CHAPTER 3

Atoms and Molecules

1. NCERT INTEXT QUESTIONS

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 ethanoate. Show that these observations are in agreement with the law of conservation of mass.
Sodium carbonate + ethanoic acid → sodium ethanoate + carbon dioxide + water

Ans :

In the given reaction, sodium carbonate reacts with ethanoic acid to produce sodium ethanoate, carbon dioxide, and water. Sodium carbonate + Ethanoic acid → Sodium ethanoate + Carbon dioxide + Water

Mass of sodium carbonate = 5.3 g (Given)

Mass of ethanoic acid = 6 g (Given)

Mass of sodium ethanoate = 8.2 g (Given)

Mass of carbon dioxide = 2.2 g (Given)

Mass of water = 0.9 g (Given)

Now, total mass before the reaction

$= (5.3 + 6)$ g $= 11.3$ g

And, total mass after the reaction

$= (8.2 + 2.2 + 0.9)$ g $= 11.3$ g

Total mass before the reaction = Total mass after the reaction

Hence, the given observations are in agreement with the law of conservation of mass.

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?

Ans :

It is given that the ratio of hydrogen and oxygen by mass to form water is 1 : 8. Then, the mass of oxygen gas required to react completely with 1 g of hydrogen gas is 8 g.
Therefore, the mass of oxygen gas required to react completely with 3 g of hydrogen gas is 8×3 g $= 24$ g.

3. Which postulate of Dalton's atomic theory is the result of the law of conservation of mass?

Ans :

The postulate of Dalton's atomic theory, "Atoms are indivisible particles, which cannot be created or destroyed in a chemical reaction" is the result of the law of conservation of mass.

4. Which postulate of Dalton's atomic theory can explain the law of definite proportions?

Ans :

The postulate of Dalton, "The relative number and kinds of atoms are fixed in a given compound" can explain the law of definite proportions.

5. Define atomic mass unit.

Ans :

Mass unit equal to exactly one-twelfth the mass of one atom of carbon-12 is called one atomic mass unit. It is written as 'u'.

6. Why is it not possible to see an atom with naked eyes?

Ans :

The size of an atom is so small that it is not possible to see it with naked eyes. Also, the atom of an element does not exist independently.

7. Write down the formulae of :
(i) Sodium oxide
(ii) Aluminium chloride
(iii) Sodium sulphide
(iv) Magnesium hydroxide

Ans :

(i) Na_2O
(ii) $AlCl_3$
(iii) Na_2S
(iv) $Mg(OH)_2$

8. Write down the names of compounds represented by the following formulae :
(i) $Al_2(SO_4)_3$
(ii) $CaCl_2$
(iii) K_2SO_4
(iv) KNO_3
(v) $CaCO_3$

Ans :

(i) Aluminium sulphate
(ii) Calcium chloride
(iii) Potassium sulphate
(iv) Potassium nitrate
(v) Calcium carbonate

9. What is meant by the term chemical formula?

Ans :

The chemical formula of a compound is a symbolic representation of its composition.

10. How many atoms are present in a (i) H_2S molecule and (ii) PO_4^{3-} ion?

Ans :

(i) In an H_2S molecule, three atoms are present; two of hydrogen and one of sulphur.
(ii) In a PO_4^{3-} ion, five atoms are present; one of phosphorus and four of oxygen.

11. Calculate the molecular masses of H_2, O_2, Cl_2, CO_2, CH_4, C_2H_6, C_2H_4, NH_3, CH_3OH.

Ans :

Molecular mass of H_2 = 2 × Atomic mass of H
= 2 × 1 = 2 u

Molecular mass of O_2 = 2× Atomic mass of O
= 2 × 16 = 32 u

Molecular mass of $C1_2$ = 2× Atomic mass of Cl
= 2 × 35.5 = 71 u

Molecular mass of CO_2 = Atomic mass of C
+ 2 × Atomic mass of O
= 12 + 2 × 16 = 44 u

Molecular mass of CH_4 = Atomic mass of C
+ 4 × Atomic mass of H
= 12 + 4 × 1 = 16 u

