ANSWER:

Given examples of the following are as follows :

a. Positive Radicals : Na^{+}, Fe^{2+},Ag^{+} Al^{3+},Cr^{3+},Fe^{3+},Au^{3+},Co^{2+},Ni^{2+},Hg^{2+},Sn^{2+}.

b. Basic Radical : Na^{+}, Fe^{2+},Ag^{+}, Al^{3+},Cr^{3+},Fe^{3+},Au^{3+},Co^{2+},Ni^{2+},Hg^{2+},Sn^{2+}.

c. Composite Radical : $SO_4{}^{2-}$,$NH_4{}^{+}$,$HCO_3{}^{-}$, $HSO_4{}^{-}$, $NO_4{}^{-}$.

d. Metal With Variable Valency : Cu(1+,2+), Hg(1+,2+) ,Fe(2+,3+).

e. Bivalent Acidic Radical : S^{2-} ,O^{2-} ,Se^{2-} .

f. Trivalent Basic Radical : Al^{3+} ,Cr^{3+},Fe^{3+},Au^{3+}.

Elements	Symbols	Charge
Mercury	Hg	Hg^{2+}
Potassium	K	K^{+}
Nitrogen	N	N^{3-}

Elements	Symbols	Charge
Copper	Cu	Cu^{2+}
Sulphur	S	S^{2-}
Carbon	C	C^{+}

Elements	Symbols	Charge
Chlorine	Cl	Cl^-
Oxygen	O	O^{2-}

3. Write the steps in deducing the chemical formulae of the following compounds.

a.Sodium sulphate :

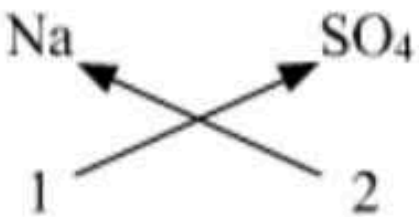
Step 1 : Write the symbols of the radicals.

Na SO_4

Step 2 : Write the valency below the respective radical.

Na	SO_4
1	2

Step 3 : Cross-multiply symbols of radicals with their respective valency.



Step 4 : Write down the chemical formula of the compound.

Na_2SO_4

b. Potassium nitrate :

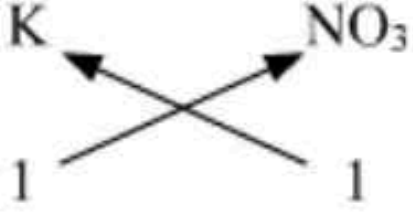
Step 1 : Write the symbols of the radicals

K NO_3

Step 2 : Write the valency below the respective radical.

K	NO_3
1	1

Step 3 : Cross-multiply symbols of radicals with their respective valency.



Step 4 : Write down the chemical formula of the compound.

KNO_3

c. Ferric phosphate :

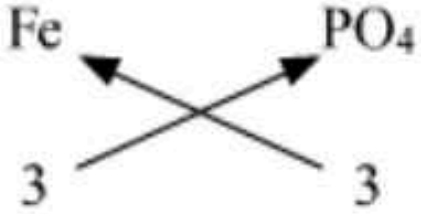
Step 1 : Write the symbols of the radicals

Fe PO_4

Step 2 : Write the valency below the respective radical.

Fe	PO_4
3	3

Step 3 : Cross-multiply symbols of radicals with their respective valency.



Step 4 : Write down the chemical formula of the compound.

$FePO_4$

d. Calcium oxide :

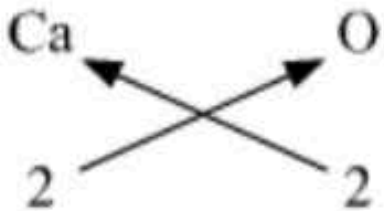
Step 1 : Write the symbols of the radicals

Ca O

Step 2 : Write the valency below the respective radical.

Ca	O
2	2

Step 3 : Cross-multiply symbols of radicals with their respective valency.



Step 4 : Write down the chemical formula of the compound.

CaO

e. Aluminium hydroxide :

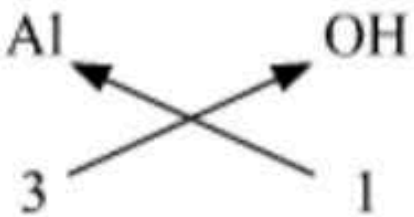
Step 1 : Write the symbols of the radicals

Al OH

Step 2 : Write the valency below the respective radical.

