pairs of *d*-orbitals will have electron density along the axes? **[NEET-Phase-2-2016]**

(1) d_{z^2}, d_{xz} (2) d_{xz}, d_{yz} (3) $d_{z^2}, d_{x^2-y^2}$ (4) $d_{xy}, d_{x^2-y^2}$

Sol. Answer (3)



d_{z^2} $d_{x^2-y^2}$

4. Two electrons occupying the same orbital are distinguished by **[NEET-2016]**

(1) Spin quantum number (2) Principal quantum number

(3) Magnetic quantum number (4) Azimuthal quantum number

Sol. Answer (1)

Fact.

5. The angular momentum of electron in 'd' orbital is equal to **[AIPMT-2015]**

(1) $0\,\hbar$ (2) $\sqrt{6}\,\hbar$ (3) $\sqrt{2}\,\hbar$ (4) $2\sqrt{3}\,\hbar$

Sol. Answer (2)

Angular momentum = $\sqrt{l(l+1)}\frac{h}{2\pi} = \sqrt{l(l+1)}\,\hbar$

6. What is the maximum number of orbitals that can be identified with the following quantum numbers?
$n = 3,\ l = 1,\ m_l = 0$ **[AIPMT-2014]**
(1) 1 (2) 2 (3) 3 (4) 4

Sol. Answer (1)
It represents 3p orbital

7. Calculate the energy in joule corresponding to light of wavelength 45 nm: (Planck's constant $h = 6.63 \times 10^{-34}$ Js; speed of light $c = 3 \times 10^8\ ms^{-1}$) **[AIPMT-2014]**
(1) 6.67×10^{15} (2) 6.67×10^{11} (3) 4.42×10^{-15} (4) 4.42×10^{-18}

Sol. Answer (4)

$$E = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{45 \times 10^{-9}} = \frac{6.63}{15} \times 10^{-17} = 4.42 \times 10^{-18}\ J$$

8. Be^{2+} is isoelectronic with which of the following ions ? **[AIPMT-2014]**
(1) H^+ (2) Li^+ (3) Na^+ (4) Mg^{2+}

Sol. Answer (2)

9. What is the maximum numbers of electrons that can be associated with the following set of quantum numbers?
n = 3, l = 1 and m = –1 **[NEET-2013]**
(1) 6 (2) 4 (3) 2 (4) 10

Sol. Answer (3)
Value of m = –1 represents one orbital. Therefore maximum number of electrons will be two

10. The value of Planck's constant is 6.63×10^{-34} Js. The speed of light is $3 \times 10^{17}\ nm\ s^{-1}$. Which value is closest to the wavelength in nanometer of a quantum of light with frequency of $6 \times 10^{15}\ s^{-1}$? **[NEET-2013]**
(1) 25 (2) 50 (3) 75 (4) 10

Sol. Answer (2)

$$\boxed{\lambda = \frac{c}{v}} = \frac{3.0 \times 10^{17}\ nms^{-1}}{6 \times 10^{15}\ s^{-1}} = \frac{1}{2} \times 10^2\ nm$$

$$= 0.5 \times 10^2\ nm = 50\ nm$$

11. Based on equation $E = -2.178 \times 10^{-18}\ J\left(\frac{Z^2}{n^2}\right)$ certain conclusions are written. Which of them is **not** correct? **[NEET-2013]**
(1) Larger the value of n, the larger is the orbit radius
(2) Equation can be used to calculate the change in energy when the electron changes orbit
(3) For n = 1, the electron has a more negative energy than it does for n = 6 which means that the electron is more loosely bound in the smallest allowed orbit
(4) The negative sign in equation simply means that the energy of electron bound to the nucleus is lower than it would be if the electrons were at the infinite distance from the nucleus

Sol. Answer (3)
In (n = 1) 1st shell e^- is tightly held compared to n = 6 (6th shell)

12. The correct set of four quantum numbers for the valence electron of rubidium atom (Z = 37) is **[AIPMT (Prelims)-2012]**
(1) $5, 0, 0, +\frac{1}{2}$ (2) $5, 1, 0, +\frac{1}{2}$ (3) $5, 1, 1, +\frac{1}{2}$ (4) $6, 0, 0, +\frac{1}{2}$

