Chapter 2. Structure of Atom

Question-1

Calculate the frequency and energy associated with photon of radiations having a wavelength of 6200 A^o. Plank's constant = 6.625×10^{-27} ergs sec.

Solution:

We know that $c = \upsilon\lambda$ or $\upsilon = \frac{c}{\lambda}$

The value of c for all electromagnetic radiation = 3.0×10^8 m sec^{-1}.

$\lambda = 6200\ A^o = 6200 \times 10^{-8}$ cm

$= 6200 \times 10^{-10}$ m

$= 62 \times 10^{-8}$ m

$\upsilon = \frac{3 \times 10^8}{62 \times 10^{-8}} = 4.839 \times 10^{14}$ cycles sec^{-1}.

The energy (E) associated with a radiation is given by

$E = h\upsilon$

$E = 6.625 \times 10^{-27} \times 4.839 \times 10^{14}$

$= 2.914 \times 10^{-12}$ ergs

$= \frac{2.914 \times 10^{-12}}{10^7}$ Joules

$= 2.914 \times 10^{-19}$ Joules.

Question-2

Calculate the wave number of lines having the frequency of 5×10^{16} cycles per sec.

Solution:

Given $c = 3 \times 10^8$ m/sec

$\upsilon = 5 \times 10^{16}$ cycles/sec

$\bar{\upsilon} = ?$

We know that

$\bar{\upsilon} = \frac{\upsilon}{c} = \frac{5 \times 10^{16}}{3 \times 10^8} = 1.666 \times 10^8\ m^{-1}$.

Question-3

In a hydrogen atom, an electron jumps from a third orbit to the first orbit. Find out the frequency and wavelength of the spectral line.

Solution:

(i) When an electron jumps from a higher orbit n_2 to the lower orbit n_1, the frequency uof the radiation is given by

$$\upsilon = 3.29 \times 10^5 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] \text{ cycles sec}^{-1}$$

Here, $n_1 = 1$ and $n_2 = 3$

$$\upsilon = 3.29 \times 10^5 \left[\frac{1}{(1)^2} - \frac{1}{(3)^2}\right] \text{ cycles sec}^{-1}$$

$$= 3.29 \times 10^5 \left[1 - \frac{1}{9}\right] \text{ cycles sec}^{-1}$$

$$= 3.29 \times 10^5 \times 0.889 \text{ cycles sec}^{-1}$$

$$= 2.925 \times 10^{15} \text{ cycles sec}^{-1}$$

Now wavelength $\lambda = \frac{c}{\upsilon}$

$$\lambda = \frac{3 \times 10^8}{2.925 \times 10^{15}} = 1.0256 \times 10^{-7} \text{ m}$$

$$= 1.0256 \times 10^{-7} \times 10^{10} \text{ A}^o = 1025.6 \text{ A}^o.$$

Thus the wavelength of light emitted falls in the UV region of the electromagnetic spectrum.

Question-4

$R_H = 1.09678 \times 10^7\ m^{-1}$, $c = 3 \times 10^8\ ms^{-1}$, $h = 6.625 \times 10^{-34}$ Js.

Solution:

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

For lowest frequency in Lyman series

$n_1 = 1, n_2 = 2$

For H, Z = 1

$$\frac{1}{\lambda} = 1.09678 \times 10^7 \times 1\left(1 - \frac{1}{4}\right) = \frac{1.09678 \times 3 \times 10^7}{4}$$

$$\lambda = \frac{4 \times 10^{-7}}{3 \times 1.09678} = 1215 \times 10^{-10}\ m \text{ or } \mathbf{1215\ A^o}.$$

Again, $c = \lambda$

$$\upsilon = \frac{c}{\lambda} = \frac{3 \times 10^8}{1215 \times 10^{-10}} = 0.002469 \times 10^{18}\ Hz = \mathbf{2.469 \times 10^{15}\ Hz}$$

Energy $E = h\upsilon$

$E = 6.625 \times 10^{-34} \times 2.469 \times 10^{15} = 10.22$ eV

For Li^{2+}, Z = 3

$Li^{2+} = (3)^2 \times 10.22 = 9 \times 10.22 =$ **91.98 eV.**

Question-5

Calculate the uncertainty in the position of a particle when the uncertainty in the momentum is (a) 1×10^{-2} (b) zero.