Al	OH
3	1

Step 3 : Cross-multiply symbols of radicals with their respective valency.



Step 4 : Write down the chemical formula of the compound.

$Al(OH)_3$

4. Write answers to the following questions and explain your answers.

a. Explain the monovalency of the element sodium.

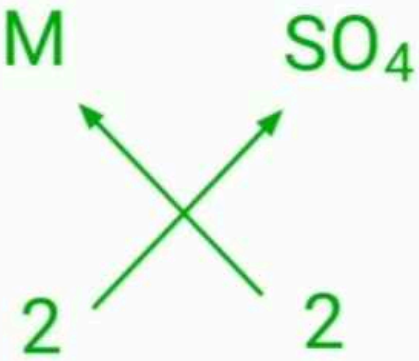
The electronic configuration of sodium is 2, 8, 1. There is only one electron in the outermost orbit of Na. If sodium atom gives one electron to an atom of some other elements, a sodium ion is formedocket. Hence the valency of sodium is one i.e. monovalent. After the give and take of electrons is over, the electronic configuration of both the resulting ions have complete ocket.

b. M is a bivalent metal. Write down the steps to find the chemical formulae of its compounds formed with the radicals : sulphate and phosphate.

The symbols and valencies of M and sulphate

Symbol	M	SO_4
Valentines	2	2

Cross multiply the valencies



The chemical formula is MSO_4.

c. Explain the need for a reference atom for atomic mass. Give some information about two reference atoms.

(1) Since the atom is very very small it is very difficult to determine its mass very accurately. Hence the concept of the relative mass was introduced.

(2) As the hydrogen atom (H) is the lightest it was taken as the reference atom in old days. The nucleus of H atom contains only one proton, therefore its mass was taken as one unit.

(3) The mass of nitrogen atom (N) is 14 times then that of the H atom. Hence the relative mass of the N atom was taken at 14 units. In this manner the relative masses of various elements were determined.

(4) In 1961 it was decided to take the the C-12 atom is the reference atom. In this the mass of C-12 atom is taken as 12 u. The mass of the hydrogen atom relative to that of the C-12 atom is equal to

$\frac{1}{12} \times 12$ u is equal to 1 u.

(Note : 1 u = $1.66053904 \times 10^{27}$ kg).

(5) On the relative atomic mass of scale, the mass of the proton is very nearly 1 u. Similarly the mass of the neutron is very nearly 1 u.

d. What is meant by Unified Atomic Mass ?

In the 20th century various instruments for accurate determination of atomic masses were developed. Therefore, instead of the relative atomic mass, it is now possible to determine the atomic masses in kg. Now unified atomic mass unit, called the dalton has been accepted as the unit for expressing atomic mass.

$1\ u = 1.66053904 \times 10^{-27} kg.$

e. Explain with examples what is meant by a 'mole' of a substance.

A mole is that quantity of substance whose mass in grams is equal in magnitude to the molecular mass of that substance in daltons. The SI unit is mole.

Examples :

The molecular mass of oxygen is 32 u;
32 g oxygen is 1 mole of oxygen.

The atomic mass of carbon is 12 u;
12 g carbon is 1 mole of carbon.

The molecular mass of H_2O is 18 u;

Examples :

18 g H_2O is 1 mole of water.

$$\text{Number of moles of a substance (n)} = \frac{\text{Mass of substance in grams}}{\text{Molecular mass of substance}}$$

5. Write the names of the following compounds and deduce their molecular masses.

Na_2SO_4 (Sodium sulphate)

Molecule	Constituents elements	Atomic masses	number of atoms in the molecule	Atomic mass × number of atoms	Mass of the constituents
Na_2SO_4 Sodium sulphate	Na Sodium	23	2	23 × 2	46
	S Sulphur	32	1	32 × 1	32
	O Oxygen	16	4	16 × 4	64

Molecular mass = Sum of constituent atomic masses

Molecular mass of Na_2SO_4 = (Atomic mass of Na) × 2 + (Atomic mass of S) × 1 + (Atomic mass of O) × 4

= (23 × 2) + (32 × 1) + (16 × 4) = 46 + 32 + 64 = 142

K_2CO_3 (Potassium carbonate)

Molecule	Constituents elements	Atomic masses	number of atoms in the molecule	Atomic mass × number of atoms	Mass of the constituents
K_2CO_3 Potassium carbonate	K Potassium	39	2	39 × 2	78
	C Carbon	12	1	12 × 1	12
	O Oxygen	16	3	16 × 3	48

Molecular mass = Sum of constituent atomic masses

Molecular mass of K_2CO_3 = (Atomic mass of K) × 2 + (Atomic mass of C) × 1 + (Atomic mass of O) × 3

= (39 × 2) + (12 × 1) + (16 × 3) = 78 + 12 + 48 = 138

Molecular mass of K_2CO_3 = 138 u.

