

Topic 1 Stoichiometric relationships

Syllabus:

1.1 Introduction to the particulate nature of matter and chemical change

Atoms of different elements combine in fixed ratios to form compounds, which have different properties from their component elements.

Mixtures contain more than one element and/ or compound that are not chemically bonded together and so retain their individual properties.

Mixtures are either homogeneous or heterogeneous.

1.2 The mole concept

The mole (n) is used to show the amount of substance.

Masses of atoms are compared on a scale relative to ^{12}C and are expressed as relative atomic mass (A_r) and relative molecular mass (M_r).

The unit of molar mass is g mol^{-1} .

Empirical formula of a compound gives the simplest ratio of the atoms and molecular formula shows the actual number of atoms present in a molecule.

1.3 Reacting masses and volumes

Finding limiting and excess reactants.

The experimental yield and theoretical yield can be different.

Avogadro's law allows to determine the mole ratio of reacting gases from the volumes of the gases.

The molar volume of an ideal gas is a constant at specified temperature and pressure.

The molar concentration of a solution is determined by the amount of solute and the volume of solution.

A standard solution is the solution with known concentration.

1.1 Introduction to the particulate nature of matter and chemical change

(A) Compound

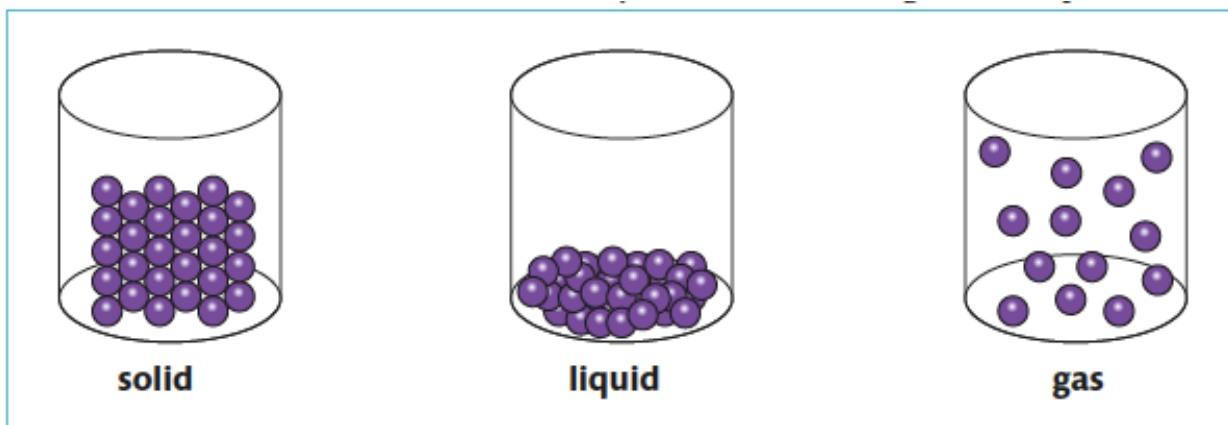
- Compounds are formed when more than one element combine and held by chemical bonding.
- Compounds have totally different properties from those of their component elements.
- A subscript shows the number of atoms of each element in a unit of the compound.

Name of compound	Symbol	Name of compound	Symbol
Water	H ₂ O	Carbon dioxide	CO ₂
Aluminium oxide	Al ₂ O ₃	Potassium chloride	KCl
Ethanol	C ₂ H ₅ OH	Ammonia	NH ₃

(B) Mixture

- Mixtures contain more than one element or compound that are not chemically bonded together.
- Homogeneous mixture has the uniform appearance and composition throughout.
E.g. Metal alloy
- Heterogeneous mixture does not have uniform composition and their properties are not the same throughout.
E.g. Water and oil

