STRUCTURE OF ATOM

Short Answer Questions (Exercise)

MCQs (Multiple Choice Questions) put a (√) on the correct answer.

1. Which one of the following results in the discovery of proton?

a) Cathode rays b). Canal rays c) X-rays d) Alpha particles

2. Which one of the following is the most penetrating?

a) Protons b) Electrons c). Neutrons d) Alpha particles

3. The concept of orbit was use by:

a) J.J. Thomson b) Rutherford c). Bohr d) Planck

4. Which one of the following shell consists of three sub-shells?

a) O shell b) N shell c) L shell d). M shell

5. Which radioisotope is used for the diagnosis of tumor in the body?

a) Cobalt-60 b). Iodine-131 c) Strontium-90 d) Phosphorus-32

6. When U-235 breaks up, it produces:

a) Electrons b). Neutrons c) Protons d) Nothing

7. The p sub-shell has:

a) One orbital b) Two orbitals c). Three orbitals d) Four orbitals

8. Deuterium is used to make:

a) Light water b). Heavy water c) Soft water d) Hard water

9. The isotope C-12 is present in abundance of:

a) 96.9 % b) 97.6 % c) 99.7 % d). none of these

10. Who discovered the proton?

a). Goldstein b) J.J. Thomson c) Niels Bohr d) Rutherford

Short Answer Questions Of Exercis

1. What is the nature of charge on cathode rays?

Ans. Cathode rays are deflected toward positive plate in a magnetic field. It shows that cathode rays are negatively charged. Cathode rays are actually electrons.

2. Give five characteristics of cathode rays.

Ans. i) These rays travel in straight lines.

ii). They can cast shadow of an opaque object.

iii). They raise temperature of a body.

iv). J.J Thomson discovered their charge/mass ratio.

v). Same type of rays was emitted by using any gas or discharge tube.

3. The atomic symbol of a phosphorus ion is given as $^{31}_{15}P^{3-}$

(a) How many protons, electrons and neutrons are there in the ion?

(b) What is name of the ion?

(c) Draw the electronic configuration of the ion.

(d) Name noble gas which has same electronic configuration as the phosphorus ion has.

Ans. (a) There are 15 protons, 18 electrons and 16 neutrons in phosphorus ion.

(b) The name of the ion is phosphide ion.

(c) Electronic configuration of the phosphide ion is:- K=2, L=8, M=8 or $1s^2$, $2s^2$ $2p^6$, $3s^2 3p^6$

(d) Argon is the noble gas which has the same electronic configuration as phosphorus ion.

4. Differentiate between shell and sub-shell with examples of each.

Ans. The probability of finding the electrons in certain regions of space around the nucleus of an atom is called shell or energy levels. i.e K, L, M, N.

Each shell or energy level has further sub-shells. i.e s, p, d, f.

5. An element has an atomic number 17. How many electrons are present in K, L and M shells of the atom?

Ans. An element has an atomic number 17. Then 2 electrons are present in **K** shell, 8 electrons are present in **L** shell and 7 electrons are present in M shell of the atom.

(K=2, L=8, M=7)

6. Write down the electronic configuration of Al^{3+}. How many electrons are present in its outermost shell?

Ans. Number of electrons in Al^{3+} =13-3=10 (3 e^- has lost) Then K=2, L=8 or $1s^2$, $2s^2$ $2p^6$.

Number of electrons present in the outermost shell of Al^{3+} are 8.

7. Magnesium has electronic configuration 2, 8, 2.

(a) How many electrons are in the outermost shell?

(b) In which sub-shell of the outermost shell electrons are present?

(c) Why magnesium tends to lose electrons?

(a) Magnesium has 2 electrons in the outermost shell.

(b) In 3s sub-shell of the outermost shell electrons are present.

(c) Magnesium tends to lose 2 electrons to achieve the stability like Neon.($_{10}Ne$)

8. What will be the nature of charge on the atom when it loses an electron or when it gains an electron?

Ans. The nature of charge on an atom will be positive when it loses an electron. e.g Na^{+}, Ca^{2+}

The nature of charge on an atom will be negative when it gains an electron. e.g Cl^{-},O^{2-}

9. For what purpose U-235 is used?

Ans. U-235 is used to generate electricity, which is the peaceful use of atomic energy.

Two atomic power plants in Pakistan are generating electricity in Karachi and in Mianwali .

10. A patient has goiter. How will it be detected?

Ans. If a patient has goiter it will be detected by Iodine -131 radioactive isotope. Isotope Iodine-131 is used for diagnosis of goiter in thyroid gland.

