Structure of Atom

(English Medium)

Exercise 64:

Solution 1.1:

D.Beam of electrons
Cathode rays are a beam of electrons having negative charge, produced from a cathode in a discharge tube.

Solution 1.2:

B. Electromagnetic waves
X-rays are electromagnetic waves with very short wavelength produced from cathode rays.

Solution 1.3:

B. Rontgen
When Rontgen struck cathode rays with the wall of a tube or anticathode, X-rays were produced.

Solution 1.4:

D. Rutherford
Rutherford discovered alpha and beta rays being emitted from a radioactive element. Gamma rays were discovered later by Willard.

Exercise 65:

Solution 1.5:

D. αparticles
α particles show deviation towards negative charge when subjected to an electromagnetic field. Thus, it possesses positive electric charge.

Solution 1.6:

D. Chadwick
Chadwick discovered neutrons while doing a research on radioactivity.

Solution 1.7:

D. 10^5

While performing experiments on gold foil and alpha radiations, Rutherford found from his calculations that atomic nucleus is 10^5 times smaller than the total area of the atom.

Solution 1.8:

C. γ-rays

Gamma rays were discovered by Willard much later than alpha and beta rays were discovered.

Solution 1.9:

B. Cl

Chlorine (Cl) has atomic number 17. Thus, its electronic configuration is 2, 8, 7.

Solution 1.10:

B. Mg

Magnesium (Mg) has atomic number 12. Thus, its electronic configuration is 2, 8, 2.

Solution 1.11:

D.X-rays

X-rays travel in a straight line and do not show any deviation even when passed through an electromagnetic field.

Solution 2.1:

From the study of hydrogen spectrum, it has been proved that hydrogen atom has one electron.

On the other hand, the study of sodium spectrum has proved that sodium has more than one electron in its atom.

Solution 2.2:

Cathode rays are a beam of electrons which have negative charge and are deviated under the effect of electromagnetic field.

Solution 2.3:

Cathode rays experience deviation in electromagnetic fields.

Solution 2.4:

Cathode rays	α-rays

Cathode rays are negatively charged.	α-rays are positively charged.
Cathode rays are produced from a metal plate which can act as a cathode when connected to a high voltage electric circuit.	α-rays are emitted from a radioactive element.

Solution 2.5:

Properties of X-rays are:

1. X-rays are electromagnetic waves.
2. They have very short wavelength.
3. They can pass through opaque substances like black paper.
4. They affect photographic plates covered by opaque substances.

Solution 2.6:

Uses of X-rays are:

1. To detect fracture in bones.
2. To observe defect in lungs.
3. To diagnose cancer of oesophagus.
4. To diagnose physical disabilities.

Solution 2.7:

Cathode rays are a beam of electrons. When cathode rays or electrons having very high velocity are struck with the wall of tube or an anticathode, X-rays are produced.

Solution 2.8:

From his experiment, Rutherford determined that in an atom, the middle part is very small, heavy and possesses positive electric charge. This middle part is called the atomic nucleus. Electrons having negative charge and negligible weight are arranged around the centre (nucleus).

Solution 2.9:

Alpha (α), beta (β) and gamma (γ) rays are emitted from uranium metal.

Solution 2.10:

To identify the charge present on radiations, the emissions from a radioactive substance are subjected to an electromagnetic field. The rays which deflect towards the negative plate possess a positive charge are α-rays, whereas the rays which deflect towards the positive plate and possess a negative charge are β-rays.

Solution 2.11:

According to Thomson's atomic model, an atom is like a spherical ball and positive electric charge is uniformly spread on its total volume.

As per this model, the positive and negative charges should mix with each other and become chargeless, which is not the case.
Also, this arrangement cannot explain the different chemical properties of different elements.
Due to the above reasons, Thomson's atomic model was not accepted.

Solution 2.12:

In his experiment, Rutherford made α rays fall incident on one side of the gold foil. He observed that most of the α rays passed through the gold foil without deviation. He thus concluded that the atom is hollow.