Solution:

(a) According to the uncertainty principle,

$\Delta x . \Delta p \approx \frac{h}{4\pi}$

Putting the values of

$h = 6.62 \times 10^{-34}$ Joules-sec

$\Delta p = 1 \times 10^{-7}$ Kg-m-sec^{-1}

$\Delta x \times 10^{-7} = \frac{6.62 \times 10^{-34}}{4 \times 3.142}$

$\Delta x = \frac{6.62 \times 10^{-34}}{4 \times 3.142 \times 10^{-7}}$ m

$= 0.527 \times 10^{-27}$ m

(b) We know that $\Delta x = \frac{h}{4\pi \times \Delta p}$

When $\Delta P = 0$, the denominator in the above expression becomes zero; hence the uncertainty in position becomes infinity.

Question-6

(iii) $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^{10}, 4s^1$.

Solution:

(a) electronic configuration of elements with atomic number

19 $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1$

28 $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^8, 4s^2$

29 $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^{10}, 4s^1$

(b) (i) Atomic number of the element is 2+2+6+2+6+1=19

Therefore, the element is **potassium**.

(ii) Atomic number of the element is 2+2+6+2+6+5+1=24

Therefore, the element is **chromium**.

(iii) Atomic number of the element is 2+2+6+2+6+10+1=29

Therefore, the element is **copper**.

Question-7

An electron is in a 4f orbital. What possible values for the quantum numbers n, l, m and s can it have?

Solution:

For an electron in a 4f orbital,

n = 4, l = 3, m = -3, -2, -1, 0, +1, +2, +3, s = $+\frac{1}{2}$ and $-\frac{1}{2}$ for each value of m.

Question-8

A neutral atom has 2K, 8L, 5M electrons. Find out the following from the data:

(a) atomic number,

(b) total number of s electrons,

(c) total number of p electrons,

(d) number of protons in the nucleus, and

(e) valency of element.

Solution:

(a) Atomic number = No. of protons = No. of electrons

Total no. of electrons = 2 + 8 + 5 = 15

Hence atomic number = **15**

(b) Total number of s electrons. To find out it, we are to write electronic configuration of At. No. = 15

$1s^2, 2s^2, 2p^6, 3s^2, 3p^3$

∴Total electrons = **6**

(c) Total number of p electrons = **9**

(d) Number of protons in the nucleus = Number of electrons in extra-nuclear part

∴ Number of protons = 15

(e) Valency of element. The arrangement of electrons in orbits is 2, 8, 5. As the atom tends to gain three electrons, therefore it is **trivalent electronegative (-3)**.

Question-9

$_{15}P^{31}$, $_{1}H^{1}$, $_{18}Ar^{40}$, $_{14}Si^{30}$, $_{16}S^{32}$, $_{19}K^{40}$, $_{20}Ca^{40}$, $_{1}H^{2}$, $_{1}H^{3}$.

Solution:

(a) $_{1}H^{1}$, $_{1}H^{2}$, $_{1}H^{3}$ - isotopes (same number of atomic number)

(b) $_{18}Ar^{40}$, $_{19}K^{40}$, $_{20}Ca^{40}$ - isobars (same number of mass number)

(c) $_{15}P^{31}$, $_{14}Si^{30}$, $_{16}S^{32}$ - isotones (same number of neutrons)

Question-10

Which are isosters?

Solution:

Molecules having same numbers of atoms and also same number of electrons are called isosters.

Example: N_2 and CO

N_2 = 14 electrons

CO = 6 + 8 = 14 electrons.