(C) Different states of matter

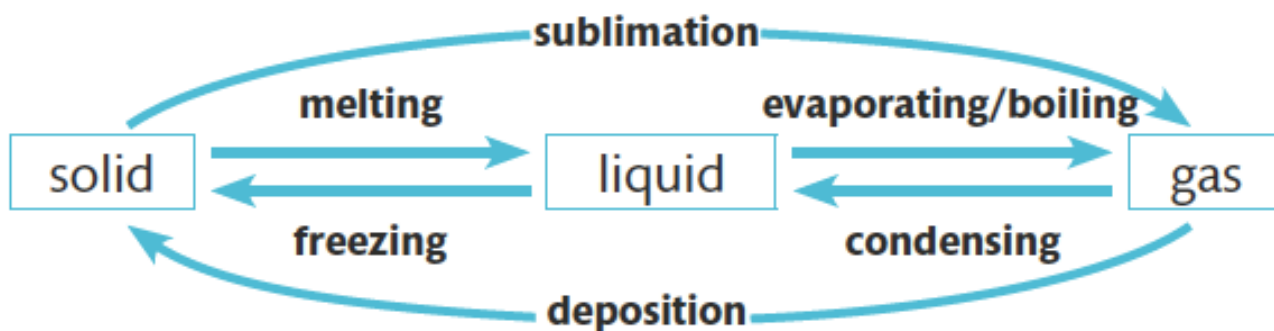


increasing temperature

increasing kinetic energy of particles

- The space between particles increases.
- Inter-particle forces change from strong to weak.
- Only solid is in fixed shape.
- Only gas is not in fixed volume.

(D) Matter changes state reversibly



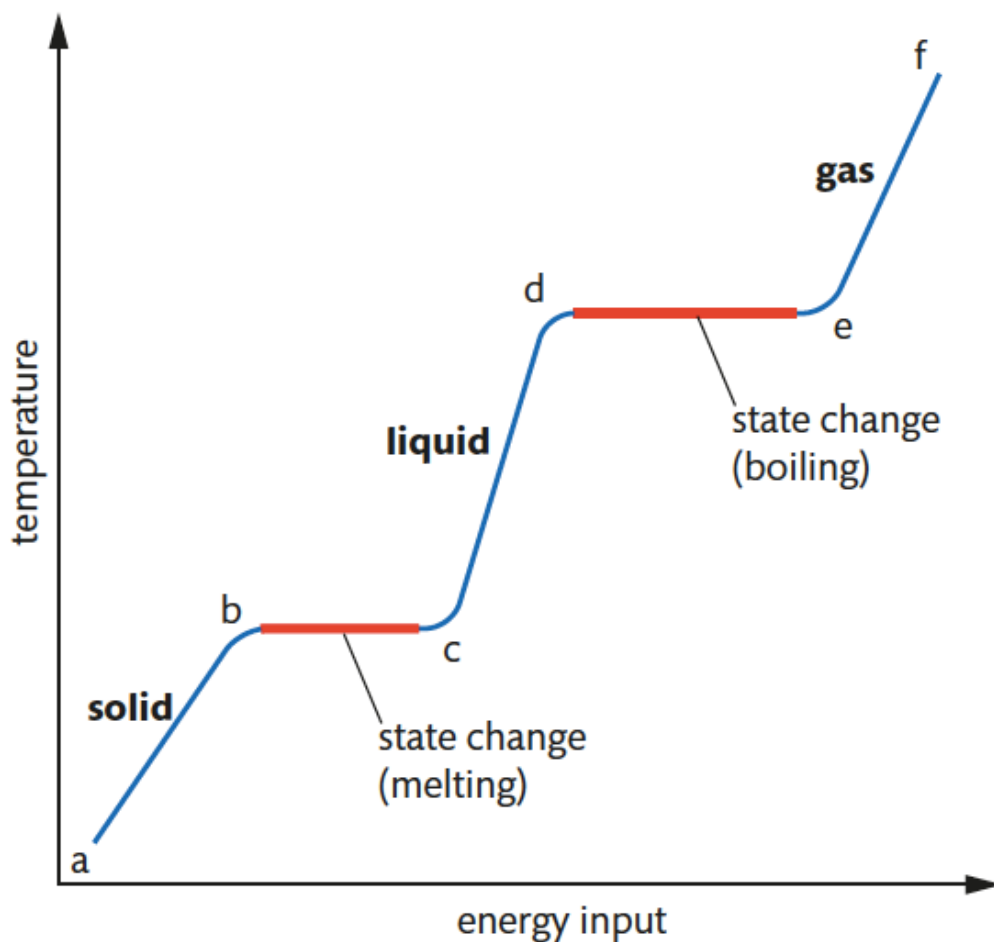
Endothermic (absorb energy)