Solution 2.13:

Orbit	Symbols	Maximum no. of electrons in the orbit.
First	K	2
Second	L	8
Third	M	18

Solution 2.14:

Atomic number: Atomic number (Z) is the number of protons or electrons present in the neutral atom of an element.
Atomic mass: Atomic mass (A) is the sum of the number of protons and the number of neutrons in the nucleus of an atom of an element.
Isotope: The atoms of the elements whose position in the periodic table are the same and have the same atomic number but different atomic mass are called isotopes.

Solution 2.15:

Stationary (stable) orbits are the orbits around the nucleus that possess continuously moving electrons which do not lose energy.

Solution 2.16:

Electrons present in the outermost orbit of an atom and responsible for the emission spectra and the chemical properties of an element are called valence electrons.

Solution 2.17:

Valence electrons are responsible for the emission spectra and the chemical properties of an element.

Exercise 66:

Solution 2.18:

Chadwick discovered neutrons in 1932 while doing a research on radioactivity.

Solution 2.19:

Isotopes of Hydrogen	No. of protons	No. of neutrons
Protium	1	0
Deuterium	1	1
Tritium	1	2

Solution 2.20:

The isotopes of elements which have high atomic masses and posses the property of radioactivity are called radioactive isotopes.
Example – ^{123}I, ^{60}Co are radioactive isotopes.

Solution 2.21:

Properties of isotopes are:

1. Atomic masses of isotopes are different.
2. Chemical properties of isotopes are similar.
3. Isotopes occupy the same position in the periodic table.

Solution 2.22:

Radioactive isotopes are used:

1. To determine the age of old trees.
2. To determine the age of fossils of man and other animals.
3. In radiometric dating.
4. In medical treatments.
5. In industries.
6. In treatment of cancer.

Solution 2.23:

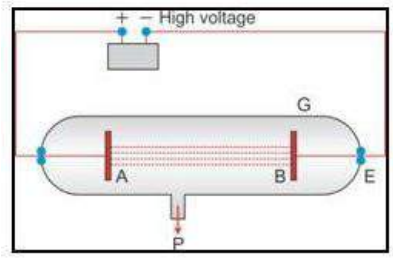
Element	Atomic number	Arrangement of electrons			
		K	L	M	N
$_{11}Na$	11	2	8	1	–
$_{13}Al$	13	2	8	3	–
$_{19}K$	19	2	8	8	1
$_{16}S$	16	2	8	8	6
$_{8}O$	08	2	6	–	–

Solution 2.24:

Element	Atomic number	Arrangement of electrons			
		K	L	M	N
$_{10}Ne$	10	2	8	–	–
$_{12}Mg$	12	2	8	2	–
$_{15}P$	15	2	8	5	–
$_{17}Cl$	17	2	8	7	–
$_{20}Ca$	20	2	8	8	2

Solution 3.1:

Cathode rays can be produced using a discharge tube as shown in the diagram below.



Vacuum is created in the discharge tube by connecting to the vacuum pump through the outlet P.
A and B are metal plates connected to a high voltage.
Plate A acts as a cathode and plate B acts as an anode.
When the circuit is completed and current is made to pass through the circuit, Plate A emits a beam of electrons. The electrons being negative in charge move towards the anode in a straight line.
This beam of electrons is cathode rays.
Properties of cathode rays are:

1. They are negatively charged.
2. They travel in a straight line.
3. They deviate in an electromagnetic field.
4. When obstructed by an anti-cathode material, cathode rays produce X-rays.
5. Cathode rays travel with a very high speed, almost equal to the speed of light.

Solution 3.2 :

Cathode rays are a beam of electrons. When cathode rays or electrons having very high velocity are struck with the wall of the tube or anticathode, X-rays are produced.
Properties of X-rays are:

1. X-rays are electromagnetic waves.
2. They have very short wavelength.

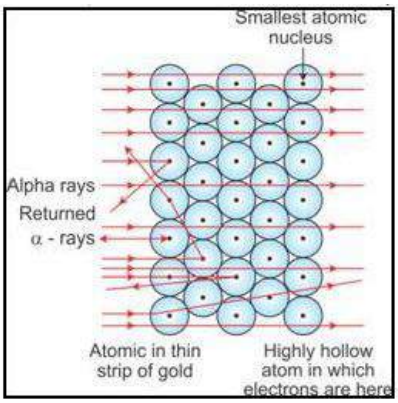
3. They can pass through opaque substances like black paper.
4. They affect photographic plates covered by opaque substances.

