

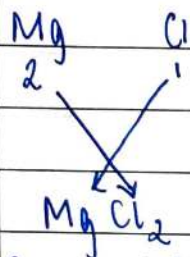
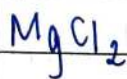


eduresourceza.com

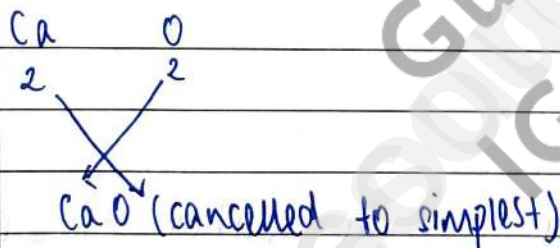
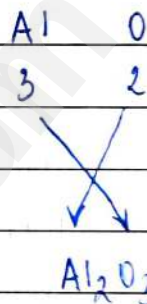
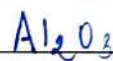
STOICHIOMETRY

Downloaded from eduresourceza.com

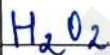
Formulae



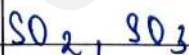
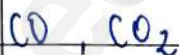
- Swap valencies.
- Cancel down (empirical).



- Valency of transition elements cannot be predicted.
- Most non-metals compounds cannot be cancelled to simplest.



- Non-metals may form oxides with different formulae.



Rules

- metal comes first, then the non-metal.
- if compound has both a metal and a non-metal with the lower group number comes first.

Downloaded from eduresourceza.com

- if both non-metals belong to the same group, the one further down comes first. Downloaded from eduresourceza.com

- some compounds are called by their common names.

• OH^- : hydroxide ion

• SO_4^{2-} : sulphate ion

• NO_3^- : nitrate ion

• CO_3^{2-} : carbonate ion

• HCO_3^- : hydrogen carbonate ion

• NH_4^+ : ammonium ion

Ionic compound formula identification

- count up number of positive and negative ions.

- cancel numbers to obtain simplest ratio.

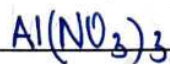
• $\text{Zn} = 4$; $\text{Cl} = 8$

$\text{Zn} = 1$; $\text{Cl} = 2$



- Formula of ionic compounds can be worked out by using the charges on the ions.

• Al^{3+} ; NO_3^-



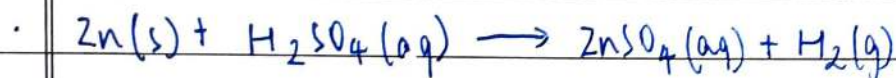
Rules

- Same number of each type of atom and mass should be the same on both sides.

- Mass of reactants = mass of products

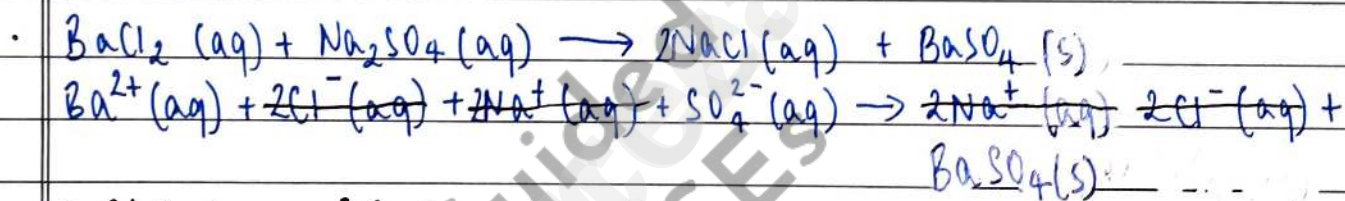
State symbols

- (s) - solid
- (l) - liquid
- (g) - gas
- (aq) - aqueous



Ionic equations

- Ions that do not take part in the reaction are called spectator ions.



Relative atomic mass - A_r

- The average mass of naturally occurring atoms on a scale where the ^{12}C atom has a mass of exactly 12 units.

Relative molecular mass - M_r

- The sum of the relative atomic masses.

Mass spectrometer is a method of weighing atoms.
Standard atom is an atom of the carbon-12 isotope.

Relative atomic mass (A_r of an element) is the average mass of naturally occurring atoms of the element on a scale where the carbon-12 has a mass of exactly 12 units.

Mass of an ion will be the same as that of the parent atom.

Relative formula mass $\downarrow$

The formula of an element or compound is taken as the basic unit.

The masses of the atoms or ions in the formula are added together.

The mass of a substance found this way is called the relative formula mass.

If the substance is an ionic compound, the mass is called relative formula mass.

Relative molecular mass $\downarrow$

The sum of the relative atomic masses of the elements present in a molecule of the substance.

4.2 - THE MOLE

A mole of a substance is the amount that contains the same number of units as the number of carbon atoms in twelve grams of carbon 12.

Example: $\downarrow$ * Carbon 12 - 12 is the atomic mass.

