Atoms and Molecules

Laws of Chemical Combination:

The process of combination of two or more elements to form new compounds is governed by certain laws called laws of chemical combination. These are:

1. Law of conservation of mass.
2. Law of constant proportions.

1. Law of conservation of mass (by Lavoisier in 1744):

This law states that mass can neither be created nor destroyed in a chemical reaction.

2. Law of constant proportions (by Proust in 1797):

This law states that in a chemical substance the elements are always present in definite proportions by mass.

For example, the ratio of hydrogen and oxygen in pure water is always 1: 8 by weight.

This law is also called *law of definite proportions* or *law of constant proportions*.

Dalton's Atomic Theory

According to Dalton's atomic theory, all matter, whether an element, a compound or a mixture is composed of small particles called atoms

Postulates of Dalton's atomic theory:

Matter is made up of extremely small indivisible particles called atoms that can neither be created nor destroyed.

Atoms of the same substance are identical in all aspects, i.e., they possess same size, shape, mass, chemical properties etc.

Atoms of different substances are different in all aspects, i.e., they possess different size, shape, mass etc.

Atom is the smallest particle that takes part in a chemical reaction.

Atoms of different elements combine with each other in a simple whole number ratio to form compound.

The relative number and kinds of atoms are constant in a given compound.

Try the following questions:

Q. 3 g of carbon on burning in 8 g oxygen produces 11 g of carbon dioxide. What mass of carbon dioxide will be formed when 3 g of carbon is burnt in 50 g of oxygen?

Q.. 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? Which law of combination will govern the answer?

Q. Which postulate of Dalton's atomic theory explains the law of definite proportions?

Q. 12 g of magnesium powder was ignited in a container having 20 g of pure oxygen. After the reaction was over, it was found that 12 g of oxygen was left unreacted. Show that it is according to law of constant proportions.

$2Mg + O_2 \rightarrow 2MgO$

Atoms:

The smallest tiny particles of matter which can't be divided further is called atom, i.e., an atom is the smallest building block of matter.

For example: Sodium (Na), Hydrogen (H), Oxygen (O), etc.

Names of Atoms or Elements and Their Symbols:

IUPAC (International Union of Pure and Applied Chemistry) approves names of elements.

The abbreviation used for lengthy names of elements are termed as their symbols.

The symbol of an element is formed by writing only the first letter or first letter followed by the second or some other letter of English name or Latin name of the element.

While writing a symbol, the first letter is always capital and the second is always small.

Symbols used for some common elements are given below:

Element	Symbol	Element	Symbol	Element	Symbol
Aluminium	Al	Copper	Cu	Nitrogen	N
Argon	Ar	Fluorine	F	Oxygen	O
Barium	Ba	Gold	Au	Potassium	K
Boron	B	Hydrogen	H	Silicon	Si
Bromine	Br	Iodine	I	Silver	Ag
Calcium	Ca	Iron	Fe	Sodium	Na
Carbon	C	Lead	Pb	Sulphur	S
Chlorine	Cl	Magnesium	Mg	Uranium	U
Cobalt	Co	Neon	Ne	Zinc	Zn

Atomic Mass

Atomic mass of an element may be defined as the average relative mass of an atom of the element as compared with the mass of an atom of carbon (C-12 isotope) taken as 12 amu.

$$\text{Atomic mass} = \frac{\text{Mass of 1 atom of an element}}{1/12 \text{ of the mass of an atom of C-12}}$$

Gram Atomic Mass: The atomic mass of an element expressed in grams is known as gram atomic mass.

Molecules:

A group of two or more than two atoms of the same or different elements that are chemically bonded together is called a molecule.

For example: Two atoms of hydrogen (H_2) and one atom of oxygen (O_2) react with each other and form one molecule of water.

Atomicity:

The number of atoms present in a molecule of an element or a compound is known as its atomicity.

For example, atomicity of oxygen (O_2) is 2 while atomicity of ozone (O_3) is 3.

Molecules of Elements:

The molecules of an element are constituted by the same type of atoms. For example, a molecule of oxygen consists of two atoms of oxygen to form a diatomic molecule O_2.

Molecules of Compounds:

Atoms of different elements join together in definite proportions to form molecules of compounds.

For example, a molecule of water consists of two atoms of hydrogen and one atom of oxygen to form a triatomic molecule H_2O.

Ion:

It is an electrically charged atom or group of atoms. It is formed by the loss or gain of one or more electrons by an atom.

Ions are of two types:

(i) Cation: It is positively charged ion and is formed by the loss of one or more electrons from an atom

For example: sodium atom, loses one electron to form a sodium ion Na

$Na - e^- \rightarrow Na^+$

(ii) Anion: It is a negatively charged ion and is formed by the gain of one or more electrons by an atom.

For example a chlorine atom gains one electron to form a chloride ion Cl^-.

$Cl + e^- \rightarrow Cl^-$

Valency:

It is defined by the combining power (or capacity) of an element.

Depending on their valency, elements can be classified as following:

(i) Monovalent cation: Having cationic valency of 1.

For example: Sodium ion (Na^+). Potassium ion (K^+), Hydrogen ion (H^+).

Monovalent anion: Having anionic valency of -1.

For example: Chloride ion (Cl^-), Bromide ion (Br^-)

(ii) Divalent cation: Having cationic valency of 2.

For example: Magnesium ion (Mg^{2+}), Ferrous ion (Fe^{2+}).

Divalent anion: Having anionic valency of −2.

For example: Oxide ion (O^{2-}), Sulphide ion (S^{2-}).

(iii) Trivalent cations: Having cationic valency of 3.

For example: Aluminium ion (Al^{3+}), Ferric ion (Fe^{3+}).

Trivalent anion: Having anionic valency of -3.

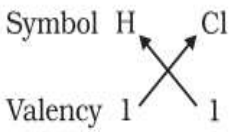
For example: Nitride ion (N^{-3}), Phosphate ion (PO_4^{3-}) etc.

Formula of Simple and Molecular Compounds:

Steps to construct the chemical formula of a compound:

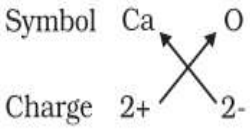
(i) While writing the chemical formulae for compounds, write the constituent elements with their valencies written down the respective elements.
(ii) Then crossover the valencies of the combining atoms as shown in the following examples.

1. Formula of hydrogen chloride



Formula of the compound would be HCl.

2. Formula for aluminium oxide:



Formula of the compound would be: Al_2O_3

Steps to represent the chemical formula of a compound:

(i) The valencies or charges on the ions must be balanced.
(ii) For a compound made up of a metal and a non-metal, the symbol of metal is written first.
(iii) In compounds formed with polyatomic ions, the ion is enclosed in a bracket before writing the number to indicate the ratio.