Sol. Answer (1)

Rb = 37 = [Ar] $4s^2, 3d^{10}, 4p^6$ last $5s^1$ e^-

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

13. Maximum number of electrons in a subshell with l = 3 and n = 4 is **[AIPMT (Prelims)-2012]**

(1) 10 (2) 12 (3) 14 (4) 16

Sol. Answer (3)

n = 4 l = 3 represents 4*f* subshell having 7 orbitals

$\therefore$ $\boxed{\text{Total number of electrons = 14}}$

14. The orbital angular momentum of a p-electron is given as **[AIPMT (Mains)-2012]**

(1) $\frac{h}{\sqrt{2}\pi}$ (2) $\sqrt{3}\frac{h}{2\pi}$ (3) $\sqrt{\frac{3}{2}}\frac{h}{\pi}$ (4) $\sqrt{6}\frac{h}{2\pi}$

Sol. Answer (1)

Angular momentum = $l(l+1)\frac{\hbar}{2\pi}$

15. The total number of atomic orbitals in fourth energy level of an atom is **[AIPMT (Prelims)-2011]**

(1) 4 (2) 8 (3) 16 (4) 32

Sol. Answer (3)

$\boxed{\text{Number of orbitals} = x^2}$ n = number of orbit

= 4^2 = 16

16. The energies E_1 and E_2 of two radiations are 25 eV and 50 eV respectively. The relation between their wavelengths i.e. λ_1 and λ_2 will be **[AIPMT (Prelims)-2011]**

(1) $\lambda_1 = \frac{1}{2}\lambda_2$ (2) $\lambda_1 = \lambda_2$ (3) $\lambda_1 = 2\lambda_2$ (4) $\lambda_1 = 4\lambda_2$

Sol. Answer (3)

$\boxed{\lambda_1 = \frac{hc}{E_1}}$ $\lambda_2 = \frac{hc}{E_2}$ E_1 = 25 eV E_2 = 50 eV

$\lambda_1 = \frac{hc}{25}$ ...... (1)

$\lambda_2 = \frac{hc}{50}$ ...... (2)

$\frac{\lambda_1}{\lambda_2} = \frac{\frac{hc}{25}}{\frac{hc}{50}} = 2$ $\therefore \frac{\lambda_1}{\lambda_2} = 2$ $\boxed{\lambda_1 = 2\lambda_2}$

17. If n = 6, the correct sequence of filling of electrons will be **[AIPMT (Prelims)-2011]**

(1) ns $\rightarrow$ np $\rightarrow$ (n – 1)d $\rightarrow$ (n – 2)f (2) ns $\rightarrow$ (n – 2)f $\rightarrow$ (n – 1)d $\rightarrow$ np

(3) ns $\rightarrow$ (n – 1)d $\rightarrow$ (n – 2)f $\rightarrow$ np (4) ns $\rightarrow$ (n – 2)f $\rightarrow$ np $\rightarrow$ (n – 1)d

Sol. Answer (2)

Putting the value of n and calculating the (n + l) value

$$\begin{array}{ccccccc} 6s & < & 4f & < & 5d & < & 6p \\ (6+0) & & (4+3) & & (5+2) & & (6+1) \\ 6 & & 7 & & 7 & & 7 \\ \text{(lower energy)} & & & \rightarrow & & & \text{(high energy)} \end{array}$$

18. According to the Bohr Theory, which of the following transitions in the hydrogen atom will give rise to the least energetic photon? **[AIPMT (Mains)-2011]**

(1) n = 6 to n = 5 (2) n = 5 to n = 3 (3) n = 6 to n = 1 (4) n = 5 to n = 4

Sol. Answer (1)

Because $(E_2 – E_1) > (E_3 – E_2) > (E_4 – E_3) > (E_5 – E_4) > (E_6 – E_5)$

As the difference is of one energy levels

$\therefore$ $(E_6 – E_5)$ have less energy

{Alternatively value of ΔE [difference between two successive energy level decreases] as the distance from the nucleus increases.}

