## Solutions

**S1.** Ans. (d)

$E_n = -R_H\left(\frac{Z^2}{n^2}\right) J$

For $He^+$ (n = 1),

$E_n = -x = -R_H\left(\frac{2^2}{1^2}\right) = -4R_H$

$\therefore R_H = \frac{x}{4}$

For $Be^{3+}$ (n = 2)

$E_n = -R_H\left(\frac{Z^2}{n^2}\right) J$

$= -\frac{x}{4} \times \left(\frac{4\times4}{2\times2}\right) = -xJ$

**S2.** Ans. (a)

- Magnetic quantum number $m_l$ informs about orientation of orbital.
- Spin quantum number $m_s$ informs about orientation of spin of electron.
- Azimuthal quantum number ($l$) informs about shape of orbital.
- Principal quantum number ($n$) informs about size of orbital.

**S3.** Ans.(b)

$n = 5$, $l = 2$, $m_l = -2, -1, +1, +2$, $m_s = +1/2$

**S4.** Ans.(a)

Statement I is true and Statement II is false.

**S5.** Ans.(c)

It is statement based question.

Statements B, C and E are correct.

(B) Mass of the electron is $9.10939 \times 10^{-31}$ kg

(C) All the isotopes of given elements show same chemical properties.

(E) Dalton's atomic theory, regarded the atom as an ultimate particle of matter.

**S6.** Ans.(d)

Sol. Number of permissible values of magnetic quantum number for a given value of azimuthal quantum ($l$)

$\Rightarrow n_m = 2l + 1$

$\Rightarrow l = \frac{n_m - 1}{2}$

**S7.** Ans.(a)

| n | l | Subshell notation |
|---|---|---|
| 2 | 0 | 2s |
| 2 | 1 | 2p |
| 3 | 0 | 3s |
| 3 | 1 | 3p |
| 3 | 2 | 3d |

**S8.** Ans.(a)

Energy of one photon = $\frac{hc}{\lambda}$ ($\lambda$ = 300 nm)

For one mole photons, $E = \frac{hc}{\lambda} \times N_A$

$E = \frac{6.626\times10^{-34}\times3\times10^{8}\times6.023\times10^{23}}{300\times10^{-9}}$

$E = 3.99 \times 10^5$ J mol$^{-1}$

Kinetic energy = $1.68 \times 10^5$ J mol$^{-1}$

$W_0$ = E – K.E.

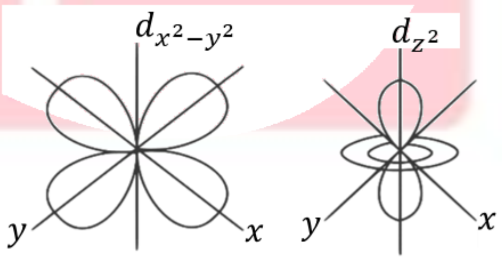
$= 3.99 \times 10^5 - 1.68 \times 10^5$

$= 2.31 \times 10^5$ J mol$^{-1}$

**S9.** Ans.(d)

In an atom, all the five 3d orbitals are equal in energy in free state i.e., degenerate.

The shape of $d_{x^2-y^2}$ is different then shape of $d_{z^2}$.




The size of orbital depends on principal quantum number 'n' therefore all the five 3d orbitals are different in size when compared to the respective 4d orbitals.

Shape of orbitals depends on azimuthal quantum number 'l' therefore shapes of 4d orbitals are similar to the respective 3d orbitals.

**S10.** Ans.(a)

$r_n \propto n^2/Z$

$$\frac{r_3(Li^{2+})}{r_2(He^+)} = \frac{(n_3)^2}{Z(Li^{2+})} \times \frac{Z(He^+)}{(n_2)^2}$$