Molecular Mass:

The number of times a molecule of a compound is heavier than the 1/12 of the mass of C-12 atom, is known as its molecular mass.
The molecular mass is equal to the sum of the atomic masses of all atoms present in one molecule of the substance.
For example, Molecular mass of H_2O= 2 × Mass of one H-atom + Mass of one O-atom = 2 ×1 + 16 = 18 u.

Formula unit mass:

It is the sum of the atomic masses of all atoms in a formula unit of a compound.
Formula unit mass is used for those substances whose constituent particles are ions.
For example, formula unit mass of ionic NaCl = 23 + 35.5 = 58.5 u.

Mole Concept:

Mole: A collection of 6.023×10^{23}particles is named as one mole.

1 mole = 6.023×10^{23} particles = Mass of 1 mole particles in grams

The mass of 1 mole particles is equal to its mass in grams.

1 mole atoms = gram atomic mass

1 mole molecules = gram molecular mass

Avogadro's constant or Avogadro's number:

The number of particles present in one mole (i.e. 6.023 x 10^{23} particles) is called Avogadro's number or Avogadro's constant.

- $\text{Number of moles in a substance} = \frac{\text{Mass of substance in grams}}{\text{grams molecular mass}}$

Try the following questions:

Q. Distinguish between atoms and molecules.

Q. Define the mole concept and molar mass.

Q. Represent the following molecules with the help of chemical formula:

(a) Aluminium chloride

(b) Calcium carbonate

(c) Copper nitrate

(d) Nitric acid

Q. Convert 20 g of water into moles.

Q. Calculate the number of molecules of sulphur (S8) present in 16 g of solid sulphur.

XXXTTTRAAAA AMMUNITION

1.Give an example of a tri-atomic molecule of an element.

2.Give one word for the following:

(i) Positively charged ion

(ii) A group of atoms carrying a charge

3.What are polyatomic ions? Give examples

4. State the Postulates of Dalton Theory?

5.What is the molecular formula for

i)Calcium hydroxide

ii)Magnesium Phosphate

iii)zinc Nitrate

iv)Aluminium oxide

v)Sodium Carbonate

vi)Aluminium chloride
5). 6.2.42g of copper gave 3.025 g of a black oxide of copper, 6. 4 9 g of a black oxide, on reduction with hydrogen, gave 5.192g of copper. Show that these figures are in accordance with law of constant proportion?
7.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 o f the same element. Atomic mass of Al = 27 u)
8.What is the mass of:
(a) 0.2 mole of oxygen atoms?
(b) 0.5 mole of water molecules?
9.ive the names of the elements present in the following compounds.
(a) Quick lime
(b) Hydrogen bromide
(c) Baking powder
(d) Potassium sulphate.
10. 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)?
11.alculate the formula unit masses of ZnO, Na_2 O, K_2CO_3 , given atomic masses of Zn = 65 u, Na = 23 u, K = 39 u, C = 12 u, and O = 16 u.
12.State the differences between an atom or a molecule.
13.Calculate the number of moles for the following:
a) 52 g of He
b) 17 g of water

1. The nucleons are
   I. Protons and electrons
   II. Neutrons and electrons
   III. Protons and neutrons
   IV. None of these

2. The isotope deuterium of hydrogen has
   I. No neutrons and one proton
   II. One neutrons and two protons
   III. One electron and two neutron
   IV. One proton and one neutron

3. The electrons present in the outermost shell are called
   I. Valency electrons
   II. Octate electrons
   III. Duplet electrons
   IV. Valence electrons

4. An alpha particle contains
   I. 4 positive charge and 2 mass unit
   II. 2 positive charge and 4 mass unit
   III. 2 positive charge and 2 mass unit
   IV. 4 positive charge and 4 mass unit

5. The atomic number of sodium is 11 and its mass number is 23. It has
   I. 11 neutrons and 12 protons
   II. 12 protons and 11 electrons
   III. 11 electrons and 12 neutrons
   IV. 12 electrons and 11 neutrons

6. The electronic configuration of chlorine is
   I. 2,7
   II. 2,8,8,7
   III. 2,8,7
   IV. 2,7,8

7. The isotope used to remove the brain tumours and treatment of cancer is
   I. U-235
   II. Na-24
   III. Iodine
   IV. C0-60

8. In an alpha scattering experiment, few alpha particles rebounded because
   I. Most of the space in the atom is occupied
   II. Positive charge of the atoms very little space
   III. The mass of the atom is concentrated in the centre

IV. All the positive charge and mass of the atom is concentrated in small volume

ANSWERS

1. III
2. IV
3. IV
4. II
5. III
6. III
7. IV
8. II

Question 1.When a B-particle is emitted, the atomic number of daughter element is one unit more as compared to that of parent element. This increase in atomic number is due to:
a)Addition of a proton to the nucleus
b)Removal of an electron from the nucleus
c)Decay of neutron present in the nucleus
d)Any one of the above

Question 2.What is an electron?
a)A wave
b)A particle
c)Either of two, depending on how it is observed
d)Neither of these

Question 3. The work function of a metal is 4.0 eV. The longest wavelength of light that can cause photoelectron emission from the metal is approximately:
a)540nm
b)400 nm
c)300 nm
d)220 nm

5.The cathode ray experiment was done for the first time by:
a)J.J. Thomson
b)John Dalton
c)Goldstein
d)Rutherford

Question 6. The charge on an electron is:
a)1.6×10^{-6} coulombs
b)1.6×10^{-20} coulombs
c)1.6×10^{-19} coulombs
d)1.6×10^{-16} coulombs

Question 7.The nucleus of an atom contains:
a)Protons
b)Electrons
c)Protons and neutrons
d)Neutrons

Question 8. By whom was neutron discovered?
a)Bohr
b)Chadwick
c)Rutherford
d)Dalton

Question 9.In an atom valence electron are present in:
a)Outermost orbit
b)Next to outermost orbit
c)First orbit
d)Any one of its orbit

Question 10.The maximum number of electrons that can be accommodated in third shell (n = 3) is:
a)2
b)8
c)18
d)10

Question 11.In an atom, the constituent electrons:
a)Do not move
b)Are uniformly distributed
c)Move around the nucleus in fixed energy levels.
d)Move around the nucleus in a random way.

Question 12.What is the number of valence electrons of AI?
a)1
b)2

c)3
d)4

Question 13. Which of the following arrangements of electrons represent magnesium (Mg)?
a)2, 8, 1
b)2, 8, 2
c)2, 8, 3
d)2, 8, 4

Question 14.Which of the following statements is incorrect for cathode rays?
a)They move in straight line
b)Their nature depends upon the nature of gas present in the discharge tube.
c)They cost shadow of solid objects placed in their path
d)They get deflected towards positive charge.

Question 15.The isotopes of an element have:
a)Same number of neutrons
b)Same atomic number
c)Same mass number
d)None of these

Question 16.Which of the following statements is not correct for Bohr's model of an atom?
a)The nucleus of an atom is situated at ts centre
b)The electrons move in circular orbits
c)Electrons jumps from one orbit to another
d)An electron neither loses nor gains energy it jumps from one orbit to another.