19. A 0.66 kg ball is moving with a speed of 100 m/s. The associated wavelength will be

($h = 6.6 \times 10^{-34}$ Js) **[AIPMT (Mains)-2010]**

(1) 6.6×10^{-32} m (2) 6.6×10^{-34} m (3) 1.0×10^{-35} m (4) 1.0×10^{-32} m

Sol. Answer (3)

$$\lambda = \frac{h}{mv} = \frac{6.6\times10^{-34}\,\text{kgm}^2\text{s}^2-\text{s}}{0.66\text{ kg}\times100\text{ m/s}} = \boxed{1.0\times10^{-35}\text{ m}}$$

20. The energy absorbed by each molecule (A_2) of a substance is 4.4×10^{-19} J and bond energy per molecule is 4.0×10^{-19} J. The kinetic energy of the molecule per atom will be **[AIPMT (Prelims)-2009]**

(1) 2.2×10^{-19} J (2) 2.0×10^{-19} J (3) 4.0×10^{-20} J (4) 2.0×10^{-20} J

Sol. Answer (4)

KE = Energy observed by molecule – Energy required to break one bond

$$\text{KE} = \frac{4.4\times10^{-19}\text{ J}-4.0\times10^{-19}\text{ J}}{2}$$

$$\text{KE per atom} = \left[\frac{0.4\times10^{-19}}{2}\right] = \left[0.2\times10^{-19}\text{ J}\right] = \left[2\times10^{-20}\text{ J}\right]$$

21. Which one of the elements with the following outer orbital configurations may exhibit the largest number of oxidation states? **[AIPMT (Prelims)-2009]**

(1) $3d^54s^1$ (2) $3d^54s^2$ (3) $3d^24s^2$ (4) $3d^34s^2$

Sol. Answer (2)

22. Maximum number of electrons in a subshell of an atom is determined by the following **[AIPMT (Prelims)-2009]**

(1) $2\ell + 1$ (2) $4\ell – 2$ (3) $2n^2$ (4) $4\ell + 2$

Sol. Answer (4)

23. Which of the following is not permissible arrangement of electrons in an atom? **[AIPMT (Prelims)-2009]**

(1) $n = 5, \ell = 3, m = 0, s = +\frac{1}{2}$ (2) $n = 3, \ell = 2, m = -3, s = -\frac{1}{2}$

(3) $n = 3, \ell = 2, m = -2, s = -\frac{1}{2}$ (4) $n = 4, \ell = 0, m = 0, s = +\frac{1}{2}$

Sol. Answer (2)

$n = 3 \qquad l = 2 \qquad m = -3 \qquad s = -\frac{1}{2}$

Value of m (orbital) depends upon l *i.e.,* it cannot be more than '*l*'. Therefore is wrong.

24. A p-n photodiode is made of a material with a band gap of 2.0 eV. The minimum frequency of the radiation that can be absorbed by the material is nearly **[AIPMT (Prelims)-2008]**

(1) 20×10^{14} Hz (2) 10×10^{14} Hz (3) 5×10^{14} Hz (4) 1×10^{14} Hz

Sol. Answer (3)

25. If uncertainty in position and momentum are equal, then uncertainty in velocity is **[AIPMT (Prelims)-2008]**

(1) $\sqrt{\frac{h}{\pi}}$ (2) $\frac{1}{2m}\sqrt{\frac{h}{\pi}}$ (3) $\sqrt{\frac{h}{2\pi}}$ (4) $\frac{1}{m}\sqrt{\frac{h}{\pi}}$

Sol. Answer (2)

$\Delta x \times \Delta p = \frac{h}{2\pi}$

26. The measurement of the electron position is associated with an uncertainty in momentum, which is equal to 1×10^{-18} g cm s^{-1}. The uncertainty in electron velocity is, (Mass of an electron is 9×10^{-28}g) **[AIPMT (Prelims)-2008]**

(1) 1×10^{11} cm s^{-1} (2) 1×10^{9} cm s^{-1} (3) 1×10^{6} cm s^{-1} (4) 1×10^{5} cm s^{-1}

Sol. Answer (2)