11. Give three properties of positive rays.

Ans. i) These rays travel in straight lines in a direction opposite to the cathode rays.

ii) Positive rays are deflected away from the positive plate in a magnetic field showing that they are positively charged particles.

iii) The nature of Canal rays is depends upon the nature of gas, present in the discharge tube.

12. What are the defects of Rutherford`s atomic model?

Ans. i) Electron being a charged particle should release or emit energy continuously and they should ultimately fall into the nucleus.

ii) If electron emits energy continuously, they should form a continuous spectrum but in fact, line spectrum is observed.

13. As long as electron remains in an orbit, it does not emit or absorb energy. When does it emit or absorb energy?

Ans. When an electron jumps from lower orbit to the higher orbit, it absorbs energy.

When an electron jumps from higher orbit to the lower orbit, it emits energy.

Long Answer Questions of Exercise

1. How are cathode rays produced? What are their five major characteristics?

Ans. Sir William Crooks took a glass tube fitted with two metallic electrodes, which were connected to a high voltage battery. The pressure inside the tube was kept 10^{-4} atm. When high voltage current is passed through the gas, shiny rays were emitted from the cathode towards the anode. These rays were given the name of cathode rays.

Five major characteristics of cathode rays are as follows:

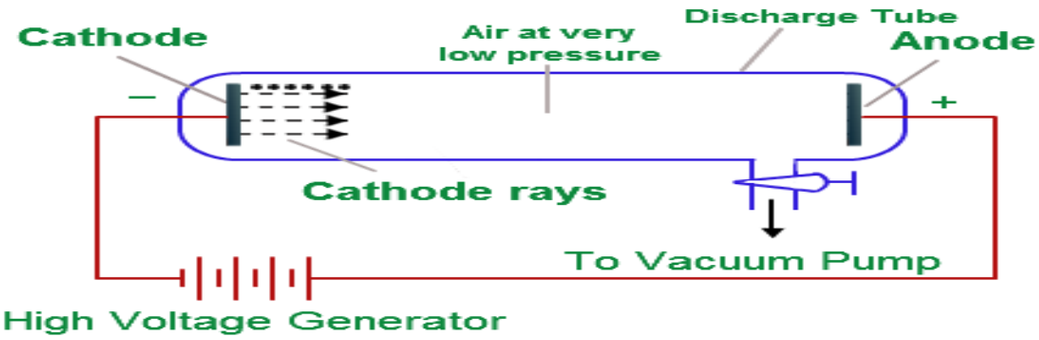
i). These rays travel in a straight line perpendicular to the cathode surface.

ii). They can cast a sharp shadow of an opaque object if placed in their path.

iii).J.J Thomson discovered their charge/mass (e/m) ratio.

iv).Light is produced when these rays hit the walls of the discharge tube.

v).Same type of rays was emitted by using any gas or discharge tube.



2. How was it proved that electrons are fundamental particles of an atom?

Ans. Sir William Crooks in 1879 performed experiments by passing electric current through low pressure gases in a discharge tube. When high voltage current was passed through the gas, shiny rays were emitted from the cathode and moved toward the anode. These rays were given the name as cathode rays. As a material particle, after finding the e/m ratio of cathode rays that was same as of electrons. We know that materials are composed of atoms, hence it was proved that electrons are the fundamental particle of an atom. These particles (electrons) carrying -ve charge and are present outside the nucleus which plays important functions in an atom.

3. Draw a labeled diagram to show the presence of protons in the discharge tube and explain how canal rays were produced.

Ans. Goldstein observed that in addition to cathode rays, other rays were also present in the discharge tube named as canal or positive rays with the following properties.

i). Canal rays travel in opposite direction to the cathode rays.

ii). These type of rays were emitted depends upon by gas using in the discharge tube.

iii).The +ve charge proved by the deflection away from the positive plate in a magnetic field.

Iv). Mass of these particles was found equal to that of a proton.