The atom of carbon 12 is chosen as standard atom.

Magnesium atom is twice as heavy as carbon 12 atom with an atomic mass of 24. Thus, 24 grams of magnesium contains the same number of atoms as twelve grams of carbon 12.

The number atoms, ions or molecules of a substance related to carbon 12 is called the AVOGADRO'S number/constant, which is 6.02×10^{23} . Thus, one mole of magnesium atom contains 6.02×10^{23} magnesium atoms.

The amount of substance with the Avogadro's number with particles is called the mole. Therefore, 6.02×10^{23} atoms of hydrogen have a mass of 1 gram.

6.02×10^{23} molecules of oxygen have a mass 32 grams.

6.02×10^{23} sodium ions have a mass of 23 grams.

Thus, it can be concluded that a mole is the amount of a substance that contains 6.02×10^{23} atoms or ions or molecules, and the Avogadro's number is the number of atoms, ions or molecules in one mole.

To find out the number of moles of an atom, molecule or ion, the following formula is used:

$$\text{Number of moles} = \frac{\text{mass of substance taken}}{\text{mass of one mole of substance}}$$

Downloaded from eduresourceza.com

$$= m/m_r \text{ or } m/A_r$$

Calculating the mass of one mole of various substances

Substance Mass

carbon (C) 12g
 6.02×10^{23} carbon atoms

iron (Fe) 56g
 6.02×10^{23} iron atoms

hydrogen (H_2) $2 \times 1 =$ 2g
 6.02×10^{23} hydrogen molecules

oxygen (O_2) $2 \times 16 =$ 32g
 6.02×10^{23} oxygen molecules

water (H_2O) $(2 \times 1) + 16 =$ 18g
 6.02×10^{23} water molecules

magnesium oxide (MgO) $24 + 16 =$ 40g
 6.02×10^{23} MgO 'formula units'

calcium carbonate ($CaCO_3$) $40 + 12 + (3 \times 16) =$ 100g
 6.02×10^{23} $CaCO_3$ 'formula units'

silicon (IV) oxide (SiO_2) $28 + (2 \times 16) =$ 60g
 6.02×10^{23} SiO_2 'formula units'

$$\frac{\text{mass}}{M_r} = n$$

$$\text{concentration} \times \text{volume} = n$$

$$\frac{\text{volume}}{24 \text{ dm}^3} = n \quad \text{or} \quad \frac{V}{V_m} = n$$

One mole of any gas occupies a volume of approximately 24dm^3 at room temperature and pressure.

The molar volume of any gas therefore has the value $24\text{dm}^3/\text{mol}$ at rtp.

$$1\text{dm}^3 = 1000\text{cm}^3 = 1 \text{ litre}$$

$$\text{no. of moles} = \frac{\text{volume}}{\text{molar volume}}$$

For instance:

If 8g of sulfur are burnt, what volume of SO_2 is produced?



Sulphur $\rightarrow 32\text{g}$

Oxygen $\rightarrow 24\text{dm}^3$ (rtp)

Sulphur dioxide $\rightarrow 24\text{dm}^3$ (rtp)

$$\text{no. of moles of sulphur burnt} = \frac{8\text{g}}{32\text{g/mol}} = 0.25\text{mol}$$

From the equation

1 mol of sulphur $\rightarrow$ 1 mol of SO_2

Hence, 0.25 mol of sulphur $\rightarrow$ 0.25 mol of SO_2

$$\text{Using no. of moles} = \frac{\text{volume}}{\text{molar volume}}$$

$$\Rightarrow 0.25 = \frac{\text{volume}}{24}$$

volume of SO_2 produced is 6dm^3 at rtp.

Moles and solution chemistry

When a chemical substance (solute) is dissolved in a volume of solvent, we can measure the quantity of solute in two ways.

We can measure either its mass (in grams) or its amount (in moles). The final volume of the solution is usually measured in cubic decimeters, dm^3 .

When the mass of the solute is measured in grams, it is mass concentration that is obtained (g/dm^3).

It is useful to measure the amount in moles, in which case we get the molar concentration in moles per cubic decimeter (mol/dm^3).

$$\text{concentration} = \frac{\text{amount of solute}}{\text{volume of solution}}$$

When 1 mol of a substance is dissolved in water and the solution is made up to 1dm^3 (1000cm^3) a solution with a concentration of 1mol/dm^3 is produced.