27. Consider the following sets of quantum numbers

	n	ℓ	m	s
(a)	3	0	0	$+\frac{1}{2}$
(b)	2	2	1	$+\frac{1}{2}$
(c)	4	3	–2	$-\frac{1}{2}$
(d)	1	0	–1	$-\frac{1}{2}$
(e)	3	2	3	$+\frac{1}{2}$

Which of the following sets of quantum number is not possible? **[AIPMT (Prelims)-2007]**

(1) a and c (2) b, c and d (3) a, b, c and d (4) b, d and e

Sol. Answer (4)

28. With which of the following configuration an atom has the lowest ionization enthalpy?

[AIPMT (Prelims)-2007]

(1) $1s^2\ 2s^2\ 2p^6$ (2) $1s^2\ 2s^2\ 2p^5$ (3) $1s^2\ 2s^2\ 2p^3$ (4) $1s^2\ 2s^2\ 2p^5\ 3s^1$

Sol. Answer (4)

29. Given : The mass of electron is 9.11×10^{-31} kg. Planck's constant is 6.626×10^{-34} Js, the uncertainty involved in the measurement of velocity within a distance of 0.1 Å is **[AIPMT (Prelims)-2006]**

(1) $5.79 \times 10^6\ ms^{-1}$ (2) $5.79 \times 10^7\ ms^{-1}$

(3) $5.79 \times 10^8\ ms^{-1}$ (4) $5.79 \times 10^5\ ms^{-1}$

Sol. Answer (1)

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

$$\Delta v = \frac{6.6\times10^{-34}\ \text{J-s}}{0.1\times10^{-10}\,\text{m}\times9.1\times10^{-31}\ \text{kg}\times4\times3.14} = 5.799\times10^{6}\ \text{m/s}$$

30. The orientation of an atomic orbital is governed by **[AIPMT (Prelims)-2006]**

(1) Azimuthal quantum number (2) Spin quantum number

(3) Magnetic quantum number (4) Principal quantum number

Sol. Answer (3)

31. The energy of second Bohr orbit of the hydrogen atom is –328 kJ mol^{-1}; hence the energy of fourth Bohr orbit would be **[AIPMT (Prelims)-2005]**

(1) –41 kJ mol^{-1} (2) –1312 kJ mol^{-1} (3) –164 kJ mol^{-1} (4) –82 kJ mol^{-1}

Sol. Answer (4)

$$\boxed{E_n = -\frac{1312}{n^2}}\ \text{kJ mol}^{-1} \text{ for hydrogen}$$

32. Uncertainty in position of an electron (mass = 9.1×10^{-28}g) moving with a velocity of 3×10^4 cm/s accurate upto 0.001% will be (Use $h/(4\pi)$ in uncertainty expression where $h = 6.626 \times 10^{-27}$ erg-s)

(1) 5.76 cm (2) 7.68 cm (3) 1.93 cm (4) 3.84 cm

Sol. Answer (3)

$$\Delta v = \frac{3\times10^4\times0.001}{10^3\times100}\ \text{cm/second}$$

$$\Delta x = \frac{h}{4\pi m\Delta v} = \frac{6.6\times10^{-34}\ \text{J-s}}{4\times3.14\times9.1\times10^{-28}\times\frac{0.001}{100}\times3\times10^{4}} = \boxed{1.93\ \text{cm}}$$

33. The radius of hydrogen atom in the ground state is 0.53 Å. The radius of Li^{2+} ion (atomic number = 3) in a similar state is

(1) 0.53 Å (2) 1.06 Å (3) 0.17 Å (4) 0.265 Å

Sol. Answer (3)

$$\boxed{r_n = \frac{r_0 \times n^2}{z}} = \frac{0.53\times(3)^2}{3} = (0.53\times 3)\,\text{Å}$$

1.59 Å ≈ 1.7 Å

n = 3 orbit

z = 3 Li^{2+}

34. In a Bohr's model of an atom, when an electron jumps from n = 1 to n = 3, how much energy will be emitted or absorbed?