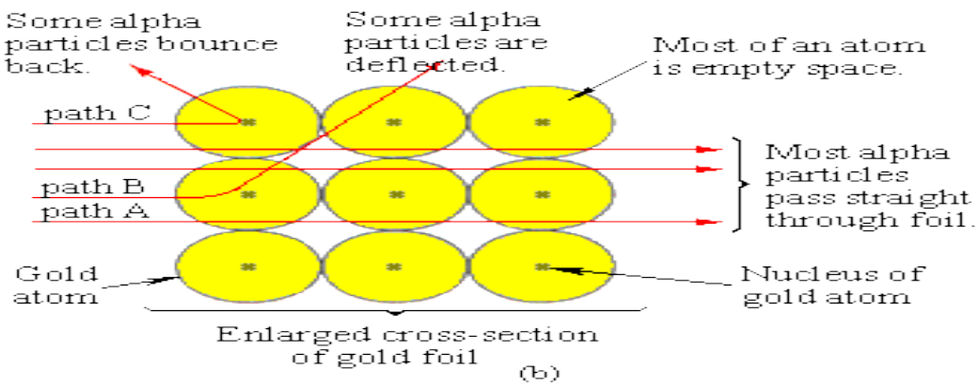
v). These rays produced when electrons and the residual gas molecules collide with each other.

4. How did Rutherford discover that atom has a nucleus located at the center of the atom?

Ans. Rutherford bombarded Alpha particles on 0.00004 cm thick gold foil. Alpha particles are emitted by radioactive elements like Radium or Polonium. These are actually helium nuclei (He^{2+}). He observed the effects of alpha-particles on a photographic plate. He proved that plum-pudding model of an atom was not correct. Rutherford observed that:-

i).Almost all particles passed through the gold foil un-deflected.

ii).Out of 20,000 particles, only few were deflected and very few bounced back on hitting gold foil shows that the nucleus is located at the center of the atom.



5. One of the postulates of Bohr`s atomic model is that angular momentum of a moving electrons is quantized. Explain its meaning and calculate the angular momentum of third orbit (i.e. n=3)

Ans. Angular momentum of an atom is quantized means that electrons can revolve only in orbits of a fixed angular momentum mvr, given as

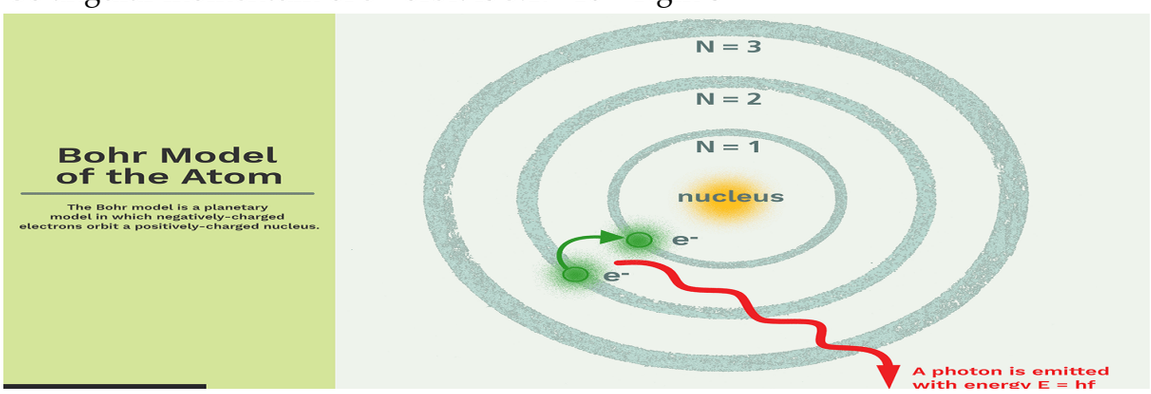
Angular momentum (mvr)= $nh/2\pi$

Data n=3 , $h=6.63\times10^{-34}$Js , $\pi=3.14$

By putting values in the above equation

Angular momentum (mvr)=$3\times6.63\times10^{-34}/2\times3.14$

So angular momentum of 3rd orbit is 3.17×10^{-34} Kgm^2s^{-1}



6. How did Bohr prove that an atom must exist?

Ans. Bohr's Atomic Theory:- According to this model revolving electron in an atom does not absorb or emit energy continuously. The energy of a revolving electron is quantized as it revolves only in orbits of fixed energy called energy levels.

Postulates of Bohr's atomic model:

i). Electrons are revolving in one of the circular orbit of radius "r " around the nucleus.

ii).Each orbit has fixed energy that is quantized.

iii).The energy is emitted or absorbed only when an electron jumps from one orbit to another.

iv).When an electron jumps from lower orbit to higher orbit, it absorbs energy and vice versa. This change in energy, ΔE is given by plank's equation. $\Delta E = E_2 - E_1 = hv$

v). Electron can revolve only in orbits of fixed angular moment mvr, given as:

$mvr = nh/2\pi$ where n is the orbit number having values 1, 2, 3 and so on.