Question 17.The atomic number of an element is 11 ad its mass number is 23. The correct order representing the number of electrons, protons and neutrons respectively in this atom is:
a)11, 11, 12
b)11, 12, 11
c)12, 11, 11
d)23, 11, 23

Question 18.Which of the following pairs are isotopes?
a)Oxygen and ozone
b)Ice and steam

c)Nitric oxide and nitrogen dioxide
d)Hydrogen and deuterium

Question 19.Which of the following have equal number of neutrons and protons?
a)Hydrogen
b)Deuterium
c)Fluorine
d)Chlorine

Question 20.The number of electrons in an element with atomic number X and atomic mass Y will be:
a)(X - Y)
b)(Y - X)
c)(X + Y)
d)X

Question 21.The relative atomic masses of many elements are not whole numbers because:
a)They cannot be determined accurately
b)The atoms ionize during determination of their masses
c)Existence of isotopes
d)Presence of impurities

Question 23.Which of the following has a charge of +1 and a mass of 1 amu?
a)A neutron
b)A proton
c)An electron
d)A helium nucleus

Question 24.Which of the following describes an isotope with a mass number of 99 that contains 56 neutrons in its nucleus?
a)$^{99}Ba_{56}$
b)$^{43}Ba_{56}$
c)$^{99}Tc_{43}$
d)$^{56}Tc_{43}$

25.Which of the following isotopes is used as the standard for atomic mass?
a)12C
b)16O
c)13C
d)1H

Question 26.Which f the following is not a basic particle of an element?
a)An atom
b)A molecule
c)An ion
d)None

Question 27.Which would be the electrical charge on a sulphur atom containing 18 ellectrons?
a)2-
b)1-
c)0
d)2+

Question 28. Which of the following pairs are isotopes?
a)Oxygen and ozone
b)Ice and steam
c)Nitric oxide and nitrogen dioxide
d)Hydrogen and deuterium

Question 29.Members of which of the following have similar chemical properties?
a)Isotope
b)Isobars
c)Allotropes
d)Both isotopes and allotropes

Question 30.A natural phenomenon that supports the experimental conclusion that atoms are divisible is:
a)Allotropy
b)Radioactivity
c)Cracking
d)None of these

Question 31.Aluminum has a valence of 3 and sulphate has valence of 2. Therefore, the correct formula for aluminum sulphate is:

a)$AL_2S_2O_4$
b)$AL_2\ (SO_4)_3$
c) $AL_3\ (SO_4)_2$
d) $ALSO_4$

Question 32.The correct representation of 3 molecules of chlorine is:
a)6 CI
b)3 Cl_2
c) $2Cl_3$
d) Cl_6

Question 33. While performing cathode ray experiments, it was observed that there was no passage of electric current under normal conditions. Which of the following can account for this observation?
a)Dust particles are present in air
b)Carbon dioxide is present in air
c)Air is a poor conductor of electricity under normal conditions
d)One of the above

Question 34.The fluorescence on the walls of discharge tube is due to:
a)Cathode rays
b)Anode rays
c)Canal rays
d)None of the above

Question 35.Which of the following electronic configurations is wrong?
a)Be (3) = 2, 1
b)S (16) = 2, 6, 8
c)P (15) = 2, 8, 5

Question 36.$^{55}_{25}Mn^{++}$ has:
a)25protons and 30neutrons
b)25neutrons and 25protons
c)25electrons and 40 protons
d)None of the above

Question 37.Which one of the following statement is not true?
a)Most of the space in an atom is empty
b)The total number of neutrons and protons is always equal in a neutral atom
c)The total number of electrons and protons in an atom is always equal

d)The total number f electrons in any energy level can be calculated by the formula 2n2

Question 38.$_{17}Cl^{35}$ and $_{17}Cl^{37}$ are examples of:
a)Isobars
b)Isotopes
c)Isoelectrons atoms
d)None of the above

Question 39. How many electrons in a Hydrogen (H) atom:
a)One
b)Two
c)Three
d)Four

Question 40.The orbital angular momentum of 2p electron is:
a)3h
b)6h
c)Zero
d)2h/2n

Question 42.The four quantum numbers that could identify the third 3p electron in sulphur are:
a)N = 3, 1 = 0, m = +1, s = +1/2
b)N = 2, 1 = 2, m = -1, s = -1/2
c)N = 3, 1 = 2, m = +1, s = -1/2
d)N = 3, 1 = 1, m = -1, s = +1/2

Question 43.The atomic number of the element with maximum number of unpaired electrons is:
a)23
b)33
c)15
d)26

Question 44.Which of the following orbital is more close to the nucleus?
a)5f
b)6d
c)7s
d)7p

Question 45.The number of d- electrons in Fe^{2+} (Z = 26) is not equal to that of:
a)s- electrons in Mg
b)p- electrons in Ne
c)d- electrons in Fe
d)p- electros in CI

Question 47. The correct setoff quantum numbers for the unpaired electron of scandium (Z = 21) is:
a)4, 2, 2, ±1/2
b)3, 2, -2, ±1/2
c)3, 1, 1, ±1/2
d)3, 2, 3, ±1/2

Question 49.The shortest wavelengths of radiation emitted when can electron from infinity falls into the ionized H-atom($R_H = 1.097 \times 10^7\ m^{-1}$)
a)91 nm
b)192 nm
c)406 nm
d)1.9×10^{-8} nm

Question 50.$_{13}Al^{27}$ is a stable isotope. $_{13}Al^{29}$ is expected to disintegrate by:
a.α emission
b)β emission
c)Positron emission
d)Proton emission

Question 51.n/p ratio of an element with atomic number greater tha 83 falls in the zone of instability. The element will undergo:
a)α - decay
b)β -decay
c)β^+ -decay
d)No decay

Question 52.Proton bombardment of Th^{230} followed by emission of two alpha particles produces:
a)Rn^{232}
b)Fr^{223}
c)Ra^{223}
d)Fr^{222}

Question 53.In the radioactive decay:

ZA^{A} ___ $Z\text{-}2B^{A-4}$ ___ $Z\text{-}1C^{A-4}$ ____ ZA^{A-4}

The sequence of radiation emitted is:

a)α, β, γ

b)α, β α

c) β, α, γ

d)α, β β

Question 54.Which of the following nuclides is least likely to be stable?

a)$20C^{40}$

b)13ALsup>30

c)50Snsup>119

d)25Mnsup>55

1.(c)
2.(c)
3.(c)
5.(a)
6.(c)
7.(c)
8.(b)
9.(a)
10.(c)
11.(c)
12.(c)
13.(b)
14.(b)
15.(b)
16.(d)
17.(a)
18.(d)
19.(b)
20.(d)
21.(c)
22.(b)
23.(b)
24.(c)
25.(a)
26.(b)
27.(a)

28.(d)
29.(c)
30.(b)
31.(b)
32.(b)
33.(c)
34.(a)
35.(c)
36.(a)
37.(b)
38.(b)
39.(a)
40.(d)
42.(d)
43.(d)
44.(c)
45.(d)
47.(b)
49.(a)
50.(b)
51.(a)
52.(b)
53.(d)
54.(b)

Very Short Answer Questions

Question 1.
Name two scientists who established the laws of chemical combination?
Answer:
Antoine L. Lavoiser and Joseph L. Proust.

