पु॰ना International School

Shree Swaminarayan Gurukul, Zundal

Class -IX

Science(Chemistry)

Specimen Copy Year-2022-23

INDEX

Chapter 3 (Atoms and Molecules)

Notes

Law of Chemical Combination
Given by Lavoisier and Joseph L. Proust as follows:
1. **Law of conservation of mass:** Mass can neither be created nor destroyed in a chemical reaction. e.g., A + B → C + D Reactants → Products Mass of reactants = Mass of products

2. **Law of constant proportion:** In a chemical substance the elements are always present in definite proportions by mass.
E.g., in water, the ratio of the mass of hydrogen to the mass of oxygen is always 1 : 8 respectively.
These laws lacked explanation. Hence, John Dalton gave his theory about the matter. He said that the smallest particle of matter is called 'atom'.

Dalton's Atomic Theory

- Every matter is made up of very small or tiny particles called atoms.
- Atoms are not divisible and cannot be created or destroyed in a chemical reaction.
- All atoms of a given element are same in size, mass and chemical properties.
- Atoms of different elements are different in size, mass and chemical properties.
- Atoms combine in the ratio of a small whole number to form compounds.
- The relative number and kinds of atoms are constant in a given compound.

Atom
Atoms are the smallest particles of an element which can take part in a chemical reaction.
Size of an atom: Atomic radius is measured in nanometers.

Symbols of atoms:
Symbols of some common elements:

Molecule
It is the smallest particle of an element or a compound which can exist independently.

- Molecules of an element constitute the same type of atoms.
- Molecules may be monoatomic, diatomic or polyatomic.
- Molecules of compounds join together in definite proportions and constitute a different type of atoms.

Atomicity
The number of atoms constituting a Molecule is known as its atomicity.

Ions
The charged particles (atoms) are called ions, they are formed by attaining positive charge or negative charge on it.
Negatively charged ion is called anion (Cl^-).
Positively charged ion is called cation (Na^+).

Valency
The combining capacity of an element is known as its valency. Valency is used to find out how the atom of an element will combine with the atom of another element to form a chemical compound.
(Every atom wants to become stable, to do so it may lose, gain or share electrons.)

- If an atom consists of 1, 2 or 3 electrons in its valence shell then its valency is 1, 2 or 3 respectively,
- If an atom consists of 5, 6 or 7 electrons in the outermost shell, then it will gain 3, 2 or 1 electron respectively and its valency will be 3, 2 or 1 respectively.
- If an atom has 4 electrons in the outermost shell than it will share this electron and hence its valency will be 4.
- If an atom has 8 electrons in the outermost electron and hence its valency will be 0.

Some elements show more than one valency,hence termed as variable valency.

Chemical Formulae

Rules: (i) The valencies or charges on the ion must balance.
(ii) Metal and non-metal compound should show the name or symbol of the metal first.
e.g., $Na^+ Cl^- \rightarrow NaCl$
(ii) If a compound consists of polyatomic ions. The ion is enclosed in a bracket before writing the number to indicate the ratio.
e.g., $[SO_4]^{2-} \rightarrow$ polyatomic radical
$H^{1+} SO_4^{2-} \rightarrow H_2SO_4$

Molecular Mass

It is the sum of the atomic masses of all the atoms in a molecule of the substance. It is expressed in atomic mass unit (u).

Formula Unit Mass

It is the sum of the atomic masses of all atoms in a formula unit of a compound. The constituent particles are ions.

Mole Concept

Definition of mole: It is defined as one mole of any species (atoms, molecules, ions or particles) is that quantity in number having a mass equal to its atomic or molecular mass in grams.
1 mole = 6.022×10^{23} in number
Molar mass = mass of 1 mole $\rightarrow$ is always expressed in grams and is also known as gram atomic mass.
lu of hydrogen has $\rightarrow$ 1 atom of hydrogen 1g of hydrogen has $\rightarrow$ 1 mole of hydrogen
= 6.022×10^{23} atoms of hydrogen

Class 9 Science NCERT Textbook Page 32

Question 1. In a reaction 5.3 g of sodium carbonate reacted with 6 g of ethanoic acid. The products were 2.2 g of carbon dioxide, 0.9 g water and 8.2 g of sodium etkanoate. Show that these observations are in agreement with the law of conservation of mass carbonate.

Answer:

Sodium carbonate + Ethanoic acid → Sodium ethanoate + Carbon dioxide + Water

5.3 g + 6 g → 8.2 g + 2.2 g + 0.9 g

LHS RHS

∴ 11.3 g = 11.3 g

(Mass of reactant) (Mass of product)

This shows that during a chemical reaction mass of reactant = mass of product.

Question 2. Hydrogen and oxygen combine in the ratio of 1 : 8 by mass to form water. What mass of oxygen gas would be required to react completely with 3 g of hydrogen gas?

Answer: Ratio of H : O by mass in water is:
Hydrogen : Oxygen —> H_2O

∴ 1 : 8 = 3 : x
x = 8 x 3
x = 24 g
∴ 24 g of oxygen gas would be required to react completely with 3 g of hydrogen gas.