Molecular mass of C_2H_6 = 2 × Atomic mass of C
+ 6 × Atomic mass of H
= 2 × 12 + 6 × 1 = 30 u

Molecular mass of C_2H_4 = 2 × Atomic mass of C
+ 4 × Atomic mass of H
= 2 × 12 + 4 × 1 = 28 u

Molecular mass of NH_3 = Atomic mass of N
+ 3 × Atomic mass of H
= 14 + 3 × 1 = 17 u

Molecular mass of CH_3OH = Atomic mass of C
+ 3 × Atomic mass of H
+ Atomic mass of O + Atomic mass of H
= 12 + 3 × 1 + 8 + 1 = 24 u

12. Calculate the formula unit masses of ZnO, Na_2O, K_2CO_3, given atomic masses of Zn = 65 u, Na = 23 u, K = 39 u, C = 12 u, and O = 16 u.

Ans :

Formula unit mass of ZnO
= Atomic mass of Zn + Atomic mass of O
= 65 + 16 = 81 u

Formula unit mass of Na_2O
= 2 × Atomic mass of Na + Atomic mass of O
= 2 × 23 + 16 = 62 u

Formula unit mass of K_2CO_3
= 2 × Atomic mass of K + Atomic mass of C
+ 3 × Atomic mass of 0
= 2 × 39 + 12 + 3 × 16
= 78 + 12 + 48 = 138 u

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

Ans :

One mole of carbon atoms weighs 12 g (Given)
i.e., mass of 1 mole of carbon atoms = 12 g
Then, mass of 6.022×10^{23} number of carbon atoms = 12 g
Therefore, mass of 1 atom of carbon

$$= \frac{12}{(6.022 \times 10^{23})}$$
$$= 1.9926 \times 10^{-23} \text{ g}$$

14. 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)?

Ans :

Atomic mass of Na = 23 u (Given)
Then, gram atomic mass of Na = 23 g
Now, 23 g of Na contains = 6.022×10^{23} number of atoms
Thus, 100 g of Na contains

$$= \frac{6.022 \times 10^{23}}{23} \times 100 \text{ number of atoms}$$
$$= 2.6182 \times 10^{24} \text{ number of atoms}$$

Again, atomic mass of Fe = 56 u (Given)
Then, gram atomic mass of Fe = 56 g
Now, 56 g of Fe contains = 6.022×10^{23} number of atoms
Thus, 100 g of Fe contains

$$= \frac{6.022 \times 10^{23}}{56} \times 100 \text{ number of atoms}$$
$$= 1.0753 \times 10^{24} \text{ number of atoms}$$

Therefore, 100 grams of sodium contain more number of atoms than 100 grams of iron.

2. NCERT EXERCISE QUESTIONS

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.

Ans :

Total mass of compound = 0.24 g (Given)
Mass of boron = 0.096 g (Given)
Mass of oxygen = 0.144 g (Given)
Thus, percentage of boron by weight in the compound

$= 0.096/0.24 \times 100\% = 40\%$

And, percentage of oxygen by weight in the compound

$= 0.144/0.24 \times 100\% = 60\%$

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 combinations will govern your answer?

Ans :

3.0 g of carbon combines with 8.0 g of oxygen to give 11.0 g of carbon dioxide.

If 3 g of carbon is burnt in 50 g of oxygen, then 3 g of carbon will react with 8 g of oxygen. The remaining 42 g of oxygen will be left un-reactive. In this case also, only 11 g of carbon dioxide will be formed. The above answer is governed by the law of constant proportions.

3. What are polyatomic ions? Give examples.

Ans :

A polyatomic ion is a group of atoms carrying a charge (positive or negative). For example : Nitrate (NO_3^-), hydroxide ion (OH^-).