Uses of X-rays are:

1. To detect fracture in bones.
2. To observe defect in lungs.
3. To diagnose cancer of oesophagus.
4. To diagnose physical disabilities.

Solution 3.3:

Rutherford conducted an experiment to explain the arrangement of electrons and protons in an atom.
Rutherford made alpha rays fall incident on a gold foil.
He used radioactive element polonium as a source of alpha rays.
If the distribution of electrons and protons in an atom is uniform, then all the alpha rays which strike the atoms should reflect back.
However, he observed that most of the alpha rays passed through the gold foil in a straight line and only few reflected back in different directions.



From his observations he concluded that;

1. The centre of an atom has a very small, heavy and positive electric charge possessing a particle called nucleus.
2. Electrons with negligible weight and negative charge must be arranged around this nucleus.
3. As very less amount of alpha rays reflected back, the atom must be hollow.

Solution 3.4:

Niels Bohr proposed the atomic model in 1912. He suggested that electrons move around the nucleus in specific orbits at a definite distance from the nucleus.
Electrons do not lose energy when moving in these orbits and thus, these orbits are called stationary or stable orbits.
Energy of the orbit nearest to the nucleus is the least and goes on increasing as the distance from the nucleus increases.
The arrangement of electrons around the nucleus in an atom can be explained as follows:

1. The first orbit closest to the nucleus is called K orbit and can accommodate maximum of 2 electrons.
2. The second orbit is called L orbit and can accommodate maximum of 8 electrons.
3. The third orbit is called M orbit and can accommodate maximum of 18 electrons.

4. The fourth orbit is the outermost orbit called N orbit and can accommodate maximum of 32 electrons.

The electrons are arranged in order in these orbits. The electrons fill the next orbit only after filling the previous one completely.

Solution 3.5:

Hydrogen has one proton and helium has two protons. Thus, mass of helium should be double than that of hydrogen. However, Rutherford observed that mass of helium was almost 4 times the mass of hydrogen.
This led him to the conclusion that there must exist another particle having its mass almost equal to that of proton and named it as neutron.
However, there was no direct proof of the existence of neutrons.
In 1932, it was Chadwick who discovered the existence of neutrons while doing a research on radioactivity.

Solution 3.6:

Isotopes: The atoms of the elements whose position in the periodic table is the same and they have the same atomic number but different atomic mass are called isotopes.
Example – hydrogen has 3 isotopes – Protium, Deuterium and Tritium. Protium has zero neutrons, deuterium has 1 and tritium has 2 neutrons. The number of protons in all the isotopes is the same viz. 1.
Radioactivity: The isotopes of the elements which have high atomic masses and posses the property of radioactivity are called radioactive isotopes.
Example – ^{235}U, ^{238}U are radioactive isotopes of uranium.
These radioactive elements have unstable nucleus and emit small particles like alpha, beta and gamma rays. This property of emission of rays is called radioactivity. Elements acquire the property of radioactivity if the ratio of neutrons to protons exceeds 1.6.
Radioactive isotopes have varied applications in different fields. Radioactive isotopes are used:

1. To determine the age of old trees.
2. To determine the age of fossils of man and other animals.
3. In radiometric dating.
4. In medical treatments.
5. In industries.
6. In treatment of cancer.

Solution 3.7:

The number of electrons present in the outermost orbit of an atom, or the number of electrons required to achieve stable configuration is the valency of an atom.
In an atom, the electrons are arranged in orbits with an increase in the energy levels around the nucleus.
Thus, the valency or valence electrons in the outermost orbit of an atom are responsible for the emission spectrum and the chemical properties of the atom.
Valency of an atom helps to decide if the atom will donate, accept or share electrons during a chemical reaction.