Question 3. Which postulate of Dalton's atomic theory is the result of the law of conservation of mass?
Answer: The postulate of Dalton's atomic theory that is the result of the law of conservation of mass is—the relative number and kinds of atoms are constant in a given compound. Atoms cannot be created nor destroyed in a chemical reaction.

Question 4. Which postulate of Dalton's atomic theory can explain the law of definite proportions?
Answer: The relative number and kinds of atoms are constant in a given compound.

Class 9 Science NCERT Textbook Page 35

Question 1. Define the atomic mass unit.
Answer: One atomic mass unit is equal to exactly one-twelfth (1/12th) the mass of one atom of carbon-12. The relative atomic masses of all elements have been found with respect to an atom of carbon-12.

Question 2. Why is it not possible to see an atom with naked eyes?
Answer: Atom is too small to be seen with naked eyes. It is measured in nanometres.
1 m = 109 nm

NCERT Textbook Questions – Page 39

Question 1. Write down the formulae of
(i) Sodium oxide
(ii) Aluminium chloride
(iii) Sodium sulphide
(iv) Magnesium hydroxide
Answer: The formulae are

(i) Formula of Sodium Oxide
Symbol → Na O
Charge → +1 –2
Formula → Na_2O

(ii) Formula of aluminium chloride
Symbol → Al Cl
Charge → +3 – 1
Formula → $AlCl_3$

(iii) Formula of Sodium Oxide
Symbol → Na S
Charge → +1 –2
Formula → Na_2S

(iv) Formula of magnesium hydroxide
Symbol → Mg OH
Charge → +2 1
Formula → $Mg(OH)_2$

Question 2. What is meant by the term chemical formula?
Answer: The chemical formula of the compound is a symbolic representation of its composition, e.g., chemical formula of sodium chloride is NaCl.

Question 3. How many atoms are present in a
(i) H_2S molecule and
(ii) $P0_4^{3-}$ ion?
Answer: (i) H_2S —> 3 atoms are present
(ii) $P0_4^{3-}$ —> 5 atoms are present

NCERT Textbook Questions – Page 40

Question 1. Calculate the molecular masses of H_2, O_2, Cl_2, $C0_2$, CH_4, C_2H_2,NH_3, CH_3OH.

Answer: The molecular masses are:

$H_2 \Rightarrow 1 \times 2 \rightarrow 2$ u

$O_2 \Rightarrow 16 \times 2 \rightarrow 32$ u

$Cl_2 \Rightarrow 35.5 \times 2 \rightarrow 71$ u

$CO_2 \Rightarrow 1 \times 12 + 2 \times 16 = 12 + 32 = 44$ u

$CH_4 \Rightarrow 1 \times 12 + 4 \times 1 = 16$ u

$C_2H_6 \Rightarrow 2 \times 12 + 6 \times 1 = 30$ u

$C_2H_4 \Rightarrow (2 \times 12) + (4 \times 1) = 28$ u

$NH_3 \Rightarrow (1 \times 14) + (3 \times 1) = 17$ u

$CH_3OH \Rightarrow 12 + (3 \times 1) + 16 + 1 = 32$ u

Question 2.Calculate the formula unit masses of ZnO, Na_2O, K_2C0_3, given atomic masses of Zn = 65 u, Na = 23 u, K = 39 u, C = 12 u, and O = 16 u.

Answer: The formula unit mass of

(i) ZnO = 65 u + 16 u = 81 u

(ii) Na_2O = (23 u x 2) + 16 u = 46 u + 16 u = 62 u

(iii) K_2C0_3 = (39 u x 2) + 12 u + 16 u x 3

= 78 u + 12 u + 48 u = 138 u

Class 9 Science NCERT Textbook Page 42

Question 1. If one mole of carbon atoms weigh 12 grams, what is the mass (in grams) of 1 atom of carbon?

Answer:

1 mole of carbon atoms 6.022×10^{23} atoms = 12 g

Mass of 1 atom = ?

$$\therefore \quad \text{Mass of 1 atom of carbon} = \frac{12}{6.022 \times 10^{23}}$$

$$= 1.99 \times 10^{-23} \text{ g}$$

Question 2. Which has more number of atoms, 100 grams of sodium or 100 grams of iron (given atomic mass of Na = 23 u, Fe = 56 u)?

Answer:

$$23 \text{ g of Na} = 6.022 \times 10^{23} \text{ atoms (1 mole).}$$

$$\therefore \quad 100 \text{ g of Na} = ?$$

$$= \frac{100 \times 6.022 \times 10^{23}}{23} = \frac{602.2}{23} \times 10^{23}$$

$$= 26.182 \times 10^{23} = 2.6182 \times 10^{24} \text{ atoms}$$

$$56 \text{ g of Fe} = 6.022 \times 10^{23} \text{ atoms}$$

$$100 \text{ g of Fe} = ?$$

$$= \frac{100 \times 6.022 \times 10^{23}}{56} = \frac{602.2 \times 10^{23}}{56}$$

$$= 10.753 \times 10^{23} = 1.075 \times 10^{24}$$

100 g of Na contain $\rightarrow 2.618 \times 10^{24}$ atoms

100 g of Fe contain $\rightarrow 1.075 \times 10^{24}$ atoms

$\therefore$ 100 g of Na contains more atoms.

