# **Answers of Questions 1 to 5 and 7(d) to 10 are:**

# **1. C; 2.C; 3.D; 4.C;**

# **A: 8, 2, VI; B: 12, 3, II, C: 19, 4, I; D: 10, 2, O; E: 31, 4, III; F: 53, 5, VII;**

# **7. (d) P: metal, Q: semi-metal, R: metal, S: semi-metal, T: non-metal, U: metal**

**8.(a) 2; 8.(b) They have the same number of electrons in the outermost shell;**

**8.(c) The reactivity increases;**

**8.(d)(i) Be dose not react with water; (ii) Ba reacts quickly with water.**

**8.(e) Barium should be stored in paraffin oil.**

**9.(a) more, less; 9.(b) less, more, do not**

**10.(a) magnesium; 10.(b) fluorine; 10.(c) chlorine; 10.(d) sodium**

# **(IV) Naming of Chemical Compounds and Chemical Formulae**

1. Writing Chemical Formulae

(a) element of metal (more positive) comes first followed by element of non-metal (more negative);

(b) take into account the combining equivalent; (so as to keep a compound neutral)

(c) brackets are added to avoid confusion.

**Names and formulae of common ions:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Positive ion (\_\_Cation\_\_\_\_\_\_\_)** | | | **Negative ion (\_\_\_Anion\_\_\_\_\_\_\_\_)** | | |
| *Charge* | *Formula* | *Name* | *Charge* | *Formula* | *Name* |
| 1+ | H+  Na+  K+  Ag+  NH4+ | \_hydrogen ion\_\_\_\_\_  \_sodium ion\_\_\_\_\_\_  \_potassium ion\_\_\_\_  \_\_silver ion\_\_\_\_\_\_\_  \_\_ammonium ion\_\_\_ | 1- | H–  OH–  Cl–  NO3–  NO2–  HCO3– | \_hydride ion\_\_\_\_\_\_\_  \_hydroxide ion\_\_\_\_\_  \_chloride ion\_\_\_\_\_\_\_  \_nitrate ion\_\_\_\_\_\_\_\_  \_nitrite ion \_\_\_\_\_\_\_\_  \_hydrogencarbonate ion |
| 2+ | Mg2+  Ca2+  Fe2+  Cu2+  Zn2+ | \_magnesium ion\_\_\_  \_calcium ion\_\_\_\_\_\_  \_iron(II) ion\_\_\_\_\_\_\_  \_copper(II) ion\_\_\_\_\_  \_zinc ion\_\_\_\_\_\_\_\_\_ | 2- | O2-  S2-  SO42-  SO32-  CO32- | \_oxide ion\_\_\_\_\_\_\_\_\_  \_sulphide ion\_\_\_\_\_\_\_  \_sulphate ion\_\_\_\_\_\_\_  \_sulphite ion\_\_\_\_\_\_\_  \_carbonate ion\_\_\_\_\_\_ |
| 3+ | Al3+  Fe3+ | \_aluminium ion\_\_\_  \_iron(III) ion\_\_\_\_\_ | 3- | N3-  PO43- | \_nitride ion\_\_\_\_\_\_\_\_\_  \_phosphate ion\_\_\_\_\_\_ |

**Properties of an atom and its ion:**

An atom and its ion, though with the same nucleus, have entirely \_\_different\_\_\_\_\_ physical and chemical properties. This is because they have different number of \_\_\_electrons\_\_\_\_\_\_\_\_\_ and therefore different electronic arrangement.

e.g. sodium metal is very reactive and chlorine gas is poisonous but sodium ions and chloride ions in sodium chloride are edible.

2. ***-ide***:

* + 1. binary combinations of two elements, usually one metal and one non-metal.
    2. In naming, the name of metal comes first followed by the name of non-metal which must be ended with ***–ide***.

e.g.

(i) **Chlorides** (a class of compounds which contains chlorine)

Sodium chloride \_\_\_\_\_NaCl\_\_\_\_\_\_\_\_\_ Magnesium chloride \_\_\_\_MgCl2\_\_\_\_\_\_\_\_

Aluminium chloride \_\_\_\_AlCl3\_\_\_\_\_\_\_\_

1. **Oxides** (a class of compounds which contains oxygen)

Sodium oxide \_\_\_\_\_Na2O\_\_\_\_\_\_\_\_ Magnesium oxide \_\_\_\_\_MgO\_\_\_\_\_\_\_\_\_\_

Aluminium oxide \_\_\_\_\_Al2O3\_\_\_\_\_\_\_\_\_

1. **Sulphides** (a class of compounds which contains \_\_\_\_sulphur\_\_\_\_\_\_\_\_\_\_)

Sodium sulphide \_\_\_\_\_Na2S\_\_\_\_\_\_\_ Magnesium sulphide \_\_\_\_MgS\_\_\_\_\_\_\_\_

Aluminium sulphide \_\_\_\_Al2S3\_\_\_\_\_\_\_\_\_

1. **Nitrides** (a class of compounds which contains \_\_\_\_nitrogen\_\_\_\_\_\_\_\_\_\_\_\_)