Structure Of Atom

Short Answer Type Questions

1. Arrange s, p and d sub-shells of a shell in the increasing order of effective nuclear charge (Z_{eff}) experienced by the electron present in them.
2. Show the distribution of electrons in oxygen atom (atomic number 8) using orbital diagram.
3. Nickel atom can lose two electrons to form Ni^{2+} ion. The atomic number of nickel is 28. From which orbital will nickel lose two electrons.
4. Which of the following orbitals are degenerate?
   $3d_{xy}$, $4d_{xy}$, $3d_{z^2}$, $3d_{yz}$, $4d_{yz}$, $4d_{z^2}$
5. Calculate the total number of angular nodes and radial nodes present in 3p orbital.
6. The arrangement of orbitals on the basis of energy is based upon their (n+l) value. Lower the value of (n+l), lower is the energy. For orbitals having same values of (n+l), the orbital with lower value of n will have lower energy.
   I. Based upon the above information, arrange the following orbitals in the increasing order of energy.
   (a) 1s, 2s, 3s, 2p
   (b) 4s, 3s, 3p, 4d
   (c) 5p, 4d, 5d, 4f, 6s
   (d) 5f, 6d, 7s, 7p
   II. Based upon the above information, solve the questions given below :
   (a) Which of the following orbitals has the lowest energy?
   4d, 4f, 5s, 5p
   (b) Which of the following orbitals has the highest energy?
   5p, 5d, 5f, 6s, 6p
7. Which of the following will not show deflection from the path on passing through an electric field?
   Proton, cathode rays, electron, neutron.
8. An atom having atomic mass number 13 has 7 neutrons. What is the atomic number of the atom?

9. Wavelengths of different radiations are given below :
   λ(A) = 300 nm λ(B) = 300 μm λ (C) = 3 nm λ = 0 (D) 30 A°
   Arrange these radiations in the increasing order of their energies.
10. The electronic configuration of valence shell of Cu is $3d^{10}4s^1$ and not $3d^94s^2$. How is this configuration explained?
11. The Balmer series in the hydrogen spectrum corresponds to the transition from $n_1 = 2$ to $n_2 = 3,4,.....$ This series lies in the visible region. Calculate the wave number of line associated with the transition in Balmer series when the electron moves to n = 4 orbit. ($R_H = 109677\ cm^{-1}$)
12. According to de Broglie, matter should exhibit dual behaviour, that is both particle and wave like properties. However, a cricket ball of mass 100 g does not move like a wave when it is thrown by a bowler at a speed of 100 km/h. Calculate the wavelength of the ball and explain why it does not show wave nature.
13. What is the experimental evidence in support of the idea that electronic energies in an atom are quantized?
14. Out of electron and proton which one will have, a higher velocity to produce matter waves of the same wavelength? Explain it.
15. A hypothetical electromagnetic wave is shown in Fig. 2.2. Find out the wavelength of the radiation.

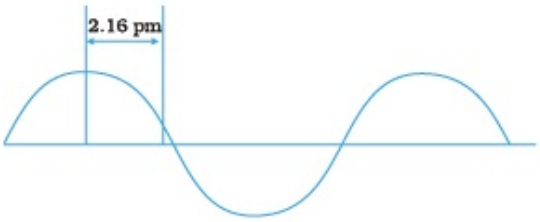


Fig. 2.2

16. Chlorophyll present in green leaves of plants absorbs light at 4.620×10^{14} Hz. Calculate the wavelength of radiation in nanometer. Which part of the electromagnetic spectrum does it belong to?
17. What is the difference between the terms orbit and orbital?

18. Table-tennis ball has a mass 10 g and a speed of 90 m/s. If speed can be measured within an accuracy of 4% what will be the uncertainty in speed and position?
19. The effect of uncertainty principle is significant only for motion of microscopic particles and is negligible for the macroscopic particles. Justify the statement with the help of a suitable example.
20. Hydrogen atom has only one electron, so mutual repulsion between electrons is absent. However, in multielectron atoms mutual repulsion between the electrons is significant. How does this affect the energy of an electron in the orbitals of the same principal quantum number in multielectron atoms?

Matching Type Questions

In some of the following questions, one option of left column may be correlated to more than one option in the right column.