Questions From NCERT Textbook for Class 9 Science

Question 1. A 0.24 g sample of compound of oxygen and boron was found by analysis to contain 0.096 g of boron and 0.144 g of oxygen. Calculate the percentage composition of the compound by weight.

Answer: Boron and oxygen compound —> Boron + Oxygen

0.24 g —> 0.096 g + 0.144 g

Percentage composition of the compound

For boron:

$0.24 \text{ g} \rightarrow 0.096 \text{ g}$

$100 \text{ g} \rightarrow ?$

$$\frac{100 \times 0.096}{0.24} = 40\%$$

For oxygen:

$0.24 \text{ g} \rightarrow 0.144 \text{ g of oxygen}$

$100 \text{ g} \rightarrow ?$

$$\frac{100 \times 0.144}{0.24} = 60\%$$

Question 2. When 3.0 g of carbon is burnt in 8.00 g oxygen, 11.00 g of carbon dioxide is produced. What mass of carbon dioxide will be formed when 3.00 g of carbon is burnt in 50.00 g of oxygen? Which law of chemical combination will govern your answer?

Answer: The reaction of burning of carbon in oxygen may be written as:

$$\underset{\substack{\text{1 mole carbon} \\ \text{12 g}}}{C} + \underset{\substack{\text{Oxygen 1 mole} \\ \text{32 g}}}{O_2} \longrightarrow \underset{\substack{\text{carbon dioxide} \\ \text{44 g}}}{CO_2}$$

It shows that 12 g of carbon bums in 32 g oxygen to form 44 g of carbon dioxide. Therefore 3 g of carbon reacts with 8 g of oxygen to form 11 g of carbon dioxide. It is given that 3.0 g of carbon is burnt with 8 g of oxygen to produce 11.0 g of CO_2. Consequently 11.0 g of carbon dioxide will be formed when 3.0 g of C is burnt in 50 g of oxygen consuming 8 g of oxygen, leaving behind 50 – 8 = 42 g of O_2. The answer governs the law of constant proportion.

Question 3. What are poly atomic ions? Give examples.
Answer: The ions which contain more than one atoms (same kind or may be of different kind) and behave as a single unit are called polyatomic ions e.g., OH^-, SO_4^{2-}, CO_3^{2-}.

Question 4. Write the chemical formulae of the following:
(a) Magnesium chloride
(b) Calcium oxide
(c) Copper nitrate
(d) Aluminium chloride
(e) Calcium carbonate.
Answer: (a) Magnesium chloride
Symbol —> Mg Cl
Change —> +2 -1
Formula —> $MgCl_2$
(b) Calcium oxide
Symbol —> Ca O
Charge —> +2 -2
Formula —> CaO
(c) Copper nitrate
Symbol —> Cu NO
Change +2 -1
Formula -4 $CU(N0_3)_2$
(d) Aluminium chloride
Symbol —> Al Cl
Change —> +3 -1
Formula —> $AlCl_3$
(d) Calcium carbonate
Symbol —> Ca CO_3
Change —> +2 -2
Formula —> $CaC0_3$

Question 5. Give the names of the elements present in the following compounds:
(a) Quick lime
(b) Hydrogen bromide
(c) Baking powder
(d) Potassium sulphate.
Answer: (a) Quick lime —> Calcium oxide
Elements —> Calcium and oxygen
(b) Hydrogen bromide
Elements —> Hydrogen and bromine
(c) Baking powder —> Sodium hydrogen carbonate
Elements —> Sodium, hydrogen, carbon and oxygen
(d) Potassium sulphate
Elements —> Potassium, sulphur and oxygen

Question 6. Calculate the molar mass of the following substances.
(a) Ethyne, C_2H_2
(b) Sulphur molecule, S_8
(c) Phosphorus molecule, P_4 (Atomic mass of phosphorus = 31)
(d) Hydrochloric acid, HCl
(e) Nitric acid, HNO_3
Answer: The molar mass of the following: [Unit is 'g']
(a) Ethyne, C_2H_2 = 2 x 12 + 2 x 1 = 24 + 2 = 26 g

(b) Sulphur molecule, S_8 = 8 x 32 = 256 g
(c) Phosphorus molecule, P_4=4 x 31 = i24g
(d) Hydrochloric acid, HCl = 1 x 1 + 1 x 35.5 = 1 + 35.5 = 36.5 g
(e) Nitric acid, $HN0_3$ = 1 x 1 + 1 x 14 + 3 x 16 = 1 + 14 + 48 = 63 g

