24-08-23

Unit 2 Atomic Structure

SHORT QUESTIONS

(i) Determination of mass of electron:

We know that,

$$\frac{e}{m} = 1.7588 \times 10^{11} \text{ Coulomb kg}^{-1} \quad (i)$$

$$e = 1.6 \times 10^{-19} \text{ C}$$

Put value of e in eq (i).

$$\frac{1.6 \times 10^{-19}}{m} = \frac{1.7588 \times 10^{11}}{1}$$

$$1.6 \times 10^{-19} \text{ C} = m \times 1.7588 \times 10^{11} \text{ C kg}^{-1}$$

$$m = \frac{1.6 \times 10^{-19} \text{ C}}{1.7588 \times 10^{11} \text{ C kg}^{-1}}$$

$$m = 9.097 \times 10^{-31} \text{ kg}$$

Determination of charge of electron:

We know that,

$$\frac{e}{m} = 1.7588 \times 10^{11} \text{ C kg}^{-1}$$

$$m = 9.1095 \times 10^{-31} \text{ kg}$$

$$\frac{e}{9.1095\times10^{-31}\,kg} \times \frac{1}{} = 1.7588\times10^{11}\,C\,kg^{-1}$$

$$e = 1.7588\times10^{11}\,C \times 9.1095\times10^{-31}$$

$$e = 1.60\times10^{-19}\,C.$$

(ii) MOSLEY'S LAW:

It states that:

"The frequency of the spectral line of X-rays spectrum varies as square of the atomic no of an element emitting it."

mathematically:

$$\sqrt{\nu} = a(Z-b)$$

a, b are proportionality. & Z is A.N.

This equation shows that more electrons are emitting per second, more wave no will be there henceforth, more energy leds to more x-rays.

Production of x-rays:

The electron (cathode rays) move to the atom to inner shell, the electrons in its way is removed therefore its also loses energy. Thus the e⁻ present before that shell will jump to that shell & emitting energy (x-rays) stabiling the atom.

So if more e⁻ will be remove, more e⁻ will jump to that unstable shell, emitting more energy leds to X-rays.

U of X-rays

iii) **Azimuthal Quantum NO:**

Azimuthal quantum no divides the shell into smaller level called subshell.

It is denoted by 'L'.

The value of n determines the value of L by the formula:

$L = (n-1)$

K	1	(1-1)=0	s
L	2	(2-1)=1	p
M	3	(3-1)=2	d
N	4	(4-1)=3	f

iv)

Orbits	Orbitals
Definition	
It is a well-defined circular pathway followed by electrons awund the nucleus.	Oribitals are the region of space around the nucleus of an atom where e⁻ are most likely to be

	faind.
shape	
Oribits is in circular shape.	Orbitals are in diff shapes.
Explanation by Principle	
It is explained by principle Quantm numbe.	It is explained by Azimuthal Quantm numbe.
degenerate	
They can not be degenerate.	They can be degenerate. e.g: P_x, P_y, P_z.
Examples	
K, L, M, N, O.....	s, p, d, f, g.....

va) **energy & wavelength**

$E = h\nu$

$\therefore \frac{c}{\lambda} = \nu$

$E = h \times \frac{c}{\lambda}$

This shows inverse relation between energy & wavelength.

b) **freqency & wavelength**

$V = \lambda f$

$c = \lambda \nu$

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

which shows there is inverse relation between frequency & wavelength.

vi) Free neutron decay:-

$_0n^1 \longrightarrow {}_1p^1 + {}_{-1}e^0 + {}_0n^0$

Free neutron decays into proton ($_1p^1$), electron -ie $^0_{-1}e$ & neutrino ($_0n^0$).

↳ small, energy.

vii) **Answer** This is because size of cation is similar.

Reasons

The Hydrogen is an atom which has one electron in its shell. On other hand, the size of He atom is larger because it has two electron in its shell.

He > H

But here, it is talking about He^+. When He loses its electron, it form He^+ ion. Hence one electron is lost, one left so force of attraction between two protons & one electron is greater that shrinks the size of He^+.

$He^+ < H$.

Conclusion

The He is smaller than H.

viii) **Answer**

4s orbital has lower energy than 3d orbital because of n+L rule.

Explanation

According to n+L rule:

4s = n+L

n=4 ; l=s=0.

4s = 4+0

= 4

3d = n+L

n=3 ; l=d=2.

3d = 3+2

= 5.

Therefore a/o to this rule, 3d orbital has more energy as compared to 4s.

1s 2s 2p 3s
3p 4s 3d 4p
5s 4d 5p 6s
4f 6p 5d 7s
5f 7p 6d 8s

ix $_{25}Mn = 1s^2 2s^2 2p^6 3s^2 3p^{10} 4s^2 3d^5$

$_{30}Zn = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6 4p^4$

$_{13}Al = 1s^2 2s^2 2p^6 3s^2 3p^1$

x) **(n+l) rule**

The order of energy in the orbitals is governed by (n+l) rule.

where n = principle quantum number

where l = azimuthal quantum number.

Also to it, it states that,

An added electron will always enter the orbit having lower (n+l) rule.

2s = [2+0] = 2.

3d = [3+2] = 5.

Therefore 2s is filled first than 3d.

If n+l rule is same for two orbitals, then e^- is filled with lower value of n.

4p = [4+1] = 5

3d = [3+2] = 5.

Both have same energy but n is smaller of d.

So 3d is filled first than 4p.

xii) **Data**

$n = 3$

find

energy at n^{th} = ?

formula

$E = \frac{-1313.35}{n^2}$ kg/mole

solve

$E = \frac{-1313.35}{(3)^2}$ kg/mole

$E = -145.9$ kg/mole.

Result

The energy of electron at $n3$ is -145.9 kgmole^{-1}.

xiii) a) **Data**

$n_1 = 1$ & $n_2 = 2$.

find

radius change = ?

solve

$R_2 = n^2 \times 0.529A^\circ$

$= (1)^2 \times .529A^\circ$

$= 0.529A^\circ$

$R_2 = (2)^2 \times 0.529A^\circ = 2.116$

$R_2 - R_1 = 02.116 - 0.529A^\circ =$

$1.587A^\circ$.

b) **Data**

$n_1 = 8$ & $n_2 = 3$.

find

radius = ?

solve

$R_1 = (8)^2 \times 0.529A^\circ$

$= 33.856A^\circ$

$R_2 = (3)^2 \times 0.529A^\circ$

$= 4.761$

$R_1 - R_2 = 29.095A^\circ$

Result	Result
The change in radius is 1.587 A:	The change in radius is 29.095 A:

xi) 7-8-23

Bohr's Defects