CO_2 (Carbon dioxide)

Molecule	Constituents elements	Atomic masses	number of atoms in the molecule	Atomic mass × number of atoms	Mass of the constituents
CO_2 Carbon dioxide	C Carbon	12	1	12 × 1	12
	O Oxygen	16	2	16 × 2	32

Molecular mass = Sum of constituent atomic masses

Molecular mass of CO_2 = (Atomic mass of C) × 1 + (Atomic mass of O) × 2

= (12 × 1) + (16 × 2) = 12 + 32 = 44

Molecular mass of CO_2 = 44 u.

$MgCl_2$ (Magnesium chloride)

Molecule	Constituents elements	Atomic masses	number of atoms in the molecule	Atomic mass × number of atoms	Mass of the constituents
$MgCl_2$ Magnesium chloride	Mg Magnesium	24	1	24 × 1	24
	Cl Chloride	35.5	2	35.5 × 2	71

Molecular mass = Sum of constituent atomic masses

Molecular mass of $MgCl_2$ = (Atomic mass of Mg) × 1 + (Atomic mass of Cl) × 2

= (24 × 1) + (35.5 × 2) = 24 + 71 = 95

Molecular mass of $MgCl_2$ = 95 u.

NaOH (Sodium hydroxide)

Molecule	Constituents elements	Atomic masses	number of atoms in the molecule	Atomic mass × number of atoms	Mass of the constituents
NaOH Sodium hydroxide	Na Sodium	23	1	23 × 1	23
	O Oxygen	16	1	16 × 1	16
	H Hydrogen	1	1	1 × 1	1

Molecular mass = Sum of constituent atomic masses

Molecular mass of NaOH = (Atomic mass of Na) × 1 + (Atomic mass of O) × 1 + (Atomic mass of H) × 1

$= (23 \times 1) + (16 \times 1) + (1 \times 1) = 23 + 16 + 1 = 40$

Molecular mass of NaOH = 40 u.

$AlPO_4$ (Aluminium phosphate)

Molecule	Constituents elements	Atomic masses	number of atoms in the molecule	Atomic mass × number of atoms	Mass of the constituents
$AlPO_4$ Aluminium phosphate	Al Aluminium	27	1	27 × 1	27
	P Phosphorus	31	1	31 × 1	31
	O Oxygen	16	4	16 × 4	64

Molecular mass = Sum of constituent atomic masses

Molecular mass of $AlPO_4$ = (Atomic mass of Al) × 1 + (Atomic mass of P) × 1 + (Atomic mass of O) × 4

= (27 × 1) + (31 × 1) + (16 × 4) = 27 + 31 + 64 = 122

Molecular mass of $AlPO_4$ = 122 u.

$NaHCO_3$ (Sodium bicarbonate)

Molecule	Constituents elements	Atomic masses	number of atoms in the molecule	Atomic mass × number of atoms	Mass of the constituents
$NaHCO_3$ Sodium bicarbonate	Na Sodium	23	1	23 × 1	23
	H Hydrogen	1	1	1 × 1	1
	C Carbon	12	1	12 × 1	12
	O Oxygen	16	3	16 × 3	48

Molecular mass = Sum of constituent atomic masses

Molecular mass of $NaHCO_3$ = (Atomic mass of Na) × 1 + (Atomic mass of H) × 1 + (Atomic mass of C) × 1 + (Atomic mass of O) × 3

= (23 × 1) + (1 × 1) + (12 × 1) + (16 × 3) = 23 + 1 + 12 + 48 = 84

Molecular mass of $NaHCO_3$ = 84 u.

6. Two samples 'm' and 'n' of slaked lime were obtained from two different reactions. The details about their composition are as follows.

‘sample m’ mass : 7g
Mass of constituent oxygen : 2g
Mass of constituent calcium : 5g

‘sample n’ mass : 1.4g
Mass of constituent oxygen : 0.4g
Mass of constituent calcium : 1.0g

Which law of chemical combination does this prove ? Explain.