Question 7. What is the mass of
(a) 1 mole of nitrogen atoms?
(b) 4 moles of aluminium atoms (Atomic mass of aluminium = 27)?
(c) 10 moles of sodium sulphite (Na_2S0_3)?
Answer: (a) Mass of 1 mole of nitrogen atoms = 14 g
(b) 4 moles of aluminium atoms
Mass of 1 mole of aluminium atoms = 27 g
∴ Mass of 4 moles of aluminium atoms = 27 x 4 = 108 g
(c) 10 moles of sodium sulphite (Na_2SO_3)
Mass of 1 mole of Na_2SO_3 = 2 x 23 + 32 + 3 x 16 = 46 + 32 + 48 = 126 g
∴ Mass of 10 moles of Na_2SO_3 = 126 x 10 = 1260 g

Question 8. Convert into mole.
(a) 12 g of oxygen gas
(b) 20 g of water
(c) 22 g of Carbon dioxide.
Answer: (a) Given mass of oxygen gas = 12 g
Molar mass of oxygen gas (O_2) = 32 g
Mole of oxygen gas 12/32 = 0.375 mole
(b) Given mass of water = 20 g
Molar mass of water (H_2O) = (2 x 1) + 16 = 18 g
Mole of water = 20/18 = 1.12 mole
(c) Given mass of Carbon dioxide = 22 g
Molar mass of carbon dioxide (CO_2) = (1 x 12) + (2 x 16)
= 12 + 32 = 44 g
∴ Mole of carbon dioxide = 22/44 = 0.5 mole

Question 9. What is the mass of:
(a) 0.2 mole of oxygen atoms?
(b) 0.5 mole of water molecules?
Answer: (a) Mole of Oxygen atoms = 0.2 mole
Molar mass of oxygen atoms = 16 g
Mass of oxygen atoms = 16 x 0.2 = 3.2 g
(b) Mole of water molecule = 0.5 mole
Molar mass of water molecules = 2 x 1 + 16= 18 g .
Mass of H_2O = 18 x 0.5 = 9 g

Question 10. Calculate the number of molecules of sulphur (S_8) present in 16 g of solid sulphur.
Answer: Molar mass of S_8 sulphur = 256 g = 6.022 x 10^{23} molecule
Given mass of sulphur = 16 g

$$\text{Molecules of sulphur} = \frac{16 \times 6.022 \times 10^{23}}{256} = \frac{96.35 \times 10^{23}}{256}$$
$$= 0.376 \times 10^{23}$$
$$= 3.76 \times 10^{22} \text{ molecules}$$

Question 11. Calculate the number of aluminium ions present in 0.051 g of aluminium oxide. (Hint: The mass of an ion is the same as that of an atom of the same element. Atomic mass of Al = 27 u)

Answer: Molar mass of aluminium oxide Al_20_3

= (2 x 27) + (3 x 16)

= 54 + 48 = 102 g.

$\therefore$ 102 g of Al_2O_3 contains $= 2 \times 6.022 \times 10^{23}$ aluminium ions

$\therefore$ 0.051 g of Al_2O_3 contains $= \frac{2 \times 6.022 \times 10^{23}}{102} \times 0.051$

$= \frac{12.044 \times 10^{23} \times 0.051}{102} = \frac{0.614 \times 10^{23}}{102}$

$= 0.006022 \times 10^{23}$

$= 6.022 \times 10^{20}$ Al^{3+} ions

Notes

Facts that Matter

- John Dalton assumed that atom is indivisible.
- In 1866 E. Goldstein discovered the presence of new radiations in a gas discharge tube and called them canal rays. These rays were positively charged radiations which led to the discovery of sub-atomic particle called proton.

In 1900 J.J. Thomson discovered the sub-atomic particle—the electron with a negative charge.

Rutherford's model of an atom
α-Particles: (+ 2 charge and 4 mass) when fast-moving a-particles are bombarded on very thin gold foil, following observations were made:

- Most of the α-particles passed straight through the gold foil.
- Some of the α-particles were deflected by the foil by small angles.
- One out of 12000 particles appeared to rebound.

Conclusions made by Rutherford based on his observations:

- Most of the space inside the atom is empty because a-particles passed through the gold foil.
- Very few particles were deflected from their path because +ve charge of the atom occupies a very little space.
- A very small fraction of a-particles were rebounded back, shows all + ve charge and mass of the gold atom is concentrated in a very small volume within an atom.
- The radius of the nucleus calculated was 105 times less than the radius of the atom.

Nuclear Model of an Atom

- Centre → +ve charge → called nucleus. All mass resides in nucleus.
- Electrons → revolve around the nucleus in orbits.
- Size of the nucleus is very small as compared to the size of the atoms.

Drawbacks of Rutherford's model of the atom: When an electron undergoes acceleration, it radiates energy. Thus revolving electron would lose energy and finally fall into the nucleus. Due to this atom should be highly unstable and hence matter would not exist in the form that we know.
But we know that atoms are quite stable.
Bohr's Model of Atom
Postulates of Neil Bohr

- Only special orbits known as discrete orbits of electrons are allowed inside the atom.
- While revolving in discrete orbits the electrons do not radiate energy. These orbits are called energy levels.