$$\frac{r_3(Li^{2+})}{105.8} = \frac{(3)^2}{3} \times \frac{2}{(2)^2}$$

$= 105.8 \times 3/2$

$r_3(Li^{2+}) = 158.7$ pm

**S11.** Ans.(d)

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

$\lambda = \frac{3\times10^8}{1368\times10^3} = 219.298\, m \;\; = 219.3\, m$

**S12.** Ans.(d)

$^{17}_{71}Lu$

Z = atomic number

Z = No. of Protons = 71 = No. of Electrons

No. of Neutrons = Mass no. – No. of Protons

= 175 – 71

=104

**S13.** Ans.(d)

Number of radial nodes = n – $l$ – 1

Number of angular nodes = $l$

For 3s orbital,

$l$ = 0

– Number of radial nodes = 3 – 0 – 1 = 2

– Number of angular nodes = 0

**S14.** Ans.(a)

n $l$

$(n + 1)$ value for, 4d = 4 + 2 = 6

5p = 5 + 1 = 6

5f = 5 + 3 = 8

6p = 6 + 1 = 7

Lower value of (n + $l$) signifies lower energy

In case of 4d and 5p, lower value of n in 4d has compare to 5p.

So, 4d has less energy in comparison to 5p.

∴ Correct order of energy will be 5f > 6p > 5p > 4d

**S15.** Ans.(b)

In visible region Balmer series transitions fall in H-spectrum.

**S16.** Ans.(c)

Element (X) electronic configuration

$1s^2\ 2s^2\ 2p^3$

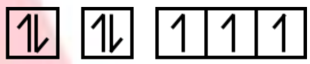
So, valency of X will be 3.

Valency of Mg is 2.

Formula of compound formed by Mg and X will be $Mg_3X_2$.

**S17.** Ans.(d)

According to Hund's Rule of maximum multiplicity, the correct electronic configuration of N-atom is



$1s^2$ $2s^2$ $2p^3$

Or

$1s^2$ $2s^2$ $2p^3$

∵ Option (d) violates Hund's Rule.

**S18.** Ans.(a)

The energy of 2s orbital is less than the energy of 2p orbital in case of hydrogen like atoms is a wrong statement because

1s > 2s = 2p > 3s = 3p = 3d ….. etc.

**S19.** Ans.(d)

The total number of orbital present in n = 4 is $n^2$.

= $(4)^2$ = 16

| Shell | No. of orbital |
|---|---|
| s | 1 |
| p | 3 |
| d | 5 |
| f | 7 |

**S20.** Ans.(a)

Among d-orbitals $d_{z^2}$ and $d_{x^2-y^2}$ have their electron densities oriented towards axes.

**S21.** Ans.(c)

When n = 3 and $l$ = 1 orbital is 3p, so total number of electron that can be filled are 6 but in any orbital only 2 electron can accumulate.

**S22.** Ans.(a)

2 electron occupying the same orbital can be distinguished using their spin quantum number ($m_s$) where one is clockwise (↑) and other is anti-clockwise (↓). In such case, the value of spin quantum number changes rest all quantum number remains the same.

**S23.** Ans.(a)

According to Aufbau's rule of increasing order of energy for filling up of electron.

3s < 3p < 4s < 3d

**S24.** Ans.(c)

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

For d orbital $l$ = 2

So, angular momentum= $\sqrt{2(2+1)}\frac{h}{2\pi}$

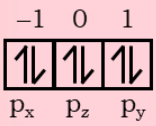
$= \sqrt{6}\frac{h}{2\pi}$

$\frac{h}{2\pi} = \hbar$ → called as Planck's reducing constant or Dirac constant.

**S25.** Ans.(d)

n =3   $l$ = 1   $m_l$ = 0

$l$ = p   3p = 1   orbital as $m_l$ = 0 sp $3p_z$.




Thus, maximum no. of orbitals identified in $3p_z$ is 1.

**S26.** Ans.(c)

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

$E = \frac{6.63\times10^{-34}\times3\times10^{8}}{45\times10^{-9}} = 4.42\times10^{-18}J$

**S27.** Ans.(d)

n = 3   $l$ = 1   $m_l$ = −1

for p orbital $l$ = 1

So orbital must be $3p_x$ or $3p_y$, where number of electron in each orbital will be 2.

**S28.** Ans.(c)

According to formula :

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

Where, $\frac{c}{\lambda} = v \Rightarrow \lambda = \frac{3\times10^{8}}{6\times10^{15}} = 50\ nm$

**S29.** Ans.(d)

The orbitals which are closer to nucleus are more strongly affected by the positive charged field of protons in nucleus. Whereas when we move away from nucleus and n (principal quantum number) increases, the effective influence of positive charged field decreases & electron in later (n) orbitals become loosely bounded.