4. Write the chemical formulae of the following :
(a) Magnesium chloride
(b) Calcium oxide
(c) Copper nitrate
(d) Aluminium chloride
(e) Calcium carbonate

Ans :

(a) $MgCl_2$
(b) CaO
(c) $Cu(NO_3)_2$
(d) $AlCl_3$
(e) $CaCO_3$

5. Give the names of the elements present in the following compounds :
(a) Quicklime
(b) Hydrogen bromide
(c) Baking powder
(d) Potassium sulphate

Ans :

(a) Calcium and oxygen (CaO)
(b) Hydrogen and bromine (HBr)
(c) Sodium, hydrogen, carbon, and oxygen ($NaHCO_3$)
(d) Potassium, sulphur, and oxygen (K_2SO_4)

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

Ans :

(a) Molar mass of ethyne,
$C_2H_2 = 2 \times 12 + 2 \times 1 = 26$ g
(b) Molar mass of sulphur molecule,
$S_8 = 8 \times 32 = 256$ g
(c) Molar mass of phosphorus molecule,
$P_4 = 4 \times 31 = 124$ g
(d) Molar mass of hydrochloric acid,
$HCl = 1 + 35.5 = 36.5$ g
(e) Molar mass of nitric acid,
$HNO_3 = 1 + 14 + 3 \times 16 = 63$ g

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_2SO_3)?

Ans :

(a) The mass of 1 mole of nitrogen atoms is 14 g.
(b) The mass of 4 moles of aluminium atoms is (4×27) g = 108 g
(c) The mass of 10 moles of sodium sulphite (Na_2SO_3) is $10 \times [2 \times 23 + 32 + 3 \times 16)$ g $= 10 \times 126$ g = 1260 g

8. Convert into mole :
(a) 12 g of oxygen gas
(b) 20 g of water
(c) 22 g of carbon dioxide

Ans :

(a) 32 g of oxygen gas = 1 mole
Then, 12 g of oxygen gas = 12/32 mole
= 0.375 mole

(b) 18 g of water = 1 mole, then, 20 g of water
= 20/18 mole = 1.111 mole

(c) 44 g of carbon dioxide
= 1 mole, then, 22 g of carbon dioxide
= 22/44 mole = 0.5 mole

9. What is the mass of :
(a) 0.2 mole of oxygen atoms?
(b) 0.5 mole of water molecules?

Ans :

(a) Mass of one mole of oxygen atoms = 16 g, then, mass of 0.2 mole of oxygen atoms $= 0.2 \times 16$ g = 3.2 g
(b) Mass of one mole of water molecule = 18 g
Then, mass of 0.5 mole of water molecules $= 0.5 \times 18$ g = 9 g

10. Calculate the number of molecules of sulphur (S_8) present in 16 g of solid sulphur.

Ans :

1 mole of solid sulphur (S_8) $= 8 \times 32$ g = 256 g
i.e., 256 g of solid sulphur contains
$= 6.022 \times 10^{23}$ molecules
Then, 16 g of solid sulphur contains

$= 6.022 \times 10^{23}/256 \times 16$ molecules

$= 3.76375 \times 10^{22}$ molecules

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)

Ans :

Mole of aluminium oxide (Al_2O_3)

$= 2 \times 27 + 3 \times 16 = 102$ g

i.e., 102 g of Al_2O_3 = 6.022×10^{23} molecules of Al_2O_3

Then, 0.051 g of Al_2O_3 contains

$= 6.022 \times 10^{23}/102 \times 0.051$ molecules

$= 3.011 \times 10^{20}$ molecules of Al_2O_3

The number of aluminium ions (Al^{3+}) present in one molecule of aluminium oxide is 2.

Therefore, the number of aluminium ions (Al^{3+}) present in 3.011×10^{20} molecules (0.051 g) of aluminium oxide (Al_2O_3) = $2 \times 3.011 \times 10^{20} = 6.022 \times 10^{20}$

3. NCERT EXEMPLAR

Objective Type Questions

1. Which of the following correctly represents 360 g of water?

(i) 2 moles of H_2O

(ii) 20 moles of water

(iii) 6.022×10^{23} molecules of water

(iv) 1.2044×10^{25} molecules of water

(a) (i) (b) (i) and (iv)

(c) (ii) and (iii) (d) (ii) and (iv)

Ans : (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.

Ans : (a) Atoms are not able to exist independently.