Orbits or shells are represented by K, L, M, N or the numbers, n = 1, 2, 3, 4

Neutrons
Distribution of electrons in different orbits (Shells) given by Bohr and Bury: Rules:

- Maximum number of electrons present in a shell is given by $2n^2$ (n = shell number)
  E.g., n = 1 (K shell) $2(1)^2 = 2$ electron
- The maximum number of electrons that can be accommodated in the outermost orbit is 8.
- Electrons are not accommodated in a given shell unless the inner shells are completely filled.

Definitions

- **Valency:** The combining capacity of an atom is called its valency,
- **Atomic number:** It is equal to a number of protons.
- **Mass number:** It is equal to the sum of protons and neutrons.

Isotopes: Atoms of the same element with same atomic number but a different mass number, are called isotopes.
Chemical properties → same but Physical properties → different

Applications of isotopes:

- Anisotope of Uranium used as fuel.
- Anisotope of Cobalt is used in the treatment of cancer
- Anisotope of Iodine is used in the treatment of goitre.

Isobars: Atoms of different elements with same mass number but different atomic numbers are called isobars.

In-Text Questions Solved

NCERT Textbook for Class 9 Science – Page 47

Question 1. What are canal rays?
Answer: Canal rays are positively charged radiations which led to the discovery of positively charged sub-atomic particle called proton.

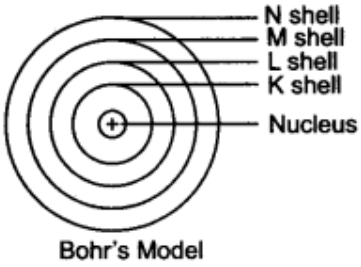
Question 2. If an atom contains one electron and one proton, will it carry any charge or not?
Answer: The atom will be electrically neutral as one – ve charge balances one + ve charge.

Class 9 Science NCERT Textbook – Page 49

Question 1. On the basis of Thomson's model of an atom, explain how the atom is neutral as a whole.
Answer: According to Thomson's model of an atom
(i) An atom consists of a positively charged sphere and the electrons are embedded in it,
(ii) The negative and positive charges are equal in magnitude. So the atom is electrically neutral.

Question 2. On the basis of Rutherford's model of an atom, which sub-atomic particle is present in the nucleus of an atom?
Answer: As per Rutherford's model of an atom, the protons which are positively charged are present in the nucleus of an atom.

Question 3. Draw a sketch of Bohr's model of an atom with three shells.
Answer:



Bohr's Model

Question 4. What do you think would be the observation if the a-particle scattering experiment is carried out using a foil of a metal other than gold?
Answer: On using any metal foil, the observations of the a-particle scattering experiment would remain the same as all atoms would have same structure.

Class 9 Science NCERT Textbook – Page 49

Question 1. Name the three sub-atomic particles of an atom.
Answer: The sub-atomic particles of an atom are

Protons → Positively charged
Electrons → Negatively charged
Neutrons → No charge

Question 2. Helium atom has an atomic mass of 4 u and two protons in its nucleus. How many neutrons does it have?
Answer:

Atomic mass of He = 4u.
Atomic mass = No. of protons + No. of neutrons
∴ 4 = 2 + no. of neutrons.
∴ No. of neutrons = 4 – 2 = 2
Helium atom has 2 neutrons.

NCERT Textbook for Class 9 Science – Page 50

Question 1. Write the distribution of electrons in carbon and sodium atoms.
Answer:
Write the distribution of electrons in carbon and sodium atoms.

Carbon Atomic number = 6
∴ No. of protons = 6
and Number of protons = Number of electrons
∴ Distribution of electrons = KL
2 4

Sodium Atomic number = 11
∴ No. of protons = 11 = No. of electrons
∴ Distribution of electrons = K L M
2 8 1

Question 2. If K and L shells of an atom are full, then what would be the total number of electrons in the atom?
Answer: K shell can hold 2 electrons and L shell can hold 8 electrons.When both the shells are full, there will be (8 + 2) 10 electrons in the atom.

Class 9 Science NCERT Textbook – Page 52

Question 1. How will you find the valency of chlorine, sulphur and magnesium?

Answer:

Valency is the combining capacity of an atom of an element.

Chlorine, Atomic Number = 17

∴ Protons = 17, Electrons = 17

∴ Distribution of electrons = K L M
2 8 7

Chlorine needs 1 electron to complete its outermost orbit/shell.

∴ Its valency is −1 (gains 1 electron).

Sulphur, Atomic number = 16

∴ Protons = 16, Electrons = 16

∴ Distribution of electrons = K L M
2 8 6

Sulphur needs 2 electrons to complete its outermost shell.

∴ Its valency is −2 (gains 2 electrons)

Magnesium, Atomic number = 12

∴ Protons = 12, electrons = 12

∴ Distribution of electrons = K L M
2 8 2

Magnesium needs to donate 2 electrons from its outermost shell to become stable.

∴ Its valency is +2 (donates 2 electrons).

NCERT Textbook for Class 9 Science – Page 52

Question 1. If number of electrons in an atom is 8 and number of protons is also 8, then
(i) What is the atomic number of the atom? and
(ii) What is the charge on the atom?