1. Match the following species with their corresponding ground state electronic configuration.

	Atom / Ion		**Electronic configuration**
(i)	Cu	(a)	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}$
(ii)	Cu^{2+}	(b)	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2$
(iii)	Zn^{2+}	(c)	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}4s^1$
(iv)	Cr^{3+}	(d)	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^9$
		(e)	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3$

2. Match the quantum numbers with the information provided by these.

	Quantum number		**Information provided**
(i)	Principal quantum number	(a)	orientation of the orbital
(ii)	Azimuthal quantum number	(b)	energy and size of orbital
(iii)	Magnetic quantum number	(c)	spin of electron
(iv)	Spin quantum number	(d)	shape of the orbital

3. Match the following rules with their statements :

Rules	Statements
(i) Hund's Rule	(a) No two electrons in an atom can have the same set of four quantum numbers.
(ii) Aufbau Principle	(b) Half-filled and completely filled orbitals have extra stablity.
(iii) Pauli Exclusion Principle	(c) Pairing of electrons in the orbitals belonging to the same subshell does not take place until each orbital is singly occupied.
(iv) Heisenberg's Uncertainty Principle	(d) It is impossible to determine the exact position and exact momentum of a subatomic particle simultaneously.
	(e) In the ground state of atoms, orbitals are filled in the order of their increasing energies.

4. Match the following

(i) X-rays	(a) $\nu = 10^{0} - 10^{4} Hz$
(ii) UV	(b) $\nu = 10^{10} Hz$
(iii) Long radio waves	(c) $\nu = 10^{16} Hz$
(iv) Microwave	(d) $\nu = 10^{18} Hz$

5. Match the following

(i) Photon	(a) Value is 4 for N shell
(ii) Electron	(b) Probability density
(iii) ψ^2	(c) Always positive value
(iv) Principal quantum number n	(d) Exhibits both momentum and

wavelength

6. Match species given in Column I with the electronic configuration given in Column II.

Column I		Column II	
(i)	Cr	(a)	$[Ar]3d^8 4s^0$
(ii)	Fe^{2+}	(b)	$[Ar]3d^{10} 4s^1$
(iii)	Ni^{2+}	(c)	$[Ar]3d^6 4s^0$
(iv)	Cu	(d)	$[Ar]\ 3d^5 4s^1$
		(e)	$[Ar]3d^6 4s^2$

Assertion and Reason Type Questions

In the following questions a statement of Assertion (A) followed by a statement of Reason (R) is given. Choose the correct option out of the choices given below each question.

1. Assertion (A) : All isotopes of a given element show the same type of chemical behaviour.
   Reason (R) : The chemical properties of an atom are controlled by the number of electrons in the atom.
   - (i) Both A and R are true and R is the correct explanation of A.
   - (ii) Both A and R are true but R is not the correct explanation of A.
   - (iii) A is true but R is false.
   - (iv) Both A and R are false.

2. Assertion (A) : Black body is an ideal body that emits and absorbs radiations of all frequencies.
   Reason (R) : The frequency of radiation emitted by a body goes from a lower frequency to higher frequency with an increase in temperature.
   - (i) Both A and R are true and R is the correct explanation of A.
   - (ii) Both A and R are true but R is not the explanation of A.
   - (iii) A is true and R is false.
   - (iv) Both A and R are false.

3. Assertion (A) : It is impossible to determine the exact position and exact momentum of an electron simultaneously.
   Reason (R) : The path of an electron in an atom is clearly defined.
   - (i) Both A and R are true and R is the correct explanation of A.
   - (ii) Both A and R are true and R is not the correct explanation of A.
   - (iii) A is true and R is false.
   - (iv) Both A and R are false.

Long Answer Type Questions

1. What is photoelectric effect? State the result of photoelectric effect experiment that could not be explained on the basis of laws of classical physics. Explain this effect on the basis of quantum theory of electromagnetic radiations.
2. Threshold frequency, v_0 is the minimum frequency which a photon must possess to eject an electron from a metal. It is different for different metals. When a photon of frequency $1.0 \times 10^{15} s^{-1}$ was allowed to hit a metal surface, an electron having 1.988×10^{19} J of kinetic energy was emitted. Calculate the threshold frequency of this metal. Show that an electron will not be emitted if a photon with a wavelength equal to 600 nm hits the metal surface.
3. When an electric discharge is passed through hydrogen gas, the hydrogen molecules dissociate to produce excited hydrogen atoms. These excited atoms emit electromagnetic radiation of discrete frequencies which can be given by the general formula