Usually, questions are given with solution volumes in cm^3 . Hence,

$$\text{number of moles} = \frac{\text{concentration}}{1000} \times \text{volume of solution (cm}^3\text{)}$$

For instance:

Calculate concentration of a solution of NaOH that contains 10g of NaOH in a final volume of 250cm^3

Relative formula mass of NaOH $\rightarrow 23 + 16 + 1 = 40$

number of moles of NaOH = $\frac{10}{40} = 0.25\text{ mol}$

$$\text{Number of moles} = \frac{\text{concentration}}{1000} \times 250 (\text{cm}^3)$$

$$0.25 = \frac{\text{concentration}}{1000} \times 250 \quad \text{concentration} = 1\text{ mol/dm}^3$$

Moles Calculation

Downloaded from eduresourceza.com

$$\text{Moles} = \frac{\text{mass of solid}}{\text{molecular mass}}$$

$$\text{Moles (liquid/gas)} = \text{volume (dm}^3\text{)} \times \text{concentration}$$

How many moles are there in 1.2g of Mg?

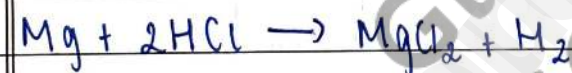
$$\frac{\text{Mass of solid}}{\text{Molecular mass}} = \frac{1.2}{24} = 0.05 \text{ moles}$$

$$\text{Molecular mass} \quad 24$$

How many moles are there in 2.74g of HCl?

$$\frac{2.74}{36.5} = 0.075 \text{ moles}$$

$$36.5$$

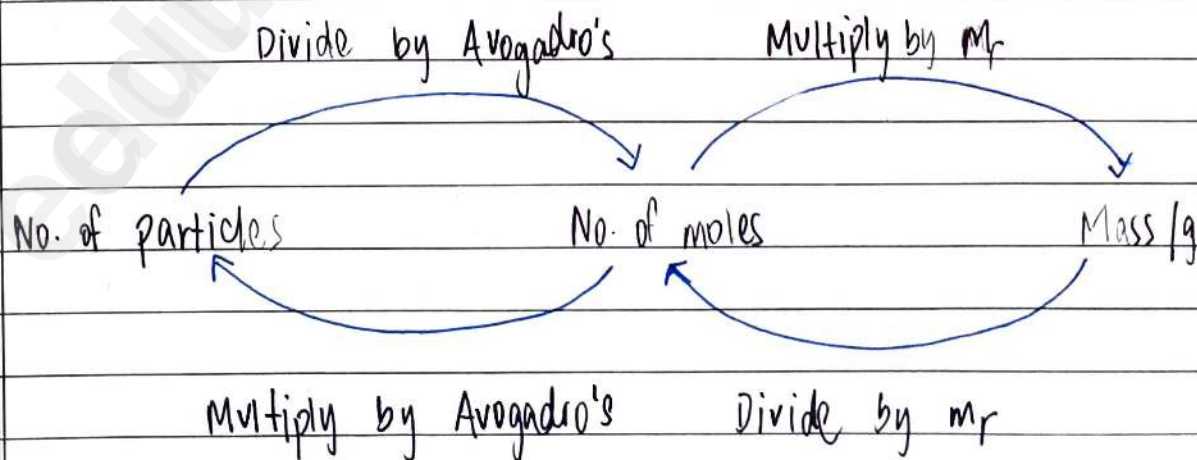


Mg: HCl

1 : 2

0.05 : x

x = 0.1



Downloaded from eduresourceza.com

Numericals for Moles

Downloaded from eduresourceza.com

1. The chemist found that it required 12.5 cm^3 of 0.05 mol/dm^3 sodium hydroxide solution to neutralise the acid.

i. State the number of moles of sodium hydroxide which are dissolved in 1 dm^3 of the sodium hydroxide solution.

0.05 moles

ii. Calculate the number of moles of sodium hydroxide which are dissolved in 12.5 cm^3 of the sodium hydroxide solution.

$$12.5 \text{ cm}^3 \rightarrow \text{dm}^3 = 0.0125 \text{ dm}^3$$

$$\text{moles} = \text{conc.} \times \text{vol.}$$

$$\text{moles} = 0.05 \times 0.125$$

$$\text{moles} = 0.00625 \text{ moles}$$

iii. Balanced equation for neutralisation reaction is:



Calculate number of moles of H_2SO_4 which were contained in 1.0 dm^3 of acidic lake water.

$$(2 \times 1) + (32) + (16 \times 4) = 98 \text{ g}$$

$$2 : 1$$

$$0.00625 : n$$

$$n = 3.125 \times 10^{-4}$$

Downloaded from eduresourceza.com

Acid - base titrations

The concentration of an unknown acid solution can be found if it is reacted with a standard solution of an alkali.

A standard solution is one that has been carefully made so its concentration is known precisely.

Volumes are measured accurately using a pipette and a burette.

Sufficient acid is added to neutralise the alkali.

The end point is found using an indicator.

This is known as titration, and can be adapted to prepare a soluble salt.

Summary of the titration method:

1. Make standard alkali solution accurately.
2. Pipette 25cm^3 of alkali into a conical flask - add indicator.
3. Put acid in burette - read starting value.
4. Run acid into flask until indicator just changes colour - read burette again.
5. Wash out apparatus, - repeat several times - take average.