3. The chemical symbol for nitrogen gas is :

(a) Ni (b) N_2

(c) N^+ (d) N

Ans : (b) N_2

4. The chemical symbol for sodium is :

(a) So (b) Sd

(c) NA (d) Na

Ans : (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

Ans : (c) 2 moles of $CaCO_3$

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

(a) 18 g of H_2O (b) 18 g of O_2

(c) 18 g of CO_2 (d) 18 g of CH_4

Ans : (d) 18 g of CH_4

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

(a) 1 g CO_2 (b) 1 g N_2

(c) 1 g H_2 (d) 1 g CH_4

Ans : (c) 1 g H_2

8. Mass of one atom of oxygen is :

(a) $\frac{16}{6.023 \times 10^{23}\ g}$ (b) $\frac{32}{6.023 \times 10^{23}\ g}$

(c) $\frac{1}{6.023 \times 10^{23}\ g}$ (d) 8u

Ans : (a) $\frac{16}{6.023 \times 10^{23}\ g}$

9. 3.42 g of sucrose are dissolved in 18 g 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}

Ans : (a) 6.68×10^{23}

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.

Ans : (c) When energy is either given to, or taken out from the system.

Short Answer Questions

11. Which of the following represents a correct chemical formula? Name it.

(a) CaCl

(b) $BiPO_4$

(c) $NaSO_4$

(d) NaS

Ans :

(a) CaCl = Wrong (valency of Ca = 2, Cl = 1)

(b) $BiPO_4$ = Correct (valency of Bi = 3, PO_4 = 3)

(c) $NaSO_4$ = Wrong (valency of Na = 1, SO_4 = 2)

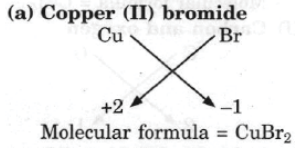
(d) NaS = Wrong (valency of Na = 1, Sulphide = 2)

12. Write the molecular formulae for the following

compounds :

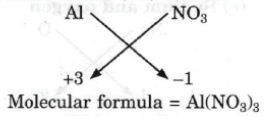
Ans :

(a) Copper (II) bromide



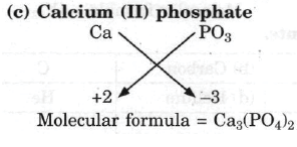
Molecular formula = $CuBr_2$

(b) Aluminium (III) nitrate



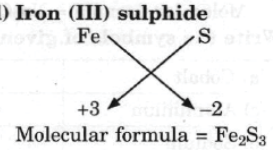
Molecular formula = $Al(NO_3)_3$

(c) Calcium (II) phosphate



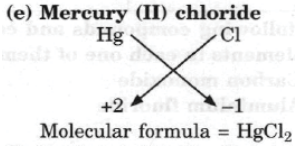
Molecular formula = $Ca_3(PO_4)_2$

(d) Iron (III) sulphide



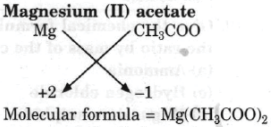
Molecular formula = Fe_2S_3

(e) Mercury (II) chloride



Molecular formula = $HgCl_2$

(f) Magnesium (II) acetate



Molecular formula = $Mg(CH_3COO)_2$

13. Write the molecular formulae of all the compounds that can be formed by the combination of given ions : Cu^{2+}, Na^+, Fe^{3+}, Cl^-, SO_4^{2-} PO_4^{3-}.

Ans :

$CuCl_2$, $CuSO_4$, $Cu_3(PO_4)$, NaCl, Na_2SO_4, Na_3PO_4, $FeCl_3$, $Fe(SO_4)_3$, $FePO_4$.