   $$\bar{\nu} = 109677 \left[\frac{1}{n_i^2} - \frac{1}{n_f^2} \right]$$

   What points of Bohr's model of an atom can be used to arrive at this formula? Based on these points derive the above formula giving description of each step and each term.
4. Calculate the energy and frequency of the radiation emitted when an electron jumps from n = 3 to n = 2 in a hydrogen atom.
5. Why was a change in the Bohr Model of atom required? Due to which important development (s), concept of movement of an electron in an orbit was replaced by, the concept of probability of finding electron in an orbital? What is the name given to the changed model of atom?

CBSE Class 11 Chemistry

Important Questions

Chapter 2

Structure of Atom

1 Marks Questions

1.Name the sub – atomic particles of an atom.

Ans: Electron, proton and neutron.

2.Name the scientist who first formulated the atomic structure.

Ans: John Dalton, a British teacher in 1808 first proposed a firm scientific basis known as Dalton's

atomic theory.

3.What is the e/m ratio of an electron?

Ans: According to Thomson's experiment, e/m ratio for an electron is $1.76 \times 10^{8} cg^{-1}$

4.What is the charge (e) of an electron?

Ans: From Millikan's experiment, the charge of an electron (e) is $-1.602 \times 10^{-19} C.$

5.(i) What is the mass of a proton?

(ii) What is the charge of a proton?

Ans:(i) The mass of a proton is $1.676 \times 10^{-27} kg$ or 1.676×10^{-24}

(ii) The charge of a proton is $+1.602 \times 10^{-19} C$

6.(i) What is the mass of a neutron?

(ii) What is the charge of a neutron?

Ans: (i) The mass of a neutron is $1.676 \times 10^{-24} g$

(ii) Neutron is electrically neutral i.e. it has no charge as an electron or a proton has.

7.Name the scientist who first gave the atomic model.

Ans: J.J. Thomson, in 1898 first proposed the atomic model called raising-pudding model.

8.What is an isotope?

Ans: Atoms of the same elements having same atomic number but different mass number are called isotopes.

$eg: {}_1^1H, {}_1^2H \ and \ {}_1^3H$

${}_{17}^{35}Cl, {}_{17}^{37}Cl \ / \ {}_{6}^{12}C, {}_{6}^{13}C, {}_{6}^{14}C$

9.What are isobars?

Ans: Atoms of different elements which have same mass number but different atomic nos.

eg: ${}_{6}^{14}C, {}_{7}^{14}N$

${}_{18}^{40}Ar, {}_{19}^{40}K, {}_{20}^{40}Ca$

10.What are isotones?

Ans: Atoms of different elements which contains the same number of neutron.

eg. ${}^{14}_{6}C$, ${}^{15}_{7}N$, ${}^{16}_{8}O$

11.What is an atomic number?

Ans: Atoms of different elements which contains the same number of neutron.

eg. ${}^{14}_{6}C$, ${}^{15}_{7}N$, ${}^{16}_{8}O$

12.What is a mass number?

Ans: Maas number of an element is the sum of number of proton and neutron present in the nucleus of an atom.

13.Give the drawbacks of J.J. Thomson's experiment.

Ans: (i) It could not explain the origin of the spectral lines of hydrogen and other atoms,

(ii) It failed to explain scattering of $\alpha - particles$ in Rutherford's scattering experiment.

14.Why Rutherford's model could not explain the stability of an atom?

Ans: According to the electromagnetic theory of Maxwell, charged particles when accelerated should emit electromagnetic radiation. Therefore, an electron in an orbit will emit radiation; the orbit will then continue to shrink which does not happen in an atom.

15.Define photoelectric effect.

Ans: It is the phenomenon in which the surface of alkali metals like potassium and calcium emit electrons when a beam of light with high frequency is made to fall on them.

16.How does the intensity of light effect photoelectrons?

Ans: The number of electron ejected and kinetic energy associated with them depend on the

brightness of light.

17.What is threshold frequency?