Question 2.
Give an example of a triatomic molecule of an element.
Answer:
Ozone (O_3)

Question 3.
Define atomicity.
Answer:
It is the number of atoms present in one molecule of a substance.

Question 4.
Write the atomicity of the following molecules:
(i) Sulphur
(ii) Phosphorus
Answer:
(i) 8
(ii) 4

Question 5.
What is an ion? Give one example.
Answer:
The negatively and positively charged particles are called ions.
For example: Cl^- , Br^- , SO_{4}^{2-},PO_{4}^{3-},H^+, Pb^+ , etc.
Question 6.
Give one word for the following:
(i) A group of atoms carrying a charge
(ii) Positively charged ion
Answer:
(i) Ion
(ii) Cation

Question 7.
The atomic number of three elements A, B and C are 9, 10 and 13 respectively. Which of them will form a cation?

Answer:
Electronic configuration of A : 2, 7
Electronic configuration of B : 2, 8
Electronic configuration of C : 2, 8, 3
'C' will form a cation because a cation is formed by the loss of one or more electrons by an atom.

Question 8.
What is wrong in saying 'one mole of nitrogen'?
Answer:
The statement does not clarify whether we are talking about atoms or molecules of nitrogen. We should say 'one mole of nitrogen atoms' or 'one mole of nitrogen molecule'.

Question 9.
'Dalton's atomic theory is contradicted by the formula of sucrose ($C_{12}H_{22}O_{11}$).' Justify the statement.
Answer:
Dalton's atomic theory states that atoms of different elements combine together in simple whole number ratio. In the formula of $C_{12}H_{22}O_{11}$ the carbon, hydrogen and oxygen combine in whole number ratio but the ratio is not simple.

Question 10.
How many times heavier is one atom of carbon than one atom of oxygen?
Answer:
Atomic mass of carbon = 12 u
Atomic mass of oxygen = 16 u
Therefore, one atom of carbon is $12u16u=34$ times heavier than one atom of oxygen.

Extra Questions Short Answer Questions-I

Question 1.
Give an example to show law of conservation of mass applies to physical changes also.
Answer:
Law of conservation of mass states that mass can neither be created nor destroyed in a chemical reaction. However, this law applies to physical changes also. For example, when ice melts into water, the mass of ice equals to the mass of water, i.e., the mass is conserved. This verifies the law of conservation of mass.

Question 2.
Which of the following symbols of elements are incorrect? Give their correct symbols.
(a) Cobalt CO
(b) Carbon c
(c) Aluminium AL
(d) Helium He

(e) Sodium So [NCERT Exemplar]
Answer:
(a) Incorrect, the correct symbol of cobalt is Co.
(b) Incorrect, the correct symbol of carbon is C.
(c) Incorrect, the correct symbol of aluminium is Al.
(d) Correct (He)
(e) Incorrect, the correct symbol of sodium is Na.

Question 3.
Which of the following are tri-atomic and tetra-atomic molecules?
CH_3Cl, $CaCl_2$, NH_3, PCl_3, P_2O_5, H_2O, C_2H_5OH
Answer:
(i) Tri-atomic molecules are $CaCl_2$, H_2O.
(ii) Tetra-atomic molecules are NH_3, PCl_3.

Question 4.
Differentiate between the actual mass of a molecule and gram molecular mass.
Answer:
Actual mass of a molecule is obtained by dividing the molar mass by Avogadro's number whereas gram molecular mass represents the molecular mass expressed in grams, i.e., it is the mass of 1 mole of molecules, i.e., Avogadro's number of molecules.

Question 5.
Calculate the formula mass of sodium carbonate ($Na_2CO_3.10H_2O$).
Answer:
Formula mass of sodium carbonate
= (2 × atomic mass of Na) + (1 × atomic mass of C) + (3 × atomic mass of O) + 10 [(2 × atomic mass of H) + (1 × atomic mass of O)]
= 2 × 23 + 1 × 12 + 3 × 16 + 10 [(2 × 1) + (1 × 16)]
= 46 + 12 + 48 + 180 = 286 u

Question 6.
Calculate the mass of one atom of hydrogen atom.
Answer:
1 mole of hydrogen atom = 1 g
or 6.022×10^{23} atoms of hydrogen weigh = 1 g
Mass of one atom = $\frac{1}{6.022 \times 10^{23}}$g
= 1.66058×10^{-24}g
Question 7.
How many moles are present in 4 g of sodium hydroxide?
Answer:
Gram molar mass of NaOH = 23 + 16 + 1 = 40 g
40 g of NaOH = 1 mol
∴ lg of NaOH = $\frac{1}{40}$mol
∴ 4 g of NaOH = $\frac{1}{40} \times 4$ mol = 0.1 mol

Question 8.
A sample of ammonia weighs 3.00 g. What mass of sulphur trioxide contains the same number of molecules as are in 3.00 g ammonia?
Answer:
Number of moles of ammonia in 3.00 g = 3.0017 mol
= 0.1764 mol
Molecular mass of $S0_3$ = 1 × 32u + 3 × 16u = 80u
1 mole of SO_3 weighs 80 g
∴ 0.1764 moles weigh = 80 × 0.1764 g
= 14.11 g
Question 9.
Carbon dioxide produced by action of dilute hydrochloric acid on potassium hydrogen carbonate is moist whereas that produced by heating potassium hydrogen carbonate is dry. What would be the difference in the composition of carbon dioxide in the two cases? State the associated law.
Answer:
The composition of CO_2 in both the cases would be same, i.e., the carbon and oxygen will combine in the same ratio 1 : 2.
The law associated is law of constant proportion.

Question 10.
How many atoms would be present in a black dot marked on the paper with graphite pencil as a full stop at the end of a sentence. [Given mass of a dot = 10^{-18} g]
Answer:
1 mole of carbon atoms weigh = 12 g
Also, 1 mole of carbon atoms = 6.0 2 2 × 10^{23} atoms
Thus, 12 g of carbon atoms has 6.022 × 10^{23} atoms.
∴ 10^{-18} g of carbon will have $6.022 \times 10^{23} 12 \times 10^{-18}$ × 10^{-18} carbon atoms
= 5.02 × 10^4 carbon atoms.
Question 11.
Does the solubility of a substance change with temperature? Explain with the help of an example. [NCERT Exemplar]
Answer:
Yes, it is a temperature dependent property. The solubility generally, increases with increase in temperature. For example, you can dissolve more sugar in hot water than in cold water.