7. What do you mean by electronic configuration? What are basic requirements while writing electronic configuration of an element (atom)?

Ans. Electronic configuration is the distribution of electrons around the nucleus in various shells and sub-shells according to their increasing energy.

The maximum capacity of shells to accommodate the electrons is as follows by $2n^2$:

i).K shell can accommodate 2 electrons. ii).L shell can accommodate 8 electrons.

iii).M shell can accommodate 18 electrons. iv).N shell can accommodate 32 electrons.

The maximum capacity of sub-shells (orbital) to accommodate the electrons is as follows:

i).s orbital can accommodate 2 electrons. ii).p orbital can accommodate 6 electrons.

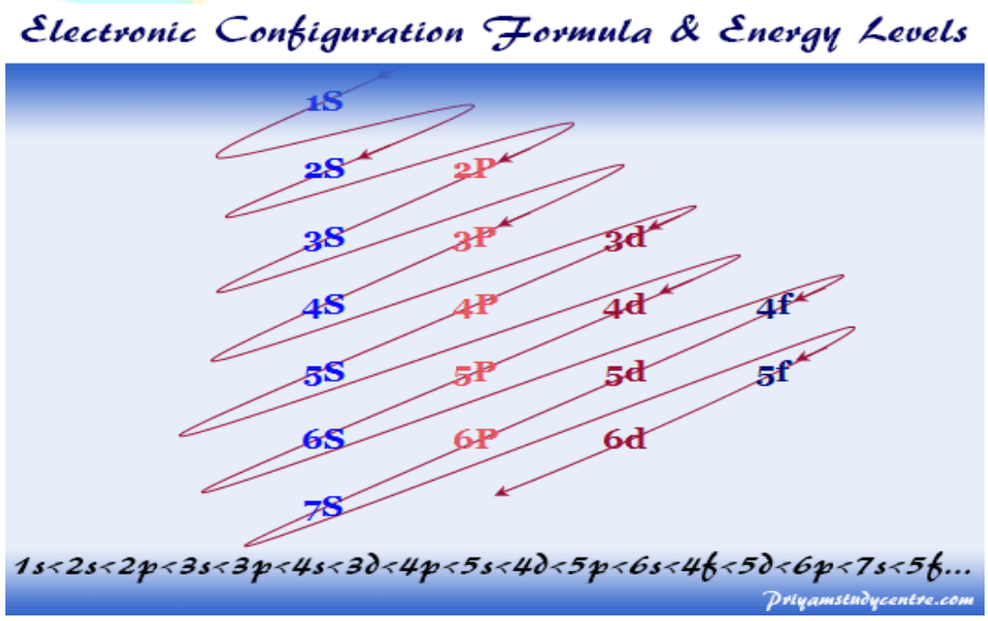
i).d orbital can accommodate 10 electrons. iv).f orbital can accommodate 14 electrons.

Basic requirements while writing the electronic configuration of an element (atom) are:

i).The number of electrons in an atom or ion should be known. E.g O=8, Cl=17 etc.

ii).The sequence of shells and sub-shells according to the energy levels KLMN or spdf.

iii). The maximum number of electrons that can be placed in different shells and sub-shells.



8. Describe the electronic configuration of Na^+, Mg^{2+} and Al^{3+} ions. Do they have the same number of electrons in the outermost shell?

Ans. Atomic Number of **Na** atom is 11 and that of Na^+ ion is 10 by losing 1 electron so,

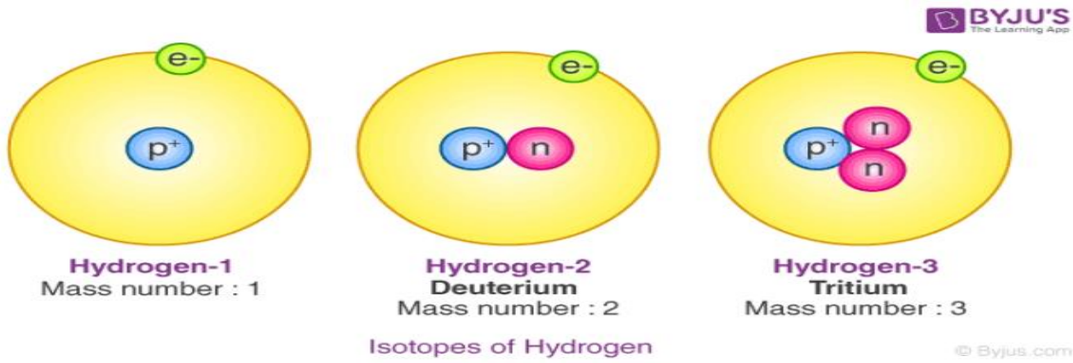
In term of shells K=2 L=8 OR in term of sub-shells $1s^2, 2s^2 2p^6$