Ans: The minimum frequency below which photo electric effect is not observed is called threshold frequency (v_o)

18.Name the scientist who demonstrated photoelectric effect experiment.

Ans: In 1887, H. Hertz demonstrated photo electric effect.

19.What did Einstein explain about photoelectric effect?

Ans: Einstein in 1905 was able to explain the photoelectric effect using Planck's quantum theory of electromagnetic radiation.

20.Calculate energy of 2mole of photons of radiation whose frequency is $5\times10^{14}Hz.$

Ans: Energy (E) of one photon = E = hv

Where $h=6.626\times10^{-34}Js$

$v=5\times10^{14}s^{-1}$

$\therefore E=\left(6.626\times10^{-34}\times5\times10^{14}\right)$

$=3.313\times10^{-19}J$

Energy of 2 mole of photon $=\left(3.313\times10^{-19}J\right)\times\left(2\times6.022\times10^{23}mol^{-1}\right)$

$=3990.2kJmol^{-1}$

21.States Heisenberg's Uncertainty Principle.

Ans: It states that It is impossible to determine simultaneously the exact position and exact momentum (or velocity) of an electron.

22..How would the velocity be effected if the position is known?

Ans: If the position of the electron is known with high degree of accuracy (Δx is small), then the velocity of the electron will be uncertain $\left(\Delta(V_x) \text{is large.}\right)$.

23.We don't see a car moving as a wave on the road why?

Ans: According to de Broglie's relation, $\lambda = {}^{h}/_{mv}$ *i.e.* $\lambda \alpha \frac{1}{m}$ the mass of the car is very large and its wavelength (λ) or wave character is negligible. Therefore, we do not see a car moving like a wave.

24.Give the de – Broglie's relation.

Ans: According to de Broglie, every particle in motion is associated with a wavelength and other wave characteristics. He deduced the relation that wavelength (λ) of a particle in motion is equal to the Planck's constant (h) divided by the momentum (p) of the particle.

i.e. $\lambda = \frac{h}{p} = \frac{1}{mv}$

Where m is the mass, v is the velocity after particles

25.Calculate the uncertainty in the velocity of a wagon of mass 4000kg whose position is known accurately of $\pm 10m$

Ans: Uncertainty in velocity (Δv) is given by

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

$$= \frac{6.6\times10^{-34}\, kgm^2 s^{-1}}{4\times\frac{22}{7}\times4\times10^{3}\, kg\times(\pm10m)}$$

$= 1.3 \times 10^{-39} ms^{-1}$

∴ The uncertainty in the velocity of the wagon is $= 1.3 \times 10^{-39} ms^{-1}$

26.What is the physical significance of ψ^2 up?

Ans: ψ^2 represent probability of finding an electron.

27.Which orbital is non – directional?

Ans:S – orbital is spherically symmetrical i. e it is non – directional.

28.What is the meaning of quantization of energy?

Ans: Quantization of energy means the energy of energy levels can have some specific values and not all the values.

29.Why is energy of 1s electron lower than 2s electron?

Ans.1s electron being close to the nucleus experiences more force of attraction than 2s–electron which is away from the nucleus.

30.What is nodal surface or nodes?

Ans: The region where the probability of finding an electron is zero i. e. $Y^2 = 0$

31.How many spherical nodal surfaces are there in 4s – sub-shell?

Ans: In ns orbital, the number of spherical nodal surfaces are(n – 1), hence is 4s (4 – 1) = 3 nodal surfaces are present.

CBSE Class 12 Chemistry

Important Questions

Chapter 2

Structure of Atom

2 Marks Questions

1.What is the mass (m) of an electron?