Answer:

No. of electrons = 8

No. of protons = 8

(*i*) Atomic number = no. of protons = 8

(*ii*) As Electrons = Protons

$\oplus = \ominus$

∴ Atom is electrically neutral (No charge)

Question 2. With the help of given Table 4.1, find out the mass number of oxygen and sulphur atom.
Table: Composition of Atoms of the First Eighteen Elements with Electron Distribution in Various Shells

Name of Element	Symbol	Atomic Number	Number of Protons	Number of Neutrons	Number of Electrons	Distribution of Electrons K	L	M	N	Valency
Hydrogen	H	1	1	-	1	1	-	-	-	1
Helium	He	2	2	2	2	2	-	-	-	0
Lithium	Li	3	3	4	3	2	1	-	-	1
Beryllium	Be	4	4	5	4	2	2	-	-	2
Boron	B	5	5	6	5	2	3	-	-	3
Carbon	C	6	6	6	6	2	4	-	-	4
Nitrogen	N	7	7	7	7	2	5	-	-	3
Oxygen	O	8	8	8	8	2	6	-	-	2
Fluorine	F	9	9	10	9	2	7	-	-	1
Neon	Ne	10	10	10	10	2	8	-	-	0
Sodium	Na	11	11	12	11	2	8	1	-	1
Magnesium	Mg	12	12	12	12	2	8	2	-	2
Aluminium	Al	13	13	14	13	2	8	3	-	3
Silicon	Si	14	14	14	14	2	8	4	-	4
Phosphorus	P	15	15	16	15	2	8	5	-	3, 5
Sulphur	S	16	16	16	16	2	8	6	-	2
Chlorine	Cl	17	17	18	17	2	8	7	-	1
Argon	Ar	18	18	22	18	2	8	8		0

Answer:

Oxygen, No. of protons = 8
∴ No. of neutrons = 8
∴ Atomic number = 8
∴ Atomic mass number = P + N
= 8 + 8
= 16

Sulphur, No. of protons = 16
∴ Atomic number = 16
No. of neutrons = 16
∴ Atomic mass number = P + N
= 16 + 16
= 32

NCERT Solutions for Class 9 Science Chapter 4 Textbook – Page 53

Question 1. For the symbol H, D and T tabulate three sub-atomic particles found in each of them

Answer:

(Protium) H → (^1_1H) Atomic number = 1, Mass number = 1
∴ No. of protons = 1
No. of electrons = 1
No. of neutrons = Nil

D → (^2_1H) Atomic number = 1, Mass number = 2
(Deuterium) ∴ No. of protons = 1
No. of electrons = 1
No. of neutrons = 1

T→ (^2_1H) Atomic number = 1, Mass number = 3
(Tritium) ∴ No. of protons = 1
No. of electrons = 1
No. of neutrons = 2

Question 2. Write the electronic configuration of any one pair of isotopes and isobar.
Answer. Isotopes: Atoms of same element having same atomic number but different mass number.
∴ Electronic configuration of isotopes remain the same.

E.g., $^{12}_{6}C$ $^{14}_{6}C$

Electronic configuration	K	L
$^{12}_{6}C$	2	4
$^{14}_{6}C$	2	4

Isobars: Atoms of different elements with different atomic number but same mass number.

E.g., $^{40}_{20}Ca$ $^{40}_{18}Ar$

Electronic configuration	K	L	M	N
$^{40}_{20}Ca$	2	8	8	2
$^{40}_{18}Ar$	2	8	8	

Questions from NCERT Text Book

Question 1. Compare the properties of electrons, protons and neutrons.
Answer:

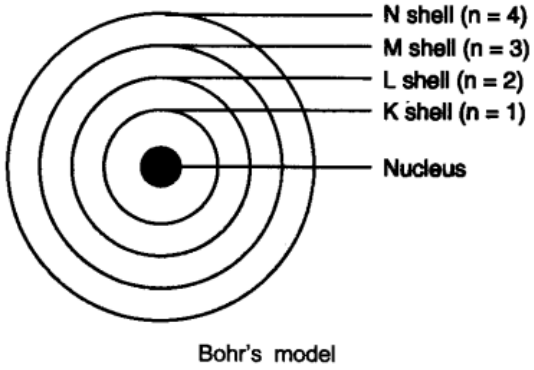
Electrons	***Protons***	***Neutrons***
1. Negatively charged.	Positively charged	No charge
2. Mass is negligible $\left(\frac{1}{1800}\right.$ times of protons $\left.\right)$.	Mass is 1 a.m.u.	Mass is 1 a.m.u.
3. Get attracted towards +ve charge.	Get attracted towards –ve charge.	Do not get attracted, as they are neutral
4. Present outside the nucleus	Present in the nucleus	Present in the nucleus of an atom

Question 2. What are the limitations of J.J. Thomson's model of the atom?
Answer: According to J.J. Thomson's model of an atom, the electrons are embedded all over in the positively charged spheres. But experiments done by other scientists showed that protons are present only in the centre of the atom and electrons are distributed around it.