Extra Questions Short Answer Questions-II

Question 1.
Write the cations and anions present (if any) in the following compounds:
(a) CH_3COONa
(b) NaCl
(c) H_2
(d) NH_4NO_3

Answer:
Anions Cations
(a) CH_3COO^- Na^+
(b) Cl^- Na^+
(c) H_2—It is a covalent compound
(d) NO^{-}_{3} NH^{+}_{4}
Question 2.
Calculate the mass percentage of oxygen present in the following compounds and state the law of chemical combination associated. Given, H = 1, O = 16.
(i) Water (H_2O) and
(ii) Hydrogen peroxide (H_2O_2)
Answer:
According to Law of multiple proportions
(i) H_2O % of O = $\frac{16}{18} \times 100 = 88.89\%$
(ii) H_2O_2, % of O = $\frac{32}{34} \times 100 = 94.12\%$
Question 3.
Classify each of the following on the basis of their atomicity.
(a) F_2
(b) NO_2
(c) CO^{2-}_{3}
(d) C_2H_6
(e) CO
(f) H_2O_2
(g) P_4O_{10}
(h) O_3
(i) HCl
(j) CH_4
(k) He
(l) Ag [NCERT Exemplar]
Answer:
(a) 2
(b) 3
(c) 4
(d) 8
(e) 2
(f) 4
(g) 14
(h)3
(i) 2
(j)5
(k) 1 (Noble gases do not combine and exist as monoatomic gases)
(l) Polyatomic: It is difficult to talk about the atomicity of metals as any measurable quantity will contain millions of atoms bound by metallic bond.
Question 4.
Calculate the molecular mass of the following:
(a) H_2CO_3

(b) C_2H_5OH
(C) $MgSO_4$
Answer:
(a) Molecular mass of H_2CO_3 = 2 × 1 + 1 × 12 + 3 × 16
= 2 + 12 + 48
= 62 u
(b) Molecular mass of C_2H_5OH = 2 × 12 + 5 × 1 + 1 × 16 + 1
= 24 + 5 + 16 + 1
= 46 u
(c) Molecular mass of $MgSO_4$ =1 × 24 + 1 × 32 + 4 × 16
= 24 + 32 + 64
= 120 u

Question 5.
What are ionic and molecular compounds? Give examples. [NCERT Exemplar]
Answer:
Atoms of different elements join together in definite proportions to form molecules of compounds. For example, water, ammonia, carbon dioxide. Compounds composed of metals and non-metals contain charged species. The charged species are known as ions. An ion is a charged particle and can be negatively or positively charged. A negatively charged ion is called an anion and the positively charged ion is called cation. For example, sodium chloride, calcium oxide.

Question 6.
Give three significance of mole.
Answer:

- One mole represents 6.022×10^{23} entities of a substance.
- One mole of an element contains 6.022×10^{23} atoms of the element.
- One mole of a substance represents one gram formula mass of the substance.

Question 7.
How many (a) molecules (b) hydrogen atoms (c) oxygen atoms are there in 0.5 mol of water?
Answer:
(a) 1 mol of water contains 6.022×10^{23} molecules
∴ 0.5 mol of water contains $\frac{6.022 \times 10^{23}}{2}$ molecules
= 3.011×10^{23} molecules
(b) 1 molecule of water contains 2 atoms of hydrogen
1 mol of water contains $2 \times 6.022 \times 10^{23}$ atoms of hydrogen
∴ 0.5 mol of water contains $\frac{2 \times 6.022 \times 10^{23}}{2}$ atoms of hydrogen
= 6.022×10^{23} atoms of hydrogen
(c) 1 molecule of water contains 1 atom of oxygen
1 mol of water contains 6.022×10^{23} atoms of oxygen

∴ 0.5 mol of water contains $6.022\times10^{23}2$ atoms of oxygen
= 3.011×10^{23} atoms of oxygen
Question 8.
Calculate the number of moles present in:
(i) 3.011×10^{23} number of oxygen atoms.
(it) 60 g of calcium
[Given that atomic mass of Ca = 40 u, Avogadro No. = 6.022×10^{23}]
Answer:
(i) 1 mole of oxygen contains 6.022×10^{23} atoms
∴ 6.022×10^{23} atoms of oxygen = 1 mol
1 atom of oxygen = $\frac{1}{6.022\times10^{23}}$ mol
∴ 3.011×10^{23} atoms of oxygen = $\frac{1\times3.011\times10^{23}}{6.022\times10^{23}}$ mol
= 0.5 mol
(ii) Atomic mass of Ca = 40 u
40g of calcium = 1 mol
60g of calcium = $\frac{60}{40}$ mol =1.5 mol
Question 9.
Calculate the mass per cent of each element of sodium chloride in one mole of it.
Answer:
Molecular mass of NaCl = (1 × 23 + 1 × 35.5) u = 58.5 u
Atomic mass of sodium = 23 u

$$\text{Mass per cent of Na} = \frac{\text{Atomic mass of Na}}{\text{Molecular mass of NaCl}} \times 100$$

$$= \frac{23}{58.5} \times 100 = \mathbf{39.32\%}$$

$$\text{Mass \% of Na} = 39.32\ \%$$

$$\text{Atomic mass of chlorine} = 35.5\ \text{u}$$

$$\text{Mass \% of Cl} = \frac{\text{Atomic mass of Cl}}{\text{Molecular mass of NaCl}} \times 100$$

$$= \frac{35.5}{58.5} \times 100 = \mathbf{60.68\ \%}$$

Question 10.
Calculate the number of particles in each of the following:
(a) 46 g of Na atom
(b) 8 g of O_2 molecules
(c) 0.1 moles of carbon atom
Answer:
(a) No. of moles of sodium = $\frac{46}{23}$ = 2 moles
We know that one mole of sodium contains 6.022×10^{23} atoms.
∴ 2 moles of sodium contain = $2 \times 6.022 \times 10^{23}$ atoms
= 1.204×10^{24} atoms

(b) 1 mole of oxygen = 32 g
32 g of 02 contains 6.02 2 × 10^{23} molecules
∴ 8 g of O_2 contains = $\frac{6.022 \times 10_{23}}{32}$ × 8 molecules
= 1.51 × 10^{23} molecules
(c) 1 mole of carbon atoms contains 6.022 × 10^{23} atoms
∴ 0.1 mole of carbon atoms contains = 6.022 × 10^{23} × 0.1 atoms
= 6.022 × 10^{22} atoms

Question 11.
Raunak took 5 moles of carbon atoms in a container and Krish also took 5 moles of sodium atoms in another container of same weight. [NCERT Exemplar]
(a) Whose container is heavier?
(b) Whose container has more number of atoms?
Answer:
(a) Mass of sodium atoms carried by Krish = (5 × 23) g = 115 g
Mass of carbon atoms carried by Raunak = (5 × 12) g = 60 g
Thus, Krish's container is heavier.
(b) Both the bags have same number of atoms as they have same number of moles of atoms.