Atomic Number of **Mg** atom is 12 and that of Mg^{2+} ion is 10 by losing 2 electrons so,
In term of shells K=2 L=8 OR in terms of sub-shells $1s^2$, $2s^2$ $2p^6$
Atomic Number of **Al** atom is 13 and that of Al^{3+}ion is 10 by losing 3 electrons so,
In term of shells K=2 L=8 OR in terms of sub-shells $1s^2$, $2s^2$ $2p^6$
In atomic form Na has 1, Mg has 2 and Al has 3 electrons in the outermost shells while losing 1, 2, and 3 electrons respectively all the three atoms becomes ions by losing electrons along with valence shells. Now in new position all the three ions have 8 electrons in the outermost or valence shells to become stable like noble gas Neon.

9. Give the applications of isotopes in the field of radiotherapy and medicine.
Ans. Applications of isotopes in the field of radiotherapy:- For the treatment of skin cancer, isotopes like P-32 and Sr-90 are used because they emit less penetrating beta radiations. For common cancer, Co-60, affecting with in the body, is used because it emits strongly penetrating gamma radiations.
Applications of isotopes in the field of medicine:- The radioactive isotopes are used as tracers in medicines to diagnose the presence of tumor in the human body. Isotopes of Iodine-131 are used for the diagnosis of goiter in thyroid gland. Similarly Technetium is used to monitor the bone growth.

10. What is an isotope? Describe the isotopes of hydrogen with diagrams.
Ans. The atoms of an element that have same atomic number and electronic configuration but different mass number or number of neutrons is called isotopes.
Isotopes of Hydrogen:- The naturally occurring hydrogen is the combination of its three isotopes, present in different abundances. The three isotopes of hydrogen are named as Protium ($^1H_1$ or P), Deuterium ($^1H_2$ or D) and Tritium ($^1H_3$ or T). Each one of them has 1 proton and 1 electron, but number of neutrons is different i.e 0, 1 and 2 respectively.

Symbol	Atomic number	Mass number	No. of protons	No. of neutrons
$^1H_1$	1	1	1	0
$^2H_1$	1	2	1	1
$^3H_1$	1	3	1	2



Extra questions and their answers which have not touched in the exercise

1. Describe the key points of Dalton's atomic theory.

Ans. i).Atom is an indivisible particle.

ii).Atom is hard and dense particle.

iii).Atoms of the same element is alike.

iv).Atoms combines in different ways to form compounds.

2. What is plum pudding theory?

Ans. Plum pudding theory:- This theory was put forth by Thomson. He postulated that atoms were solid structure of positively charge with tiny negative particles stuck inside.

3. Describe the main differences between Rutherford and Bohr atomic theories.

Rutherford's atomic theory	**Bohr's atomic theory**
i). It was based upon classical theory.	**i).**It was based upon quantum theory.
ii). Electrons revolves around the nucleus.	**ii).**Electrons revolves around the nucleus in orbits.
iii). Atoms should show continuous spectrum.	**iii).**Atoms should show line spectrum.
iv). Atoms should collapse.	**iv).**Atoms should exist.
v). No idea of orbits was introduced.	**v).**Idea of orbits was introduced.

4. Write the uses of isotopes in archaeological and geological fields.

Ans. Uses of isotopes in archaeological and geological fields:- An important method of age determination of old carbon containing objects (fossils) by measuring the radioactivity of C-14 in them is called radio-carbon dating or simply carbon dating.

5. Write the uses of isotopes in chemical reaction and structure determination.

Ans. Uses of isotopes in chemical reaction and structure determination:- C-14 is used to label CO_2. As CO_2 is used by the plants for photosynthesis to form glucose.

6. Describe the results of Rutherford's atomic model.

Ans. i). Since most of the particles passed through the foil undeflected, therefore most of the volume occupied by an atom is empty.

ii). The deflection of few particles proved that nucleus is in the Centre of an atom.

iii). The complete rebouncing of few particles shows that the nucleus is very dense and hard.

iv). The deflection few particles shows that the size of nucleus is very small.

v). Electrons revolves around the nucleus

vi). An atom as a whole neutral (number of electrons = number of protons in the nucleus.

vii). Except electrons all other particles are present in the nucleus, are called nucleons.

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