# Chapter 4. The Language of Chemistry

## Exercise 4

### Solution 1.

(a) 

(b) gram

(c) molecular formula

(d) basic, acidic

(e) 4, 3, 2, 1

(f) 2, 3

(g) $Fe_2[CO_3]_3$

### Solution 2.

| Acid Radicals → / Basic Radicals ↓ | Chloride | Nitrate | Sulphate | Carbonate | Hydroxide | Phosphate |
|---|---|---|---|---|---|---|
| Magnesium | $MgCl_2$ | $Mg(NO_3)_2$ | $MgSO_4$ | $MgCO_3$ | $Mg(OH)_2$ | $Mg_3(PO_4)_2$ |
| Sodium | NaCl | $NaNO_3$ | $Na_2SO_4$ | $Na_2CO_3$ | NaOH | $Na_3PO_4$ |
| Zinc | $ZnCl_2$ | $Zn(NO_3)_2$ | $ZnSO_4$ | $ZnCO_3$ | $Zn[OH]_2$ | $Zn_3[PO_4)_2$ |
| Silver | AgCl | $AgNO_3$ | $Ag_2SO_4$ | $Ag_2CO_3$ | AgOH | $Ag_3PO_4$ |
| Ammonium | $NH_4Cl$ | $NH_4NO_3$ | $[NH_4]_2SO_4$ | $[NH_4]_2SO_4$ | NH4OH | $[NH_4]_3PO_4$ |
| Calcium | $CaCl_2$ | $Ca(NO_3)_2$ | $CaSO_4$ | $CaCO_3$ | $Ca[OH]_2$ | $Ca_3[PO_4]_2$ |
| Iron (II) | $FeCl_2$ | $Fe(NO_3)_2$ | $FeSO_4$ | $FeCO_3$ | $Fe[OH]_2$ | $Fe_3[PO_4]_2$ |
| Potassium | KCl | $KNO_3$ | $K_2SO_4$ | $K_2CO_3$ | KOH | $K_3PO_4$ |

### Solution 3.

Sodium chloride + Silver nitrate Silver chloride + Sodium nitrate

(a) Equation $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$

(b) Yes, the equation is balanced.

(c) $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$

$(23 + 35.5)\ (108 + 14 + 48)\ (108 + 35.5)\ (23 + 14 + 48)$

**Wt. of reactants 228.5g** **Wt. of products 228.5g**

(d) This equation satisfies the "Law of Conservation of Mass."
Law of Conservation of mass: "Matter is neither created nor destroyed in course of a chemical reaction."

## Solution 4.

**(a)**

$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

This equation conveys following information:

1. The actual result of chemical change.
2. The substances take part in a chemical reaction and substances formed as a result of reaction.
3. Here one molecule of zinc, one molecule ofSulphuric acid react to give one molecule of zinc sulphate and one molecule of Hydrogen.
4. Composition of respective molecules i.e. one molecule ofsulphuric acid contains two atoms of hydrogen, one atom of sulphur and four atoms of oxygen.
5. Relativemoleculer masses of different substances i.e. molecular mass of
   Zn= 65, $H_2SO_4$ (2+32+64) = **98**
   $ZnSO_4$ (65+32+64) = **161**
   $H_2$ = **2**
6. 22.4 litres of hydrogen are formed at S.T.P.

**(b)**

$Mg + 2HCl_2 \rightarrow MgCl_2 + H_2$

This equation conveys following information:

1. Magnesium reacts with of Hydrochloric acid to form Magnesium chloride and Hydrogen gas.
2. 24g of Magnesium react with 2(1 + 35.5) = 73g of Hydrochloric acid to produce (24 + 71) i.e. 95g of Magnesium chloride
3. That Hydrogen produced out at S.T.P. is 22.4 liters.

**Solution 5.**

(a) A poly-atomic ion is a charged ion composed of two or more atoms covalently bounded that can be carbonate ($CO_3^{2-}$) and sulphate ($SO_4^{2-}$)

(b) The fundamental laws which are involved in every equation are:

1. A chemical equation consists of formulae of reactants connected by plus sign (+) and arrow (→) followed by the formulae of products connected by plus sign (+).
2. The sign of an arrow (→) is to read 'to form'. It also shows the direction in which reaction is predominant.

**Solution 6.**

(a) two
(b) six
(c) three
(d) four
(e) (i) three (ii) five (iii) four (iv) two

**Solution 7.**

According to law of conservation of mass, "matter can neither be created nor be destroyed in a chemical reaction". This is possible only, if total number of atoms on the reactants side is equals to total number of atoms on products side. Thus, a chemical reaction should be always balanced.