Atoms and Molecules Class 9 Extra Questions Long Answer Questions

Question 1.
Arrange the following in order of decreasing masses:
(i) 10^{23} molecules of CO_2 gas
(ii) 0.1 g atom of silver
(iii) 1 gram of carbon
(iv) 0.1 mole of H_2SO_4
(v) 10^{23} atoms of calcium.
(Given Atomic masses: Ag = 108 u, S = 32 u, N = 14 u, Ca = 40 u)
Answer:
(i) 1 mole of CO_2= 44 g = 6.02 × 10^{23} molecules
i.e., 6.02 × 10^{23} molecules of CO_2 = 44 g of CO_2
10^{23} molecules of CO_2 = $\frac{44}{6.02 \times 10_{23}}$ × 10^{23} = 7.31 g
(ii) 1 g atom of Ag = Gram atomic mass of Ag = 108 g
∴ 0.1 g atom of Ag = 0.1 × 108 g = 10.8 g
(iii) 1 g of carbon = 1 g
(iv) 1 mole of H_2SO_4 = Gram molecular mass
= 2 × 1 + 32 + 4 × 16 = 98 g
∴ 0.1 mole of H_2SO_4 = 0.1 × 98 g = 9.8 g
(v) 1 mole of Ca = 40 g = 6.02 × 10^{23} atoms of Ca
i.e., 6.02 × 10^{23} atoms of Ca have mass = 40 g
∴ 10^{23} atoms of Ca have mass = $\frac{40}{6.02 \times 10_{23}}$ × 10^{23} = 6.64 g

Thus, masses in the decreasing order are: 0.1 g atom of Ag > 0.1 mole of H_2SO_4 > 10^{23} molecules of CO_2 > 10^{23} atoms of Ca > 1 g of carbon

Question 2.

Calculate the number of aluminium ions (Al^{3+}) in 0.056 g of alumina (Al_2O_3).

Answer:

Molecular mass of alumina (Al_2O_3) = 2 × Al^{3+} + 3 × O^{2-}

= 2 × 27 u + 3 × 16 u

= 102 u

Gram molecular mass = 102 g

1 mol of alumina (Al_2O_3) = 102 g

102 g of Al_2O_3 = 1 mol

∴ 0.056 g of Al_2O_3 = 1×0.056102 mol

= 5.49 × 10^{-4} mol

We know that one mol of alumina contains 2 mol of Al^{3+} ions.

∴ 5.49 × 10^{-4} mol of Al_2O_3 contains 2 × 5.49 × 10^{-4} mol of Al^{3+} ions

∴Number of Al^{3+} ions in 0.056 g = 2 × 5.49 × 10^{-4} × 6.022 × 10^{23}

= 6.613 × 10^{20} ions of Al^{3+}

Question 3.

Calculate the mass per cent of each element present in the molecule of calcium carbonate.

Answer:

Molecular formula of calcium carbonate = $CaCO_3$

Molecular mass of $CaCO_3$ = 1 × Ca + 1 × C + 3 × O

= 1 × 40u + 1 × 12u + 3 × 16u = 100u

Gram molecular mass =100 g/mol

1 mol of $CaC0_3$ = 100 g

$$(a)\ \text{Mass \% of Ca in } CaCO_3 = \frac{\text{Mass of Ca}}{\text{Molecular mass of } CaCO_3} \times 100$$

$$= \frac{40\text{g}}{100\text{g}} \times 100 = \mathbf{40\%}$$

$$(b)\ \text{Mass \% of carbon in } CaCO_3 = \frac{\text{Mass of carbon}}{\text{Molecular mass of } CaCO_3} \times 100$$

$$= \frac{12\text{g}}{100\text{g}} \times 100 = \mathbf{12\%}$$

$$(c)\ \text{Mass \% of oxygen in } CaCO_3 = \frac{\text{Mass of oxygen}}{\text{Molecular mass of } CaCO_3} \times 100$$

$$= \frac{48\text{g}}{100\text{g}} \times 100 = \mathbf{48\%}$$

Question 4.

Verify by calculating that

(a) 5 moles of CO_2 and 5 moles of H20 do not have the same mass.
(b) 240 g of calcium and 240 g of magnesium elements have a mole ratio of 3 : 5.
[NCERT Exemplar]
Answer:
(a) CO_2 has molar mass = 44 g mol^{-1}
5 moles of CO_2 have molar mass = 44 × 5 = 220 g
H_2O has molar mass = 18 g mol^{-1}
5 moles of H_2O have mass = 18 × 5g = 90g

(b) Number of moles in 240 g Ca metal = $\frac{240}{40}$ = 6
Number of moles in 240 g of Mg metal = $\frac{240}{40}$ = 10
Ratio is 6 : 10
or, 3 : 5
Question 5.
Find the ratio of mass of the combining elements in the following compounds:
(a) $CaCO_3$
(b) $MgCl_2$
(c) H_2SO_4
(d) C_2H_5OH
(e) NH_3
(f) $Ca(OH)_2$
Answer:
(a) $CaCO_3$
Ca : C : O × 3
40 : 12 : 16 × 3
40 : 12 : 48
10 : 3 : 12

(b) $MgCl_2$
Mg : Cl × 2
24 : 35.5 × 2
24 : 71

(c) H_2SO_4
H × 2 : S : O × 4
1 × 2 : 32 : 16 × 4
2 : 32 : 64
1 : 16 : 32

(d) C_2H_5OH
C × 2 : H × 6 : O
12 × 2 : 1 × 6 : 16
24 : 6 : 16
12 : 3 : 8

(e) NH_3
N : H × 3
14 : 1 × 3
14 : 3

(f) $Ca(OH)_2$
Ca : O × 2 : H × 2
40 : 16 × 2 : 1 × 2
40 : 32 : 2
20 : 16 : 1

Question 6.
Calcium chloride when dissolved in water dissociates into its ions according to the following equation.
$CaCl_2$ (aq) → Ca^{2+} (aq) + $2Cl^-$ (aq)
Calculate the number of ions obtained from $CaCl_2$ when 222 g of it is dissolved in water.
[NCERT Exemplar]
Answer:
1 mole of calcium chloride = 111 g
∴ 222 g of $CaCl_2$ is equivalent to 2 moles of $CaCl_2$
Since 1 formula unit $CaCl_2$ gives 3 ions, therefore, 1 mole of $CaCl_2$ will give 3 moles of ions.
2 moles of $CaCl_2$ would give 3 × 2 = 6 moles of ions.
Number of ions = Number of moles of ions × Avogadro number
= $6 \times 6.022 \times 10^{23}$
= 36.132×10^{23}
= 3.6132×10^{24} ions.