Ans: mass of an electron (m) = $\frac{e}{\left(e/m\right)}$

$$= \frac{1.602 \times 10^{-19} C}{1.76 \times 10^{8} C g^{-1}}$$

$$= 9.10 \times 10^{-28} g$$

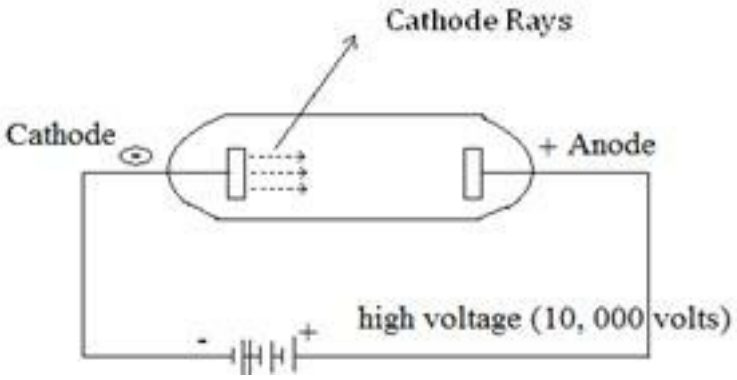
$$= 9.1 \times 10^{-31} kg$$

So, the mass of an electron is $= 9.1 \times 10^{-31} kg$ or $1/1837$ th of the mass of a hydrogen atom.

2.Which experiment led to the discovery of electrons and how?

Ans: The cathode ray discharge tube experiment performed by J.J. Thomson led to the discovery of negatively charged particles called electron.

A cathode ray tube consists of two thin pieces of metals called electrodes sealed inside a glass tube with sealed ends. The glass tube is attached to a vacuum pump and the pressure inside the tube is reduced to 0.01mm. When fairly high voltage (10, 000V) is applied across the electrodes, invisible rays are emitted from the cathode called cathode rays. Analysis of this rays led to the discovery electrons.



3.Give the main properties of canal ray experiment.

Ans: The canal ray experiment led to the discovery of –

(i) The anode rays, travel in straight line

(ii) They are positively charged as they get deflected towards the –ve end when subjected to an electric and magnetic field.

(iii) They depend upon the nature of gas present in the cathode tube.

(iv) The charge to mass ration (e/m) of the particle is found to depend on the gas from which they originate.

(v) They are also material particles

The analysis of these proportions led to the discovery of positively charged proton.

4.Find out atomic number, mass number, number of electron and neutron in an element $^{40}_{20}\times$ **?**

Ans: The mass no. of $\times$ is 40

The atomic no. of $\times$ is 20

No. of proton is = Z – A = 40 – 20 = 20

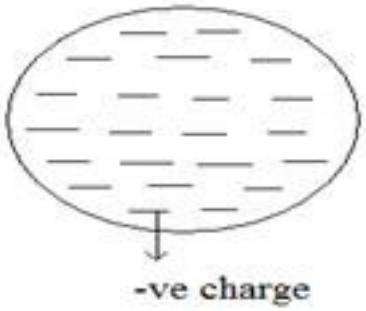
No. of electron its (A) = 20

No. of proton is (A) = 20

5.Give the main features of Thomson's Model for an atom.

Ans: J.J. Thomson proposed that an atom consists of a spherical sphere (radius of about 10^{-10}m)in which the positive charges are uniformly distributed the electrons are embedded into it in such a manner so as to give stable electrostatic arrangement.

This model is also called raisin pudding model.



6.What did Rutherford conclude from the observations of $\alpha - ray$ scattering experiment?

Ans: Rutherford proposed the nuclear model of an atom as

(i) The positive charge and most of the mass of an atom was concentrated in an extremely small region. He called it nucleus.

(ii) The nucleus is surrounded by electrons that move around the nucleus with a very high speed in orbits.

(iii) Electron and nucleus are held together by electrostatic forces of attraction.

7.What is the relation between kinetic energy and frequency of the photoelectrons?

Ans: Kinetic energy of the ejected electron is proportional to the frequency of the electromagnetic radiation.

8.What transition in the hydrogen spectrum would have the same wavelength as the Balmer transition, n = 4 to n = 2 of He^+ spectrum?

Ans: For the Balmer transition, n = 4, to n = 2 in a He^+ ion, we can write.

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

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

$$= \frac{3}{4} R_H \text{ --------} (i)$$

For a hydrogen atom

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

Equating equation (ii) and (i), we get

$$\frac{1}{n_1^2} - \frac{1}{n_2^2} = \frac{3}{4}$$

This equation gives $n_1 = 1$ and n = 2. Thus the transition n = 2 to n = 1 in hydrogen atom will have same wavelength as transition, n = 4 to n = 2 in He^+

9.Spectral lines are regarded as the finger prints of the elements. Why?