(1) 2.389×10^{-12} ergs (2) 0.239×10^{-10} ergs (3) 2.15×10^{-11} ergs (4) 0.1936×10^{-10} ergs

Sol. Answer (4)

Energy of electron when n = 1 $E_1 = -\frac{1312}{(1)^2}$ kJ/mol

Energy of electron when n = 3 $E_3 = -\frac{1312}{(3)^2} = -\frac{1312}{9}$ kJ/mol

$$\boxed{\Delta E = E_3 - E_1}$$

$$= \frac{-1312}{9} - \left(\frac{-1312}{1}\right) = +1166 \text{ kJ}$$

$= 1166 \times 10^3$ J

$= 1166 \times 10^{+10}$ erg

Alternatively

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

$$= 3.0\times10^8 \times 6.6\times10^{-34} \times 8.314\left[\frac{1}{1^2} - \frac{1}{3^2}\right] \text{J}$$

$$= 3.0\times10^8 \times 6.6\times10^{-34} \times 8.314\left[\frac{8}{9}\right] \text{J}$$

35. The electronic configuration of gadolinium (Atomic No. 64) is

(1) [Xe]$4f^3\,5d^5\,6s^2$ (2) [Xe]$4f^6\,5d^2\,6d^2$ (3) [Xe]$4f^8\,5d^9\,6s^2$ (4) [Xe] $4f^7\,5d^1\,6s^2$

Sol. Answer (4)

Gd have exceptional configuration e^- will enter in 5d because 4f have 7 electrons and have half filled stability

$$\boxed{\text{Gd} = [\text{Xe}]^{54}\ 4f^7 5d^1 6s^2}$$

36. The ion that is isoelectronic with CO is

(1) CN^- (2) N_2^+ (3) O_2^- (4) N_2^-

Sol. Answer (1)

Isoelectronic means same number of electrons

CO = Number of electrons = 14

$CN^- = 6 + 7 + 1 = 14$

37. The Bohr orbit radius for the hydrogen atom (n = 1) is approximately 0.530 Å. The radius for the first excited state (n = 2) orbit is (in Å)

(1) 4.77 (2) 1.06 (3) 0.13 (4) 2.12

Sol. Answer (4)

$$\boxed{r_n = \frac{r_0 \times n^2}{z}}$$

n = Number of orbit, z = charge on nucleus

Ist excited state for H $= \frac{n=2}{z=1}$

$$= \frac{0.53 \times (2)^2}{1}$$

$$= 0.53 \times 4 = 2.12 \text{ Å}$$

38. The position of both, an electron and a helium atom is known within 1.0 nm. Further the momentum of the electron is known within 5.0×10^{-26} kg ms^{-1}. The minimum uncertainty in the measurement of the momentum of the helium atom is

(1) 8.0×10^{-26} kg ms^{-1}

(2) 80 kg ms^{-1}

(3) 50 kg ms^{-1}

(4) 5.0×10^{-26} kg ms^{-1}

Sol. Answer (4)

$$\boxed{\Delta x_{electron} \times \Delta P_{electron} = \frac{h}{4\pi}}$$

$$\Delta x_{electron} = \frac{h}{4\pi\ \Delta P_{electron}}$$

$$\Delta x_{electron} = \Delta x_{He} = 1.0 \text{ nm}$$

$$\Delta x_{He} \times \Delta P_{He} = \frac{h}{4\pi}$$

$$\Delta x_{He} = \frac{h}{4\pi \Delta P_{He}}$$

$$\therefore \frac{h}{4\pi \Delta P_{electron}} = \frac{h}{4\pi \Delta P_{He}}$$

$$\boxed{\Delta P_{He} = 5.0 \times 10^{-26} \text{ kg ms}^{-1}}$$

39. Which of the following configuration is correct for iron?

(1) $1s^22s^22p^63s^23p^64s^23d^7$ (2) $1s^22s^22p^63s^23p^64s^23d^5$

(3) $1s^22s^22p^63s^23p^63d^5$ (4) $1s^22s^22p^63s^23p^64s^23d^6$

Sol. Answer (4)

Fe = 26 = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^6$

40. Which of the following has maximum number of unpaired *d*-electrons?

(1) N^{3+} (2) Fe^{2+} (3) Zn^+ (4) Cu^+

Sol. Answer (2)

N^{3+} = 4 = $1s^2, 2s^2$ Zero unpaired

Fe^{2+} = 24 = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^6$ $\boxed{\uparrow\downarrow}\underbrace{\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}}$ Four unpaired