Sodium nitride \_\_\_\_\_Na3N\_\_\_\_\_\_\_\_ Magnesium nitride \_\_\_\_Mg3N2\_\_\_\_\_\_\_\_

Aluminium nitride \_\_\_\_AlN\_\_\_\_\_\_\_\_\_\_

1. **Exception: Hydroxide** (It is a polyatomic ion which contains \_\_hydrogen\_\_\_\_ and \_\_\_oxygen\_\_\_\_)

Sodium hydroxide \_\_\_\_\_NaOH\_\_\_\_\_\_\_\_ Magnesium hydroxide \_\_\_Mg(OH)2\_\_\_\_

Aluminium hydroxide \_\_\_\_Al(OH)3\_\_\_\_\_\_

3. ***-ate:***

(a) It consists of three elements, one metal and two non-metals, one of the non-metals must be oxygen.

(b) It contains more oxygen than that of compound ending with ***–ite***.

e.g.

(i) Polyatomic ion: **Sulphate** (contains sulphur and oxygen)

Sodium sulphate \_\_\_\_\_Na2SO4\_\_\_\_\_ Magnesium sulphate \_\_\_\_MgSO4\_\_\_\_\_\_

Aluminium sulphate \_\_\_Al2(SO4)3\_\_\_\_\_

1. Polyatomic ion: **Nitrate** (contains nitrogen and \_\_\_\_oxygen\_\_\_\_\_\_)

Sodium nitrate \_\_\_\_\_\_NaNO3\_\_\_\_\_ Magnesium nitrate \_\_\_Mg(NO3)2\_\_\_\_\_\_

Aluminium nitrate \_\_\_Al(NO3)3\_\_\_\_\_\_

1. Polyatomic ion: **Carbonate** (contains \_\_carbon\_\_\_\_ and \_\_oxygen\_\_\_\_\_)

Sodium carbonate \_\_\_Na2CO3\_\_\_\_\_\_\_\_ Magnesium carbonate \_\_\_MgCO3\_\_\_\_\_

Aluminium carbonate \_\_\_\_Al2(CO3)3\_\_\_\_\_

4. ***-ite:***

(a) It consists of three elements, one metal and two non-metals, one of the non-metal must be oxygen.

(b) It contains less oxygen than that of compound ending with ***–ate***.

e.g.

(i) Polyatomic ion: **Sulphite** (contains \_\_\_sulphur\_\_\_\_\_ and \_\_\_oxygen\_\_\_\_\_)

Sodium sulphite \_\_\_\_\_Na2SO3\_\_\_\_\_\_ Magnesium sulphite \_\_\_MgSO3\_\_\_\_\_\_\_

Aluminium sulphite \_\_\_Al2(SO3)3\_\_\_\_\_\_

(ii) Polyatomic ion: **Nitrite** (contains \_\_\_nitrogen\_\_\_\_ and \_\_\_oxygen\_\_\_\_\_)

Sodium nitrite \_\_\_\_\_NaNO2\_\_\_\_\_\_\_\_\_\_ Magnesium nitrite \_\_\_Mg(NO2)2\_\_\_\_\_\_

Aluminium nitrite \_\_\_\_Al(NO2)3\_\_\_\_\_\_\_

# **(V) Chemical Equation**

# A. Definition

Chemical equation is a summary of a chemical reaction by using chemical symbols and formulae.

**Reactant(s) → Product(s)**

e.g. A + B → C + D

The above equation represents “A reacts with B to give C and D”, where \_\_\_\_A\_\_\_\_ and \_\_\_B\_\_\_\_ are reactants, while \_\_\_\_C\_\_\_\_ and \_\_\_D\_\_\_ are products.

e.g. Combustion of carbon: carbon reacts with oxygen (molecule) to give carbon dioxide, the reaction can be represented by the following chemical equation.

C + O2 → CO2

Note:

(1) The numbers of the different types of atoms on the left hand side should be the same as that on the right hand side.

(2) The above equation means: 1 \_\_\_atom\_\_\_\_ of C reacts with 1 \_\_\_molecule\_\_\_\_ of O2 to give 1 \_\_\_\_molecule\_\_\_\_\_ of CO2.

(3) Give state symbols to the reactants and products:

solid → (s) liquid → (l)

gas → (g) aqueous solution → (aq)

N.B.: aqueous solution means the substance has dissolved in water.

\*\*\*Steps in balancing equation\*\*\*

1. Applying the chemistry knowledge to predict the products (sometimes products may be given).

2. By inspection, counting the **types** and **number** of atom on both reactant and product sides; they should be consistent.

3. Unless otherwise stated, all chemical compounds are assumed to exist in their stable form at room conditions (i.e. 25oC and 1 atmospheric pressure).

###### B. Exercises

Write chemical equations for the following word equations. Give the corresponding state symbols.

* 1. Hydrogen reacts with oxygen to form water.

2H2(g) + O2(g) → 2H2O(l)

* 1. Lead(II) oxide reacts with carbon to form lead and carbon dioxide.