Question 3. What are the limitations of Rutherford's model of the atom?
Answer: According to Rutherford's model of an atom the electrons are revolving in a circular orbit around the nucleus. Any such particle that revolves would undergo acceleration and radiate energy. The revolving electron would lose its energy and finally fall into the nucleus, the atom would be highly unstable. But we know that atoms are quite stable.

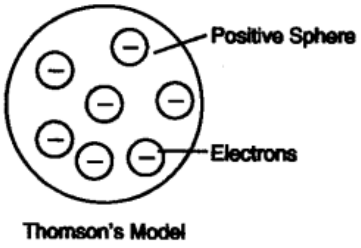
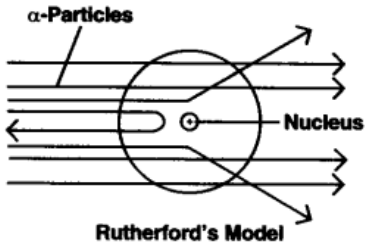
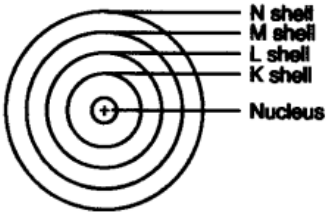
Question 4. Describe Bohr's model of the atom.
Answer: Bohr's model of the atom
(1) Atom has nucleus in the centre.
(2) Electrons revolve around the nucleus.
(3) Certain special orbits known as discrete orbits of electrons are allowed inside the atom.
(4) While revolving in discrete orbits the electrons do not radiate energy.
(5) These orbits or shells are called energy levels.

(6) These orbits or shells are represented by the letters K, L, M, N or the numbers n = 1, 2, 3, 4



Bohr's model

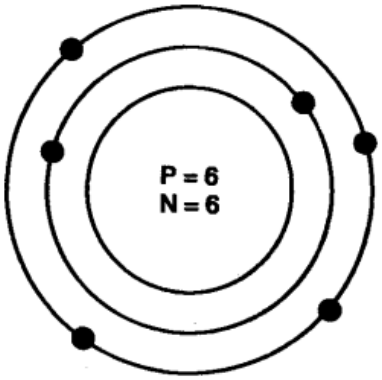
Question 5. Compare all the proposed Bohr's models of an atom given in this chapter.
Answer:

Thomson	Rutherford	Bohr
• Sphere of positive charge	• Sphere of positive charge in centre called nucleus. All mass of an atom resides in the nucleus	• Positive charge in centre called nucleus.
• Electrons are spread randomly all over in the sphere	• Electrons revolve around the nucleus in well defined orbits.	• Electrons revolve in discrete orbits and do not radiate energy.
•  Thomson's Model	•  Rutherford's Model	•  Bohr's Model
• Positive charge = Negative charge. • Atom is electrically neutral.	• Size of nucleus is very small as compared to size of atom.	• The orbits were termed as energy shells labelled as K, L, M, N or $n = 1, 2, 3, 4$ (numbered)

Question 6. Summarise the rules for writing of distribution of electrons in various shells for the first eighteen elements.
Answer: The rules for writing of distribution of electrons in various shells for the first eighteen elements are:
(i) The maximum number of electrons present in a shell is given by the formula-$2n^2$
∵ n = orbit number i.e., 1, 2, 3
∵ Maximum number of electrons in different shells are:
K shell n = 1 $2n^2 \Rightarrow 2(1)^2 = 2$
L shell n = 2 $2n^2 \Rightarrow 2(2)^2 = 8$
M shell n = 3 $2n^2 \Rightarrow 2(3)^2 = 18$
N shell n = 4 $2n^2 \Rightarrow 2(4)^2 = 32$
(ii) The maximum number of electrons that can be accommodated in the outermost orbit is 8.
(iii) Electrons are not accommodated in a given shell unless the inner shells are filled. (Shells are filled step-wise).

Question 7. Define valency by taking examples of silicon and oxygen.
Answer: Valency is the combining capacity of an atom.
Atomic number of oxygen = 8 Atomic number of silicon = 14 K L M
Electronic configuration of oxygen = 2 6 –
Electronic configuration of silicon =2 8 4
In the atoms of oxygen the valence electrons are 6 (i.e., electrons in the outermost shell). To fill the orbit, 2 electrons are required. In the atom of silicon, the valence electrons are 4. To fill this orbit 4 electrons are required.
Hence, the combining capacity of oxygen is 2 and of silicon is 4.
i.e., Valency of oxygen = 2
Valency of silicon = 4

Question 8. Explain with examples:
(i) Atomic number (ii) Mass number,
(iii) Isotopes and (iv) Isobars.
Give any two uses of isotopes.
Answer: (i) Atomic number: The atomic number of an element is equal to the number of protons in the nucleus of its atom. e.g., Oxygen has 6 protons hence atomic no. = 6.
(ii) Mass number: The mass number of an atom is equal to the number of protons and neutrons in its nucleus.
Nucleons = number of protons + number of neutrons Example: Protons + Neutrons = Nucleus = Mass number 6 + 6 = 12



(iii) Isotopes: Isotopes are atoms of the same element which have different mass number but same atomic number.