$Zn^{\oplus}$ = 29 = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1, 3d^{10}$ One unpaired

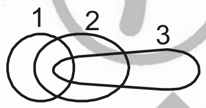
$Cu^{\oplus}$ = 28 = $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^0, 3d^{10}$ Zero unpaired

41. Who modified Bohr's theory by introducing elliptical orbits for electron path?

(1) Rutherford (2) Thomson (3) Hund (4) Sommerfield

Sol. Answer (4)

$$\boxed{\frac{n}{k} = \frac{\text{length of major axis}}{\text{length of minor axis}}}$$



Number of elliptrical orbit in shell = (n – 1)

42. The de Broglie wavelength of a particle with mass 1 g and velocity 100 m/s is

(1) 6.63×10^{-35} m (2) 6.63×10^{-34} m (3) 6.63×10^{-33} m (4) 6.65×10^{-35} m

Sol. Answer (3)

$\lambda = \frac{h}{mv}$ m = 1 g = 0.001 kg v = 100 m/s

$$\lambda = \frac{6.6 \times 10^{-34} \text{kg m}^2\text{s}^{-2}}{0.001\,\text{kg} \times 100 \text{ m/s}}$$

$$\boxed{\lambda = 6.63 \times 10^{-33} \text{ m}}$$

43. The following quantum numbers are possible for how many orbitals : $n = 3$, $l = 2$, $m = +2$?

(1) 1 (2) 2 (3) 3 (4) 4

Sol. Answer (1)

As the value of m = + 2

i.e. one value

Therefore one orbital is represented.

44. The frequency of radiation emitted when the electron falls from n = 4 to n = 1 in a hydrogen atom will be (Given ionization energy of H = 2.18×10^{-18} J atom^{-1} and h = 6.625×10^{-34} Js)

(1) 1.54×10^{15} s^{-1} (2) 1.03×10^{15} s^{-1}

(3) 3.08×10^{15} s^{-1} (4) 2.00×10^{15} s^{-1}

Sol. Answer (3)

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

$$\nu = 3.0 \times 10^{10} \times 109678\left[\frac{1}{1^2} - \frac{1}{4^2}\right] \times (1)^2$$

$$\nu = 3 \times \frac{10}{10^{10}} \times 109678 \text{ cm}^{-1}\left[\frac{15}{16}\right] = 3.09 \times 10^{15} \text{ s}^{-1}$$

Alternatively

$I \cdot E = E_\infty - E_1$

$2.18 \times 10^{-18} = E_\infty - E_1$

$\boxed{E_1 = -2.18 \times 10^{-18} \text{ J}}$

$$E_4 = -\frac{2.18 \times 10^{-18}}{(4)^2} = -\frac{2.18 \times 10^{-18}}{16} = -0.136 \times 10^{-18} \text{ J}$$

$\Delta E = E_4 - E_1 \left[-0.136 - (-2.18)\right] \times 10^{-18}$

$= 2.04 \times 10^{-18} \qquad \lambda = \dfrac{hc}{\Delta E}$ .... (1)

$\nu = \dfrac{c}{\lambda}$ .... (2)

Put (1) in (2)

$$\nu = \frac{c}{hc} \times \Delta E = \frac{\Delta E}{h}$$

$$\nu = \frac{2.04 \times 10^{-18}}{6.6 \times 10^{-34}} = 0.309 \times 10^{+16} = 3.09 \times 10^{15} \text{ s}^{-1}$$

45. Which one of the following ions has electronic configuration [Ar]$3d^6$?

(1) Co^{3+} (2) Ni^{3+}

(3) Mn^{3+} (4) Fe^{3+}

(At. nos. Mn = 25, Fe = 26, Co = 27, Ni = 28)

Sol. Answer (1)

Electronic configuration [Ar] $3d^6$ represents 24 electrons

i.e. $\boxed{Co^{3+} = 24\ e^-}$

$Ni^{3+} = 28 - 3 = 25\ e^-$

$Mn^{3+} = 25 - 3 = 22\ e^-$

$Fe^{3+} = 26 - 3 = 23\ e^-$

46. Which of the following is not among shortcomings of Bohr's model?

(1) Bohr theory could not account for the fine lines in the atomic spectrum

(2) Bohr theory was unable to account for the splitting of the spectral lines in the presence of magnetic field