2PbO(s) + C(s) → 2Pb(s) + CO2(g)

3) Calcium oxide dissolves in water to form calcium hydroxide solution.

CaO(s) + H2O(l) → Ca(OH)2(aq)

1. Calcium hydroxide solution absorbs carbon dioxide to form suspension of calcium carbonate.

Ca(OH)2(aq) + CO2(g) → CaCO3(s) + H2O(l)

1. Calcium carbonate suspension absorbs excess amount of carbon dioxide to form calcium hydrogencarbonate solution.

CaCO3(s) + CO2(g) + H2O(l) → Ca(HCO3)2(aq)

1. Iron filings react with sulphur powder to form iron(II) sulphide.

Fe(s) + S(s) → FeS(s)

1. Magnesium ribbon reacts with oxygen gas to form magnesium oxide.

2Mg(s) + O2(g) → 2MgO(s)

1. Hydrogen chloride gas dissolves in water to form hydrochloric acid.

|  |
| --- |
|  |

1. Hydrochloric acid reacts with sodium hydroxide solution to form sodium chloride solution and water.

HCl(aq) + NaOH(aq) → NaCl(aq) + H2O(l)

1. Carbon dioxide reacts with water to form glucose and oxygen.

6CO2(g) + 6H2O(l) → C6H12O6(aq) + 6O2(g)

1. Nitrogen reacts with hydrogen to form ammonia gas.

N2(g) + 3H2(g) → 2NH3(g)

1. Methane gas burns in oxygen to form carbon dioxide and water.

CH4(g) + 2O2(g) → CO2(g) + 2H2O(l)

1. Sodium chloride solution reacts with lead(II) nitrate solution to form sodium nitrate solution and lead(II) chloride solid.

2NaCl(aq) + Pb(NO3)2(aq) → 2NaNO3(aq) + PbCl2(s)

1. Carbon monoxide reacts with oxygen to form carbon dioxide.

2CO(g) + O2(g) → 2CO2(g)

1. Zinc granules dissolve in hydrochloric acid to form zinc chloride solution and hydrogen.

Zn(s) + 2HCl(aq) → ZnCl2(aq) + H2(g)

1. Copper(II) oxide reacts with hydrogen to form copper and water.

CuO(s) + H2(g) → Cu(s) + H2O(l)

1. Ethanol burns in oxygen to give carbon dioxide and water.

C2H5OH(l) + 3O2(g) → 2CO2(g) + 3H2O(l)

1. Iron(III) oxide reacts with carbon to form iron and carbon dioxide.

2Fe2O3(s) + 3C(s) → 4Fe(s) + 3CO2(g)

1. Iron reacts with oxygen to form iron(III) oxide.

4Fe(s) + 3O2(g) → 2Fe2O3(s)

1. Sodium reacts with water to form sodium hydroxide solution and hydrogen.

2Na(s) + 2H2O(l) → 2NaOH(aq) + H2(g)

1. Magnesium reacts with nitrogen to form magnesium nitride.

3Mg(s) + N2(g) → Mg3N2(s)

1. Carbon monoxide reacts with nitrogen monoxide to form nitrogen and carbon dioxide.

2CO(g) + 2NO(g) → N2(g) + CO2(g)

1. Molten aluminium oxide is electrolyzed to form aluminium and oxygen.

2Al2O3(l) → 4Al(s) + 3O2(g)

1. Butane gas is heated and cracked to form ethane and ethene.

# C4H10(g) → C2H6(g) + C2H4(g)

# C. Neutralization

General equation: acid + alkali → salt + water

Complete and balance the following equations. They are examples of neutralization.

1. HCl + NaOH → NaCl + H2O

2. HCl + KOH → KCl + H2O

1. H2SO4 + 2 NaOH → Na2SO4 + 2H2O
2. H2SO4 + 2 KOH → K2SO4 + 2H2O
3. HNO3 + NaOH → NaNO3 + H2O
4. HNO3 + KOH → KNO3 + H2O

# D. Reactions between metal and water

General equation: metal (Group I or Group II) + water → metal hydroxide + hydrogen

Complete and balance the following equations:

1. 2 Na + 2 H2O → 2 NaOH + H2

2. 2 K + 2 H2O → 2 KOH + H2

3. Mg + 2 H2O → Mg(OH)2 + H2

hot water

4. Ca + 2 H2O → Ca(OH)2 + H2

5. Cs + H2O → 2 CsOH + H2 (very vigorous reaction)

# E. Reaction between acid and carbonate / hydrogencarbonate

General equation:

acid + carbonate / hydrogencarbonate → salt + carbon dioxide + water

Complete and balance the following equations:

1. 2 HCl + Na2CO3 → 2 NaCl + CO2 + H2O

2. H2SO4 + Na2CO3 → Na2SO4 + CO2 + H2O

3. 2 HNO3 + Na2CO3 → 2 NaNO3 + CO2 + H2O

4. HCl + NaHCO3 → NaCl + CO2 + H2O

1. H2SO4 + 2 NaHCO3 → Na2SO4 + 2 CO2 + 2 H2O
2. HNO3 + NaHCO3 → NaNO3 + CO2 + H2O