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

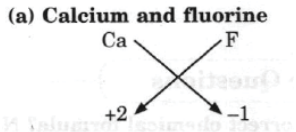
Ans :

Compounds	Cations	Anions
CH_3COONa	Na^+	CH_3COO^-
NaCl	Na^+	Cl^-
H_2	Nil	Nil
NH_4NO_3	NH_4^+	NO_3^-

15. Give the formulae of the compounds formed from the following sets of elements.

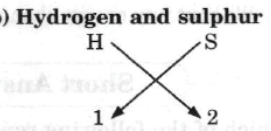
Ans :

(a) Calcium and fluorine



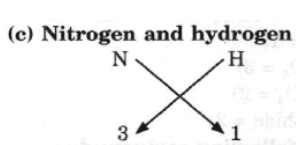
Molecular formula = CaF_2

(b) Hydrogen and sulphur



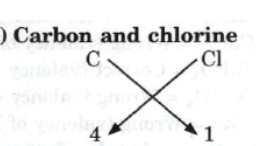
Molecular formula = H_2S

(c) Nitrogen and hydrogen



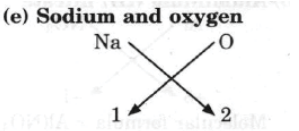
Molecular formula = NH_3

(d) Carbon and chlorine



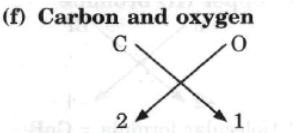
Molecular formula = CCl_4

(e) Sodium and oxygen



Molecular formula = Na_2O

(f) Carbon and oxygen



Molecular formula = CO_2

16. Write the symbols of given elements.

Ans :

(a) Cobalt	Co	(b) Carbon	C
(c) Aluminium	Al	(d) Helium	He
(e) Sodium	Na		

17. Give the chemical formulae for the following compounds and compute the ratio by mass of the combining elements in each one of them.
(a) Ammonia
(b) Carbon monoxide
(c) Hydrogen chloride
(d) Aluminium fluoride
(e) Magnesium sulphide

Ans :

(a) NH_3	(b) CO	(c) HCl	(d) AlF_3	(e) MgS
N : H × 3	C : O	H : Cl	Al : F × 3	Mg : S
14 : 1 × 3	12 : 16	1 : 35.5	27 : 19 × 3	24 : 32
14 : 3	3 : 4	1 : 35.5	9 : 19	3 : 4

18. State the number of atoms present in each of the following chemical species.
(a) CO_3^{2-} (b) PO_4^{3-} (c) P_2O_5 (d) CO

Ans :

(a)	CO_3^{2-}	1 + 3 = 4
(b)	PO_4^{3-}	1 + 4 = 5
(c)	P_2O_5	2 + 5 = 7
(d)	CO	1 + 1 = 2

19. What is the fraction of the mass of water due to neutrons?

Ans :

(i) Mass of 1 molecule of water = 18 amu
(ii) No. of proton in 2 atoms of H = 2 and no. of neutron = 0
(iii) No. of proton in 1 atom of O = 8 and no. of neutron = 8
(iv) Fraction of mass due to neutron in water $\frac{8}{18} = \frac{4}{9}$

20. Does the solubility of a substance change with temperature? Explain with the help of an example.

Ans :

Yes, it is a temperature dependent property. The solubility generally increases with increase in temperature. For example : We can dissolve more

sugar in hot water than in cold water.

21. You are provided with a fine white coloured powder which is either sugar or salt. How would you identify it without tasting?

Ans :

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 conducts, it is a salt.

Long Answer Questions

22. Verify by calculating that :

(a) 5 moles of CO_2 and 5 moles of H_2O do not have the same mass.

(b) 240 g of calcium and 240 g of magnesium elements have a mole ratio of 3 : 5.

Ans :

(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 × 5 g = 90 g

(b) Number of moles in 240 g Ca metal $\frac{240}{40} = 6$

Number of moles in 240 g of Mg metal 24 $= \frac{240}{24} = 10$

Ratio, 6: 10

3 : 5

23. Find the ratio by 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) $Ca(OH)_2$

Ans :

(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

24. Calcium chloride when dissolved in according to the following equation :

$$CaCl_{2(aq)} \longrightarrow Ca^{2+}_{(aq)} + 2Cl^{-}_{(aq)}$$

Calculate the number of ions obtained from $CaCl_2$ when 222 g of it is dissolved in water.