Let us consider an example,
$Fe + H_2O \rightarrow Fe_3O_4 + H_2$
In this equation number of atoms on both sides is not the same, the equation is not balanced.
The balanced form of this equation is given by,
$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$

**Solution 8.**

(a) $3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$

(b) $3Ca + N_2 \rightarrow Ca_3N_2$

(c) $Zn + 2KOH \rightarrow K_2ZnO_2 + H_2$

(d) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

(e) $3PbO + 2NH_3 \rightarrow 3Pb + 3H_2O + N_2$

(f) $2Pb_3O_4 \rightarrow 6PbO + O_2$

(g) $2PbS + 3O_2 \rightarrow 2PbO + 2SO_2$

(h) $S + 2H_2SO_4 \rightarrow 3SO_2 + 2H_2O$

(i) $S + 6HNO_3 \rightarrow H_2SO_4 + 6NO_2 + 2H_2O$

(j) $MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$

(k) $C + 2H_2SO_4 \rightarrow CO_2 + 2H_2O + 2SO_2$

(l) $6KOH + 3Cl_2 \rightarrow 5KCl + KClO + 3H_2O$

(m) $2NO_2 + H_2O \rightarrow HNO_2 + HNO_3$

(n) $Pb_3O_4 + 8HCl \rightarrow 3PbCl_2 + 4H_2O + Cl_2$

(o) $2H_2O + 2Cl_2 + \text{Sunlight} \rightarrow 4HCl + O_2$

(p) $2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$

(q) $2HNO_3 + H_2S \rightarrow 2NO_2 + 2H_2O + S$

(r) $P + 5HNO_3 \rightarrow 5NO_2 + H_2O + H_3PO_4$

**Solution 9.**

(a) $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

(b) $2KHCO_3 + H_2SO_4 \rightarrow K_2SO_4 + 2CO_2 + 2H_2O$

(c) $Fe + H_2SO_4 \rightarrow Fe(SO_4) + H_2$

(d) $Cl_2 + SO_2 + 2H_2O \rightarrow H_2SO_4 + 2HCl$

(e) $2AgNO_3 \rightarrow 2Ag + 2NO_2 + O_2$

(f) $3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$

(g) $4NH_3 + 5O_2 \xrightarrow{Pt,\ 800^oC} 6H_2O + 4NO\ ? + Heat$

(h) $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$

(i) $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$

(j) $Al_4C_3 + 12H_2O \rightarrow 4Al(OH)_3 + 3CH_4$

(k) $4FeS_2 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2$

(l) $2KMnO_4 + HCl \rightarrow 2KCl + 2MnCl_2 + 5Cl_2 + 8H_2O$

(m) $Al_2(SO_4)_3 + 8NaOH \rightarrow 3Na_2SO_4 + 2NaAlO_2 + 4H_2O$

(n) $2Al + 2NaOH + 2H_2O \rightarrow 2NaAlO_2 + 3H_2$

(o) $2K_2Cr_2O_7 + 8H_2SO_4 \rightarrow 2K_2SO_4 + 2Cr_2(SO_4)_3 + 8H_2O + 3O_2$

(p) $K_2Cr_2O_7 + 14HCl \rightarrow 2KCl + 2CrCl_3 + 7H_2O + 3Cl_2$

(q) $S + 6HNO_3 \rightarrow H_2SO_4 + 6NO_2 + 2H_2O$

(r) $2KI + 2MnO_2 + 4H_2SO_4 \rightarrow I_2 + 2KHSO_4 + 2MnSO_4 + 4H_2O$

## Solution 10.

**(a)** The atomic mass unit (amu) is defined as $1/12^{th}$ of the mass of an atom of carbon.

1 a.m.u. = $1.67 \times 10^{-24}$ gm = $1.67 \times 10^{-27}$ kg
1 gm mass = $6.02 \times 10^{23}$ a.m.u. and 1 kg mass = $6.02 \times 10^{26}$ a.m.u. **(b)**

(i) The relative molecular mass of = $CuSO_45H_2O$
= 63.5 + 32 + (16 x 4) + 5 (2 + 16)
= 159.5 + 90 = **249.5**

(ii) The relative molecular mass of = $(NH_4)_2CO_3 = N_2H_8CO_3$
= 14 x 2 + 1 x 8 + 12 + 3 x 16
= 28 + 8 + 12 + 48 = **96**

(iii) The relative molecular mass of = $(NH_2)_2CO = N_2H_4CO$
= 2 x 14 + 1 x 4 + 12 + 16
= 28 + 4 + 12 + 16 = **60**

(iv) The relative molecular mass of = $Mg_3N_2$ = 3 x 24 + 2 x 14 = 72 + 28 = **100**

## Solution 11.

**(a)** (iii) Berzelius
**(b)** (i) One
**(c)** (iii) $Fe_2(SO_4)_3$
**(d)** (i) 1: 8
**(e)** (ii) $Ca(HCO_3)_2$

**Solution 12.**

(a) A molecular formula represent The Molecule of an element or of a Compound.
(b) The molecular formula of water ($H_2O$) represents 18 parts by mass of water.
(c) A balanced equation obeys the law of conservation of mass wherever unbalanced equation does not obey this law.
(d) CO and Co represent carbon-monoxide and cobalt respectively.