(1) Slaked lime have two samples 'm' and 'n'. From 7 g of sample m, 5 g of Ca and 2 g of oxygen were obtained, that means in sample m, the elements Ca and O are in the proportion 5 : 2 by weight.

(2) Similarly, from 1.4 g of sample 'n' 1 g of Ca and 0.4 g of oxygen were obtained that means in sample n, the elements Ca and O are in the proportion 1 : 0.4 by weight of Ca and O in different samples (m and n) remains constant.

Sample m Ca : O 5 : 2

Sample n Ca : O 1 : 0.4 i.e. 5 : 2

This proves the law of constant proportion. The proportion by weight of the constituent elements (Ca and O) in different samples of a compound (m and n) is fixed.

7. Deduce the number of molecules of the following compounds in the given quantities.

32g oxygen

Molecular mass of oxygen = $\begin{matrix} 16 + 16 \\ O \quad O \end{matrix}$ = 32

$\therefore$ 1 mole of oxygen (O) = 32 g of oxygen

1 mole of oxygen contains 6.022×10^{23} molecules

$\therefore$ 32 g of oxygen contains 6.022×10^{23} molecules

90g water

Molecular mass of water = $(2 \times 1) + 16 = 18$

$2H \quad O$

$\therefore$ 1 mole of H_2O = 18 g H_2O

The number of moles of H_2O =

$$\frac{\text{Weight of water}}{\text{Molecular mass of water}} = \frac{90}{18} = 5 \text{ mole } H_2O$$

1 mole of oxygen contains 6.022×10^{23} molecules

$\therefore$ 5 mole of water contains $= 5 \times 6.022 \times 10^{23}$

$= 30.022 \times 10^{23}$

90 g water contains $= 3.002 \times 10^{24}$ molecules

8.8g carbon dioxide

Molecular mass of carbon dioxide = $12 + 16 + 16 = 44$

C O O

$\therefore$ 1 mole of CO_2 = 44 g CO_2

$$\text{The number of moles of } CO_2 = \frac{\text{Weight of } CO_2}{\text{Molecular mass of } CO_2}$$

$\therefore$ 0.2 mole of CO_2 contains $= 0.2 \times 6.022 \times 10^{23}$

$= 1.2044 \times 10^{23}$ molecules

8.8 g CO_2 contains 1.2044×10^{23} molecules

7.1g chlorine

Molecular mass of chlorine (Cl_2)

= 35.5 + 35.5 = 71

= Cl Cl

$\therefore$ 1 mole of chlorine = 71 g chlorine

$$\text{The number of moles of } Cl_2 = \frac{\text{Weight of chlorine}}{\text{Molecular mass of chlorine}}$$

$$= \frac{7.1}{71} = 0.1$$

$$= 0.1 \text{ mole } Cl_2$$

1 mole of chlorine contains = 6.022×10^{23} molecules

$= 0.1$ mole chlorine contains

$= 0.1 \times 6.022 \times 10^{23}$

$= 0.6022 \times 10^{23}$

$= 6.022 \times 10^{22}$ molecules

7.1 g chlorine contains 6.022×10^{22} molecules

8. If 0.2 mol of the following substances are required how many grams of those substances should be taken.

Sodium chloride (NaCl)

Molecular mass of sodium chloride = 23 + 35.5 = 58.5

Na Cl

$\therefore$ 1 mole of NaCl = 58.5 g of NaCl

Mass of NaCl in grams

$$= \text{Number of moles of NaCl} \times \text{Molecular mass}$$

$$= 0.2 \times 58.5$$

$$= 11.7 \text{ g}$$

$$0.2 \text{ mole of NaCl} = 11.7 \text{ g NaCl}$$

Magnesium oxide (MgO)

Molecular mass of magnesium oxide = 24 + 16

Mg O

= 40

$\therefore$ 1 mole of MgO = 40.0 g of MgO

Mass of MgO in grams

= Number of moles of MgO × Molecular mass

= 0.2 × 40

= 8.0 g

0.2 mole of MgO = 8.0 g of MgO

Calcium carbonate ($CaCO_3$)

Molecular mass of calcium carbonate = 40 + 12 + 48

Ca C O

= 100

$\therefore$ 1 mole of $CaCO_3$ = 100 g of $CaCO_3$

Mass of Calcium carbonate in grams

= Mass of moles of $CaCO_3$ × Molecular mass

= 0.2 × 100

= 20 g

0.2 mole of $CaCO_3$ = 20 g of $CaCO_3$