$E.g.,\ {}^{1}_{1}H,\ {}^{2}_{1}H,\ {}^{3}_{1}H$

(iv) Isobars: Isobars are atoms having the same mass number but different atomic numbers.

$E.g.,\ {}^{40}_{20}Ca\ {}^{40}_{18}Ar$

Both calcium and argon have same mass number but different atomic number.
Two uses of isotopes are:
(i) An isotope of iodine is used in the treatment of goitre.
(ii) An isotope of uranium is used as a fuel in nuclear reactors.

Question 9. Na^+ has completely filled K and L shells. Explain.
Answer: Sodium atom (Na), has atomic number =11
Number of protons =11
Number of electrons = 11
Electronic configuration of Na = K L M – 2 8 1
Sodium atom (Na) looses 1 electron to become stable and form Na^+ ion. Hence it has completely filled K and L shells.

Question 10. If bromine atom is available in the form of say, two isotopes $^{79}_{35}Br$ (49.7%) and $^{81}_{35}Br$ (50.3%), calculate the average atomic mass of bromine atom.
Answer:
The average atomic mass of bromine atom

$$= \left(79 \times \frac{49.7}{100}\right) + \left(81 \times \frac{50.3}{100}\right)$$
$$= 39.263 + 40.743$$
$$= 80.006 \text{ u}$$

Question 11. The average atomic mass of a sample of an element X is 16.2 u. What are the percentages of isotopes $^{16}_{8}X$ and $^{18}_{8}X$ in the sample?
Answer: Let the percentage of $^{16}_{8}X$ be x and the percentage of $^{16}_{8}X$ be 100 – x.

$$\therefore \quad \left(16 \times \frac{x}{100}\right) + \frac{18(100 - x)}{100} = 16.2$$
$$\frac{16x}{100} + \frac{1800 - 18x}{100} = 16.2$$
$$\therefore \quad \frac{16x - 18x + 1800}{100} = 16.2$$
$$\therefore \quad -2x + 1800 = 16.2 \times 100$$
$$\therefore \quad -2x = 1620 - 1800$$
$$\therefore \quad -2x = -180$$
$$\therefore \quad x = \frac{180}{2} = 90$$
$$\therefore \quad {}^{16}_{6}X = 90\%$$
$$\text{and} \quad {}^{18}_{8}X = 10\%$$

Question 12. If Z = 3, what would be the valency of the element? Also, name the element.
Answer: Z = 3, (i.e, atomic number —> z)
∴ Electronic configuration = 2, 1
Valency = 1
Name of the element is lithium.

Question 13. Composition of the nuclei of two atomic species X and Y are given as under
X – Y
Protons =6 6
Neutrons = 6 8
Give the mass number of X and Y. What is the relation between the two species?
Answer: Mass number of X = Protons + Neutrons
= 6 + 6 = 12
Mass number of Y = Protons + Neutrons = 6 + 8 = 14
As the atomic number is same i.e., = 6.
[atomic number = number of protons].
Both X and Y are isotopes of same element.

Question 14. For the following statements, write T for True and F for False.
(a) J.J. Thomson proposed that the nucleus of an atom contains only nucleons.

(b) A neutron is formed by an electron and a proton combining together. Therefore,it is neutral.
(c) The mass of an electron is about 1/2000 times that of proton.
(d) An isotope of iodine is used for making tincture iodine, which is used as a medicine.
Answer: (a) False (b) False
(c) True (d) False

Put tick against correct choice and cross (x) against wrong choice in questions 15, 16 and 17.
Question 15. Rutherford's alpha-particle scattering experiment was responsible for the discovery of
(a) Atomic nucleus (c) Proton
(b)Electron (d)neutron
Answer: (a) Atomic nucleus

Question 16.Isotopes of an element have
(a) the same physical properties (c) different number of neutrons
(b)different number of neutrons (d) different atomic numbers.
Answer: (c) different number of neutrons

Question 17. Number of valence electrons in Ct ion are :
(a) 16 (b) 8
(c) 17 (d) 18
Answer: (b) 8

Question 18. Which one of the following is a correct electronic configuration of sodium?
(a) 2, 8 (b) 8, 2, 1
(c) 2, 1, 8 (d) 2, 8, 1
Answer: (d) 2, 8, 1

Question 19. Complete the following table.

Atomic Number	*Mass Number*	*Number of Neutrons*	*Number of Protons*	*Number of Electrons*	*Name of the Atomic Species*
9	–	10	–	–	–
16	32	–	–	–	Sulphur
–	24	–	12	–	–
–	2	–	1	–	–
–	1	0	1	0	–

Answer:

Atomic Number	*Mass Number*	*Number of Neutrons*	*Number of Protons*	*Number of Electrons*	*Name of the Atomic Species*
9	19	10	9	9	Fluorine
16	32	16	16	16	Sulphur
12	24	12	12	12	Magnesium
1	2	1	1	1	Hydrogen Deuterium
1	1	0	1	0	Hydrogen