(3) Bohr theory failed for He atom

(4) It did not give information about energy level

Sol. Answer (4)

Bohr's model explain the energy level i.e. Energy of electron in each orbital is quantized.

$$\boxed{E_n = \frac{-1312}{x^2} z^2 \text{ kJ/mol}}$$

47. Number of spectral lines falling in Balmer series when electrons are de-excited from n^{th} shell will be given as

(1) $(n - 2)$ in UV (2) $(n - 2)$ in visible region

(3) $(n - 3)$ in near IR (4) $(n - 3)$ in far IR

Sol. Answer (2)

48. The ratio of the energy required to remove an electron from the first three Bohr's orbits of hydrogen is

(1) 3 : 2 : 1 (2) 9 : 4 : 1 (3) 36 : 9 : 4 (4) 1 : 4 : 9

Sol. Answer (3)

$$E_n = \frac{-1312}{x^2} = \frac{x}{x^2}$$

$$E_1 = +\frac{x}{1^2} \qquad E_2 = \frac{x}{2^2} \qquad E_3 = \frac{x}{3^2}$$

$$\frac{1}{1} : \frac{1}{4} : \frac{1}{9} = \frac{36:9:4}{36} = \boxed{36:9:4}$$

SECTION - D

Assertion - Reason Type Questions

1. A : Orbital angular momentum of (1*s*, 2*s*, 3*s* etc.) all *s* electrons is same.

R : Orbital angular momentum depends on orientation of orbitals.

Sol. Answer (3)

2. A : Energy of electron is taken negative.

R : Energy of electron at infinity is zero.

Sol. Answer (1)

3. A : Bohr's orbits are also called stationary states.

R : Electrons are stationary in an orbit.

Sol. Answer (3)

4. A : K.E. of two subatomic particles, having same de-Broglie's wavelength is same.

R : de-Broglie's wavelength is directly related to mass of subatomic particles.

Sol. Answer (4)

5. A : Electronic energy for hydrogen atom of different orbitals follow the sequence : $1s < 2s = 2p < 3s = 3p = 3d$.

R : Electronic energy for hydrogen atom depends only on n and is independent of 'l' & 'm' values.

Sol. Answer (1)

6. A : Wavelength for first line of any series in hydrogen spectrum is biggest among all other lines of the same series.

R : Wavelength of spectral line for an electronic transition is inversely related to difference in the energy levels involved in the transition.

Sol. Answer (1)

7. A : Zn(II) salts are diamagnetic.

R : Zn^{2+} ion has one unpaired electron.

Sol. Answer (3)

8. A : In third energy level there is no f-subshell.

R : For n = 3, the possible values of l are 0, 1, 2 and for f-subshell l = 3.

Sol. Answer (1)

9. A : The charge to mass ratio of the particles in anode rays depends on nature of gas taken in the discharge tube.

R : The particles of anode rays carry positive charge.

Sol. Answer (2)

10. A : Angular momentum of an electron in an atom is quantized.

R : In an atom only those orbits are permitted in which angular momentum of the electron is a natural number multiple of $\frac{h}{2\pi}$.

Sol. Answer (1)

11. A : The radius of second orbit of He^+ is equal to that of first orbit of hydrogen.

R : The radius of an orbit in hydrogen like species is directly proportional to n and inversely proportional to Z.

Sol. Answer (4)

12. A : The orbitals having equal energy are known as degenerate orbitals.

R : The three 2*p* orbitals are degenerate in the presence of external magnetic field.

Sol. Answer (3)

13. A : In a multielectron atom, the electrons in different sub-shells have different energies.

R : Energy of an orbital depends upon $n + l$ value.

Sol. Answer (1)

14. A : Isotopes of an element have almost similar chemical properties.

R : Isotopes have same electronic configuration.

Sol. Answer (1)

15. A : The number of angular nodes in $3d_{z^2}$ is zero.

R : Number of angular nodes of atomic orbitals is equal to value of l.

Sol. Answer (2)

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