Ans :

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 mol of $CaCl_2$ will give 3 moles of ions.
2 moles of $CaCl_2$ would give 3 × 2 = 6 moles of ions

No. of ions = No. of moles of ions × Avogadro number

$= 6 \times 6.022 \times 10^{23}$

$= 36.132 \times 10^{23} = 3.6132 \times 10^{24}$ ions

25. Cinnabar (HgS) is a prominent ore of mercury. How many grams of mercury are present in 225 g of pure HgS? Molar mass of Hg and S are 200.6 g mol^{-1} and 32 g mol^{-1} respectively.

Ans :

Molar mass of HgS = 200.6 + 32

= 232.6 g mol^{-1}

Mass of Hg in 232.6 g of HgS = 200.6 g

Mass of Hg in 225 g of HgS $= \frac{200.6}{232.6} \times 225$

= 194.04 g

26. A sample of vitamin C is known to contain 2.58×10^{24} oxygen atoms. How many moles of oxygen atoms are present in the sample?

Ans :

1 mole of oxygen atoms = 6.022×10^{23} atoms
Number of moles of oxygen atoms

$$= \frac{2.58 \times 10^{24}}{6.022 \times 10^{23}}$$

$= 4.28$ mol

4.28 moles of oxygen atoms.

27. Raunak took 5 moles of carbon atoms in a container arid Krish also took 5 moles of sodium atoms in another container of same weight.

(a) Whose container is heavier?

(b) Whose container has more number of atoms?

Ans :

(a) Mass of sodium atoms carried by Krish

= (5 × 23) g = 115 g

While mass of carbon atom carried by Raunak

= (5 × 12) g = 60 g

Thus, Krish's container is heavy.

(b) Both the bags have same number of atoms as they have same number of moles of atoms.

28. Fill in the missing data in the table :

Species property	Water	CO_2	Na-Atom	$MgCl_2$
No. of moles	2	-----	---	0.5
No. of particles	-----	3.011×10^{23}	---	---
Mass	36 g	-----	115 g	---

Ans :

Species property	Water	CO_2	Na-Atom	$MgCl_2$
No. of moles	2	0.5 mole	5 moles	0.5
No. of particles	$2 \times 6.022 \times 10^{23}$	3.011×10^{23}	$5 \times 6.022 \times 10^{23}$	$0.5 \times 6.022 \times 10^{23} \times 3$
Mass	36 g	22 g	115 g	47.5 g

29. What is the SI prefix for each of the following multiples and submultiples of a unit?

(a)	10^3	(b)	10^{-1}
(c)	10^{-2}	(d)	10^{-6}
(e)	10^{-9}	(f)	10^{-12}

Ans :

(a)	kilo	(b)	deci
(c)	centi	(d)	micro
(e)	nano	(f)	pico

30. Express each of the following in kilograms :
(a) 5.84×10^{-3} mg
(b) 58.34 g
(c) 0.584 g
(d) 5.873×10^{-21} g

Ans :

(a) 5.84×10^{-9} kg
(b) 5.834×10^{-2} kg
(c) 5.84×10^{-4} kg
(d) 5.873×10^{-24} kg

31. Which has more number of atoms?
100 g of N_2 or 100 g of NH_3

Ans :

(i) $$100 \text{ g of } N_2 = \frac{100}{28} \text{ moles}$$

$$\text{Number of molecules} = \frac{100}{28} \times 6.022 \times 10^{23}$$

$$\text{Number of atoms} = 2 \times \frac{100}{28} \times 6.022 \times 10^{23}$$

$$= 43.01 \times 10^{23}$$

(ii) $$100 \text{ g of } NH_3 = \frac{100}{17} \text{ moles}$$

$$= \frac{100}{17} \times 6.022 \times 10^{23} \text{ molecules}$$

$$= \frac{100}{17} \times 6.022 \times 10^{23} \times 4 \text{ atoms}$$

$$= 141.69 \times 10^{23}$$

$\therefore$ NH_3 would have more atoms.

32. Compute the number of ions present in 5.85 g of sodium chloride.

Ans :

$$5.85 \text{ g of NaCl} = \frac{5.85}{58.5} = 0.1 \text{ mole}$$

or 0.1 mole of NaCl particle.
Each NaCl particle is equivalent to one Na^+ one Cl^- = 2 ions

$$\text{Total moles of ions} = 0.1 \times 2 = 0.2 \text{ mole}$$

$$\text{No. of ions} = 0.2 \times 6.022 \times 10^{23}$$

$$= 1.2042 \times 10^{23} \text{ ions}$$

33. 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?