Question 7.
What is a mole? What is the unit of mole? How many molecules are there in a certain mass of a substance?
Answer:
A mole is the amount of a substance which contains the same number of chemical units (atoms, molecules or ions) as there are atoms in exactly 12 g of carbon-12. The unit of mole is given by the symbol 'mol'.
We know that Avogadro number is 6.022×10^{23}
Number of molecules in a certain mass

$$= \frac{\text{Mass of the substance}}{\text{Molar mass}} \times N_A$$

$$= \frac{W}{M} \times 6.022 \times 10^{23} \text{ molecules}$$

where 'W is the mass of the substance in which number of molecules is to be calculated and 'M' is the molecular mass of the substance.

Question 8.
The difference in the mass of 100 moles each of sodium atoms and sodium ions is 5.48002 g. Compute the mass of an electron. [NCERT Exemplar]
Answer:
A sodium atom and ion differ by one electron. For 100 moles each of sodium atoms and ions there would be a difference of 100 moles of electrons.

$$\text{Mass of 100 moles of electrons} = 5.48002 \text{ g}$$

$$\text{Mass of 1 mole of electron} = \frac{5.48002}{100} \text{ g}$$

$$\text{Mass of one electron} = \frac{5.48002}{100 \times 6.022 \times 10^{23}}$$

$$= 9.1 \times 10^{-28} \text{g}$$

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

Question 9.
The mass of one steel screw is 4.1 lg. Find the mass of one mole of these steel screws. Compare this value with the mass of the Earth (5.98×10^{24} kg). Which one of the two is heavier and by how many times? [NCERT Exemplar]
Answer:
1 mole of steel screws = 6.022×10^{23} screws
Mass of 1 screw = 4.11 g
∴ Mass of 1 mole of screws = $4.11 \times 6.022 \times 10^{23}$ g
= 24.75×10^{23} g = 2.475×10^{24} g
One mole of screw weighs = 2.475×10^{24} g = 2.475×10^{21} kg
$\frac{\text{Mass of the Earth}}{\text{Mass of 1 mole of screws}} = \frac{5.98 \times 10^{24} \text{kg}}{2.475 \times 10^{21} \text{kg}}$ = 2.4×10^{21}kg
Mass of Earth is 2.4×10^{3} times the mass of screws.
The Earth is 2400 times heavier than one mole of screws.
Question 10.
Compute the number of ions present in 5.85 g of sodium chloride. [NCERT Exemplar]
Answer:
5.85 g of NaCl = $\frac{5.85}{58.5}$ = 0.1 moles
or 0.1 moles of NaCl particle.
Each NaCl particle is equivalent to 2 ions, i.e., one Na^{2} and one Cl^{-}
⇒ Total moles of ions = 0.1 × 2 = 0.2 moles
Number of ions = $0.2 \times 6.022 \times 10^{23}$
= 1.2042×10^{23} ions
Question 11.
A gold sample contains 90% of gold and the rest copper. How many atoms of gold are present in one gram of this sample of gold? [NCERT Exemplar] .
Answer:
One gram of gold sample will contain $\frac{90}{100}$ = 0.9 g of gold
Number of moles of gold = $\frac{\text{Mass of gold}}{\text{Atomic mass of gold}}$
= $\frac{0.9}{197}$ = 0.0046
One mole of gold contains NA atoms = 6.022×10^{23}

∴ 0.0046 mole of gold will contain = $0.0046 \times 6.022 \times 10^{23}$
= 2.77×10^{21} atoms

Question 12.
Compute the difference in masses of one mole each of aluminium atoms and one mole of its ions. (Mass of an electron is 9.1×10^{-28} g). Which one is heavier? [NCERT Exemplar]

Answer:
Mass of 1 mole of aluminium atom = Molar mass of aluminium = 27 g mol^{-1}.
An aluminium atom needs to lose three electrons to become an ion. Al^{3+}.
For one mole of Al^{3+} ion, three moles of electrons are to be lost.
The mass of three moles of electrons = $3 \times (9.1 \times 10^{-28}) \times 6.0\ 2\ 2 \times 10^{23}$ g
= $27.3 \times 6.022 \times 10^{-5}$g
= 164.400×10^{-5}g = 0.00164 g
Molar mass of Al^{3+} = (27 – 0.00164) g mol^{-1}
= 26.9984 g mol^{-1}
Difference = 27 – 26.9984
= 0.0016 g

Question 13.
A silver ornament of mass 'm' gram is polished with gold equivalent to 1% of the mass of silver. Compute the ratio of the number of atoms of gold and silver in the ornament. [NCERT Exemplar]

Answer:
Mass of silver = m g

$$\text{Mass of gold} = \frac{m}{100}\text{g}$$

$$\text{Number of atoms of silver} = \frac{\text{Mass}}{\text{Atomic mass}} \times N_A = \frac{m}{108} \times N_A$$

$$\text{Number of atoms of gold} = \frac{m}{100 \times 197} \times N_A$$

$$\text{Ratio of number of atoms of gold to silver} = \text{Au} : \text{Ag}$$

$$= \frac{m}{100 \times 197} \times N_A : \frac{m}{108} \times N_A$$

$$= 108 : 100 \times 197$$

$$= 108 : 19700$$

$$= \mathbf{1 : 182.41}$$

Question 14.
A sample of ethane (C_2H_6) gas has the same mass as 1.5×10^{20} molecules of methane (CH_4). How many C_2H_6 molecules does the sample of gas contain? [NCERTExemplar]

Answer:

$$\text{Mass of 1 molecule of } CH_4 = \frac{16\ g}{N_A}$$

$$\text{Mass of } 1.5 \times 10^{20} \text{ molecules of methane} = \frac{1.5 \times 10^{20} \times 16}{N_A} g$$

$$\text{Mass of 1 molecule of } C_2H_6 = \frac{30}{N_A} g$$

$$\text{Mass of molecules of } C_2H_6 = \frac{1.5 \times 10^{20} \times 16}{N_A} g$$

$$\therefore \quad \text{Number of molecules of ethane} = \frac{1.5 \times 10^{20} \times 16}{N_A} \times \frac{N_A}{30} = \mathbf{0.8 \times 10^{20}}$$

Question 15.
In photosynthesis, 6 molecules of carbon dioxide combine with an equal number of water molecules through a complex series of reactions to give a molecule of glucose having a molecular formula $C_6H_{12}O_6$. How many grams of water would be required to produce 18 g of glucose? Compute the volume of water so consumed assuming the density of water to be lg cm^{-3}.
[NCERT Exemplar]
Answer:

$$6CO_2 + 6\ H_2O \xrightarrow[\text{Sunlight}]{\text{Chlorophyll}} C_6H_{12}O_6 + 6O_2$$

1 mole of glucose needs 6 moles of water

180 g of glucose needs (6 × 18) g of water

$$1g \text{ of glucose will need } \frac{108}{180} g \text{ of water.}$$

$$18 \text{ g of glucose would need } \frac{108}{180} \times 18 \text{ g of water} = 10.8 \text{ g}$$

$$\text{Volume of water used} = \frac{\text{Mass}}{\text{Density}}$$

$$= \frac{10.8 \text{ g}}{1 \text{ g cm}^{-3}} = \mathbf{10.8\ cm^3}$$

Question 16.
Calculate the ratio between the mass of one atom of hydrogen and mass of one atom of silver.
Answer:
1 mole of H atoms = 1 g
1 mole of H atoms = 6.022×10^{23} atoms.