Ans: Spectral lines are regarded as the finger prints of the elements because the elements can be identified from these lines. Just like finger prints, the spectral lines of no two elements resemble each other.

10.Why cannot the motion of an electron around the nucleus be determined accurately?

Ans: Because there is an uncertainty in the velocity of moving electron around the nucleus (Heisenberg's Uncertainty Principle).

11.Calculate the uncertainty in the momentum of an electron if it is confined to a linear region of length 1×10^{-10}.

Ans: According to uncertainty Principle

$$\Delta x.\Delta p = \frac{h}{4\pi}$$

$$or, \Delta p = \frac{h}{4\pi\Delta x}$$

$$or, \Delta p = \frac{6.626\times10^{34}\,kgm^2s^{-1}}{4\times3.143\times10^{-10}\,m)}$$

$$= 5.27\times10^{-26}\,kgms^{-1}$$

12.Give the mathematical expression of uncertainty principle.

Ans: Mathematically, it can be given as

$$\Delta x\times\Delta p_x \geq h/4\pi$$

$$or, \Delta x\times\Delta(mv_x) \geq h/4\pi$$

$$or, \Delta x\times\Delta V_x \geq h/4\pi m$$

Where Δx is the uncertainty in position and $\Delta p_x\ (\Delta v_x)$ is the uncertainty in momentum (or velocity) of the particle.

13.Which quantum number determines

(i) energy of electron

(ii) Orientation of orbitals.

Ans. (i) Principal quantum number (n), and

(ii) Magnetic quantum number (m).

14.Arrange the electrons represented by the following sets of quantem number in decreasing order of energy.

1. **n = 4, l = 0, m = 0, s = +1/2**
2. **n = 3, l = 1, m = 1, s = -1/2**
3. **n = 3, l = 2, m = 0, s = +1/2**

Ans.(i) Represents 4s orbital

(ii) Represents 3p orbital

(iii) Represents 3d orbital

(iv) Represents 3s orbital

The decreasing order of energy 3d > 4s > 3p > 3s

n = 3, l = 0, m = 0, s = -1/2

CBSE Class 12 Chemistry

Important Questions

Chapter 2

Structure of Atom

3 Marks Questions

1.What designations are given to the orbitals having

(i) n = 2, l = 1 (ii) n = 2, l = 0 (iii) n = 4, l = 3

(iv) n = 4, l = 2 (v) n = 4, l = 1?

Ans. (i) Here, n = 2, and l = 1

Since l = 1 it means a p-orbital, hence the given orbital is designated as 2p.

(ii) Here, n = 2 and l = 0

Since l = 0 means s – orbital, hence the given orbital is 2s.

(iii) Here, n = 4 and l = 3

Since, l = 3 represents f – orbital, hence the given orbital is a 4f orbital.

(iv) Here, n = 4 and l = 2

Since, l = 2 represents d – orbital, hence the given orbital is a 4d – orbital.

(v) n = 4 and l = 1

since, l = 1 means it is a p – orbital, hence the given orbital can be designated as – 4p orbital.

2.Write the electronic configuration of (i) Mn^{4+}, (ii) Fe^{3+} (iii) Cr^{2+} and Zn^{2+} Mention the number of unpaired electrons in each case.

Ans.(i) Mn (z = 25), Mn^{4+} (z = 21)

The electronic configuration of Mn^{4+} to Given by

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3$

As the outermost shell 3d has 3 electrons, thus the number of unpaired

electrons is 3.

(ii) Fe (z = 26), Fe^{3+} (z = 23)

The electronic configuration of Fe^{3+} is given lay

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5$

The number of unpaired electron is 5.

(iii) Cr (z = 24), Cr^{2+} (z = 22)

The electronic configuration of Cr^{2+} is

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4$

The number of unpaired electron is 4.

(iv) Zn (z = 30), Zn^{2+} (z = 28)

The electronic configuration of Zn^{2+} is

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}$

The number of unpaired electron is 0.