Ans :

One gram of gold sample will contain $\frac{90}{100}$

$$= 0.9 \text{ g of gold}$$

$$\text{Number of moles of gold} = \frac{\text{Mass of gold}}{\text{Atomic mass of gold}}$$

$$= \frac{0.9}{197} = 0.0046$$

One mole of gold contains N_A atoms $= 6.022 \times 10^{23}$
$\therefore$ 0.0046 mole of gold will contain

$$= 0.0046 \times 6.022 \times 10^{23}$$

$$= 2.77 \times 10^{21}$$

34. What are ionic and molecular compounds? Give examples.

Ans :

Atoms of different elements join together in definite proportions to form molecules of compounds. Examples : 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. Examples : Sodium chloride, calcium oxide.

35. 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?

Ans :

Mass of 1 mole of aluminium atom = the 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

$$= 3 \times (9.1 \times 10^{-28}) \times 6.022 \times 10^{23} \text{ g}$$
$$= 27.3 \times 6.022 \times 10^{-5} \text{ g}$$
$$= 164.400 \times 10^{-5} \text{ g} = 0.00164 \text{ g}$$

Molar mass of Al^{3+} = (27 – 0.00164) g mol^{-1}

= 26.9984 g mol^{-1}

Difference = 27 – 26.9984 = 0.0016 g

36. 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.

Ans :

$$\text{Mass of silver} = \text{m g}$$
$$\text{Mass of gold} = \frac{m}{100} \text{ g}$$
$$\text{Number of atoms of silver} = \frac{\text{Mass}}{\text{Atomic mass}} \times N_A$$
$$= \frac{m}{108} \times N_A$$
$$\text{Number of atoms of gold} = \frac{m}{100} \times 197 \times N_A$$

Ratio of number of atoms of gold to silver

$$= \text{Au : Ag}$$
$$= \frac{m}{100} \times 197 \times N_A : \frac{m}{100} \times N_A$$
$$= 108 : 100 \times 197$$
$$= 108 : 19700 = 1 : 182.41$$

37. Fill in the blanks :

(a) In a chemical reaction, the sum of the masses of the reactants and products remains unchanged. This is called _____.

(b) A group of atoms carrying a fixed charge on them is called _____.

(c) The formula unit mass of $Ca_3(PO_4)_2$ is _____.

(d) Formula of sodium carbonate is _____ and that of ammonium sulphate is _____.

Ans :

(a) Law of conservation of mass

(b) Polyatomic ion

(c) (3 × atomic mass of Ca) + (2 × atomic mass of phosphorus) + (8 × atomic mass of oxygen) = 310

(d) Na_2CO_3; $(NH_4)_2SO_4$

38. Write the formulae for the following and calculate the molecular mass for each one of them :

(a) Caustic potash

(b) Baking powder

(c) Limestone

(d) Caustic soda

(e) Ethanol

(f) Common salt

Ans :

(a) KOH = (39 + 16 + 1) = 56 g mol^{-1}

(b) $NaHCO_3 = 23 + 1 + 12 + (3 \times 16) = 84$ g mol^{-1}

(c) $CaCO_3 = 40 + 12 + (3 \times 16) = 100$ g mol^{-1}

(d) NaOH = 23 + 16 + 1 = 40 g mol^{-1}

(e) $C_2H_5OH = C_2H_6O = 2 \times 12 + (6 \times 1) + 16 = 46$ g mol^{-1}

(f) NaCl = 23 + 35.5 = 58.5 g mol^{-1}

39. 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 1 g cm^{-3}.

Ans :

$$6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$$

1 mole of glucose needs 6 moles of water.

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

1 g 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

$$\text{Volume of water used} = \frac{\text{Mass}}{\text{Density}}$$
$$= 10.8 \text{ g}/1 \text{ g cm}^{-3}$$
$$= 10.8 \text{ cm}^3$$

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