Mass of 6.022×10^{23} atoms of H = 1 g

$$\therefore \text{Mass of one atom of H} = \frac{1}{6.022 \times 10^{23}} \text{ g}$$

$$= 1.66 \times 10^{-24} \text{ g}$$

1 mole of silver atoms = 108 g

1 mole of silver contains 6.022×10^{23} atoms

$$\therefore \ 6.022 \times 10^{23} \text{ atoms of silver} = 108 \text{ g}$$

$$\therefore \text{ Mass of one atom of silver atom} = \frac{108}{6.022 \times 10^{23}} \text{ g}$$

$$= 1.793 \times 10^{-22} \text{ g}$$

Ratio between masses of silver and hydrogen atoms

$$= \frac{1.793 \times 10^{-22} \text{g}}{1.66 \times 10^{-24} \text{g}}$$

$$= \mathbf{1.080 \times 10^{2}}$$

Extra Questions

Question 1.
A colourless liquid is thought to be a pure compound. Analysis of three samples of the material yield the following results.

	Mass of Sample	Mass of Carbon	Mass of Hydrogen
Sample 1	1.0 g	0.862 g	0.138 g
Sample 2	1.549 g	1.335 g	0.214 g
Sample 3	0.988 g	0.852 g	0.136 g

Could the material be a pure compound?
Answer:
Analysis

	Mass of Carbon	+	Mass of Hydrogen	=	Mass of Sample
Sample 1	0.862 g	+	0.138 g	=	1.0 g
Sample 2	1.335 g	+	0.214 g	=	1.549 g
Sample 3	0.852 g	+	0.136 g	=	0.988 g

Yes, the material is a pure compound as all the three samples have the same composition.

Question 2.
A big drop of water has volume 1.0 mL. How many molecules of water are there in this drop, If the density of water is lg/mL?

Answer:
Volume of drop of water = 1.0 mL
Density of water = 1.0 g/mL
∴ Mass of drop of water = Volume × Density = 1.0 g
Molecular mass of H_2O = 2 × lu + 1 × 16u = 18u
Gram molecular mass of water =18 g/mol
18 g of water contains = 6.02 2 × 10^{23} molecules
∴ 1 g of water contains = $\frac{6.022 \times 10^{23}}{18}$ molecules
= 3.34 × 10^{22} molecules
Question 3.
What is the fraction of the mass of water due to neutrons? [NCERT Exemplar]
Answer:
Mass of one mole (Avogadro Number) of neutrons ~ 1 g

$$\text{Mass of one neutron} = \frac{1}{\text{Avogadro Number } (N_A)}\text{ g}$$

$$\text{Mass of one molecule of water} = \frac{\text{Molar mass}}{N_A} = \frac{18}{N_A}\text{ g}$$

There are 8 neutrons in one atom of oxygen

$$\text{Mass of 8 neutrons} = \frac{8}{N_A}$$

$$\text{Mass of one molecule of water} = \frac{\text{Molar mass}}{N_A} = \frac{18}{N_A}\text{ g}$$

$$\text{Fraction of mass of water due to neutrons} \sim \frac{8}{18}.$$

Question 4.
You are provided with a fine white coloured powder which is either sugar or salt. How would you identify it without tasting? [NCERT Exemplar]
Answer:
On heating the powder, it will char if it is a sugar.
Alternatively, the powder may be dissolved in water and checked for its conduction of electricity. If it conductsm it is salt.

Question 5.
Calculate the number of electrons present in 15.4 g of carbon tetrachloride (CCl_4).
Answer:
Number of moles of CCl_4 = $\frac{\text{Mass of } CCl_4}{\text{Molecular mass of } CCl_4} = \frac{15.4g}{154g}$
∵ = 0.1 mole
1 mole of CCl_4 = 6.02 2 × 10^{23} molecules of CCl_4
∴ 0.1 mole of CCl_4 = 0.1 × 6.022 × 10^{23} molecules of CCl_4
= 6.022 × 10^{22} molecules of CCl_4
We know that one atom of carbon has 6 electrons and one atom of chlorine has 17

electrons. Therefore, one molecule of CCl_4 will contain 6 + (4 × 17) = 74 electrons.
∴ Number of electrons in 6.022×10^{22} molecules of CCl_4
$= 74 \times 6.022 \times 10^{22}$ electrons
$= 445.6 \times 10^{22}$ electrons
$= 4.456 \times 1o^{24}$ electrons

1. Which of the following correctly represents 360 g of water?
   (i) 2 moles of H_20
   (ii) 20 moles of water
   (iii) $6.022 \times 10_{23}$ molecules of water
   (iv) $1.2044 \times 10_{25}$ molecules of water

- (a) (i)
- (b) (i) and (iv)
- (c) (ii) and (iii)
- (d) (ii) and (iv)

2. Which of the following statements is not true about an atom?

- (a) Atoms are not able to exist independently
- (b) Atoms are the basic units from which molecules and ions are formed
- (c) Atoms are always neutral in nature
- (d) Atoms aggregate in large numbers to form the matter that we can see, feel or touch

3. The chemical symbol for nitrogen gas is

- (a) Ni
- (b) N_2
- (c) N^+
- (d) N

4. The chemical symbol for sodium is

- (a) So
- (b) Sd

- (c) NA
- (d) Na

5. Which of the following would weigh the highest?

- (a) 0.2 mole of sucrose ($C_{12}H_{22}O_{11}$)
- (b) 2 moles of CO_2
- (c) 2 moles of $CaCO_3$
- (d) 10 moles of H_2O

6. Which of the following has maximum number of atoms?

- (a) 18g of H_2O
- (b) 18g of O_2
- (c) 18g of CO_2
- (d) 18g of CH_4

7. Which of the following contains maximum number of molecules?

- (a) 1g CO_2
- (b) 1g N_2
- (c) 1g H_2
- (d) 1g CH_4

8. Mass of one atom of oxygen is

(a) $\frac{16}{6.023\times10^{23}}$ g (b) $\frac{32}{6.023\times10^{23}}$ g

(c) $\frac{1}{6.023\times10^{23}}$ g (d) 8u

9. 3.42 g of sucrose are dissolved in 18g of water in a beaker. The number of oxygen atoms in the solution are

- (a) 6.68×10^{23}
- (b) 6.09×10^{22}
- (c) 6.022×10^{23}
- (d) 6.022×10^{21}

10. A change in the physical state can be brought about

- (a) only when energy is given to the system
- (b) only when energy is taken out from the system
- (c) when energy is either given to, or taken out from the system

- (d) without any energy change

1. (d)	2. (a)	3. (b)	4. (d)	5. (c)
6. (d)	7. (c)	8. (a)	9. (a)	10. (c)