ATOMS AND MOLECULES

QUESTION BANK

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^- , SO2−4,PO3−4,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.

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 = 16.022×1023g
= 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 = 140mol
∴ 4 g of NaOH = 140 × 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 6.022×102312×10−18 × 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.

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 = 1618 × 100 = 88.89%
(ii) H_2O_2, % of O = 3234 × 100 = 94.12%

Question 3.
Classify each of the following on the basis of their atomicity.
(a) F_2
(b) NO_2
(c) CO2−3
(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 $H_2CO_3 = 2 \times 1 + 1 \times 12 + 3 \times 16$
$= 2 + 12 + 48$
$= 62$ u
(b) Molecular mass of $C_2H_5OH = 2 \times 12 + 5 \times 1 + 1 \times 16 + 1$
$= 24 + 5 + 16 + 1$
$= 46$ u
(c) Molecular mass of $MgSO_4 = 1 \times 24 + 1 \times 32 + 4 \times 16$
$= 24 + 32 + 64$
$= 120$ 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 6.022×10232 molecules
$= 3.011 \times 10^{23}$ 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 2×6.022×10232 atoms of hydrogen
$= 6.022 \times 10^{23}$ 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 6.022×10232 atoms of oxygen
$= 3.011 \times 10^{23}$ 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 = 16.022×1023 mol
∴ 3.011×10^{23} atoms of oxygen = 1×3.011×10236.022×1023 mol
= 0.5 mol
(ii) Atomic mass of Ca = 40 u
40g of calcium = 1 mol
60g of calcium = 6040 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

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

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

Mass % of Na = 39.32 %

Atomic mass of chlorine = 35.5 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 = 4623 = 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 $6.02\ 2 \times 10^{23}$ molecules
∴ 8 g of O_2 contains = 6.022×102332 × 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 = $6.022 \times 10^{23} \times 0.1$ 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.

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 $CO_2 = 446.02 \times 1023 \times 10^{23} = 7.31$ 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
$= 2 \times 1 + 32 + 4 \times 16 = 98$ g
∴ 0.1 mole of $H_2SO_4 = 0.1 \times 98$ 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 = $406.02 \times 1023 \times 10^{23} = 6.64$ 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) = $2 \times Al^{3+} + 3 \times O^{2-}$
$= 2 \times 27$ 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 $Al_2O_3 = 1 \times 0.056102$ mol
$= 5.49 \times 10^{-4}$ 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 $2 \times 5.49 \times 10^{-4}$ mol of Al^{3+} ions
∴Number of Al^{3+} ions in 0.056 g = $2 \times 5.49 \times 10^{-4} \times 6.022 \times 10^{23}$
= 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 = 24040 = 6
Number of moles in 240 g of Mg metal = 24040 = 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
Mass of the Earth Mass of 1 mole of screws =5.98×1024kg2.475×1021kg = 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 = 5.8558.5 = 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 90100 = 0.9 g of gold
Number of moles of gold = Mass of gold Atomic mass of gold
= 0.9197 = 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

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

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

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

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

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

$$= 108 : 100 \times 197$$

$$= 108 : 19700$$

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

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:

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

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

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

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

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

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

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

$$\therefore \text{Mass of one atom of H} = \frac{1}{6.022\times10^{23}}\text{ g}$$

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

1 mole of silver atoms = 108 g

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

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

$$\therefore \text{Mass of one atom of silver atom} = \frac{108}{6.022\times10^{23}}\text{ g}$$

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

Ratio between masses of silver and hydrogen atoms

$$= \frac{1.793\times10^{-22}\text{g}}{1.66\times10^{-24}\text{g}}$$

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

HOTS [Higher Order Thinking Skills]

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 = 6.022×102318 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 = Mass of CCl4 Molecular mass of CCl4=15.4g154g
∵ = 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 × 6.022 × 10^{22} electrons
= 445.6 × 10^{22} electrons
= 4.456 × 1o^{24} electrons