From solid to liquid to gas

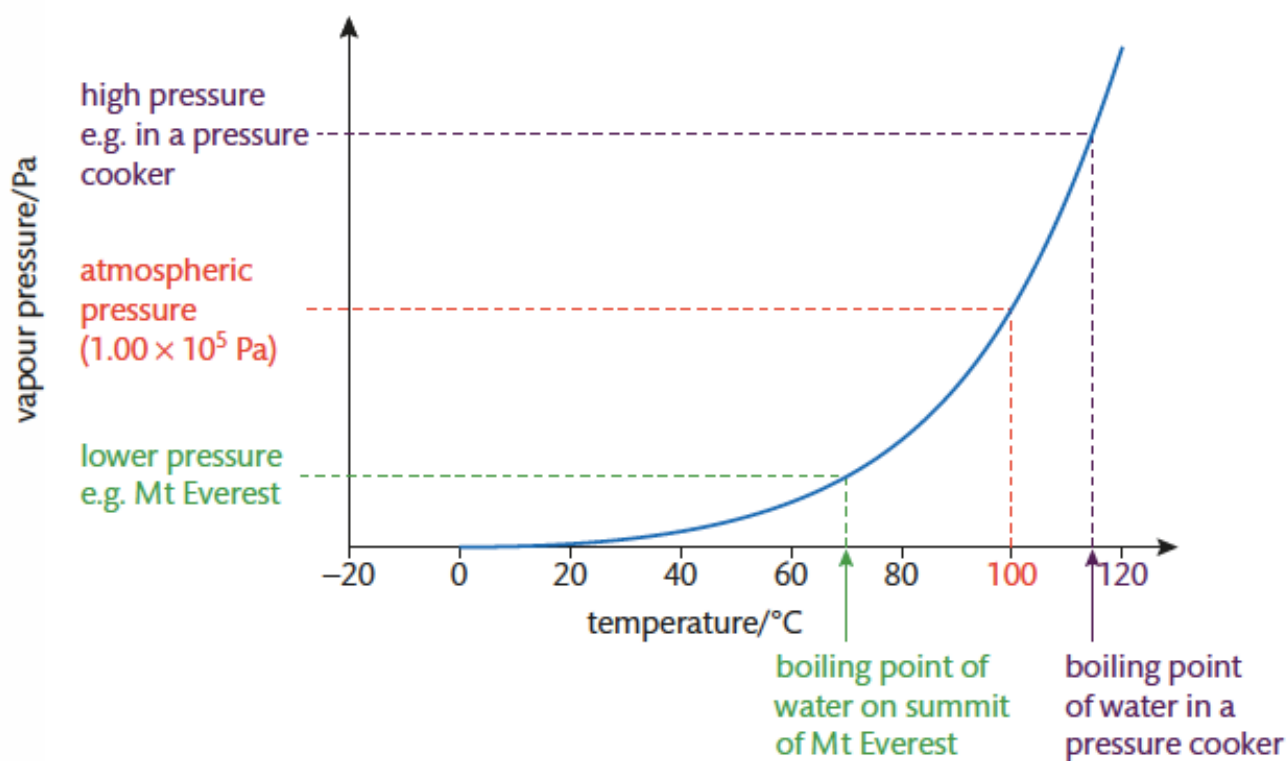
(boiling water to steam, heat is needed)

Exothermic (release energy)

From gas to liquid to solid



The effect of pressure on the temperature



1.2 The mole concept

(A) Mole to molecules to atoms OR ions

Avogadro constant : 6.02×10^{23}

One mole of substance = 6.02×10^{23} molecules

Number of molecules = Mole \times 6.02×10^{23}

Question 1

Find the number of molecules in 0.600 moles of carbon dioxide.

Question 2

Find the number of molecules in 0.20 moles of water.

Question 3

Find the number of molecules in 2.00 moles of sulfur dioxide.

Question 4

Find the number of molecules in 0.900 moles of $CuSO_4$.

Question 5

Find the number of molecules in 1.5 moles of Al_2O_3 .

Number of atoms = Number of molecules x Number of atoms in a molecule

Question 1

Find the **number of moles** of atom in 0.600 moles of carbon dioxide.

Question 2

Find the **number of moles** of atom in 0.600 moles of NaCl.

Question 3

Find the number of hydrogen atoms in 0.800 moles of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$.

Question 4

Find the number of atoms in 0.300 moles of $\text{Al}(\text{OH})_3$.

Question 5

Find the number of atom in 0.240 moles of $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$.

Polyatomic ions

Anions			Anions		
Charge	Name	Formula	Charge	Name	Formula
1-	Fluoride ion	F ⁻	2-	Oxide ion	O ²⁻
	Chloride ion	Cl ⁻		Sulphide ion	S ²⁻
	Bromide ion	Br ⁻		Sulphate ion	SO ₄ ²⁻
	Iodide ion	I ⁻		Carbonate ion	CO ₃ ²⁻
	Hydroxide ion	OH ⁻		Dichromate ion	Cr ₂ O ₇ ²⁻
	Nitrate ion	NO ₃ ⁻		Thiosulphate ion	S ₂ O ₃ ²⁻
	Hydrogen carbonate ion	HCO ₃ ⁻	Chromate ion	CrO ₄ ²⁻	
	Hydrogen sulphate ion	HSO ₄ ⁻	3-	Nitride ion	N ³⁻
	Permanganate ion	MnO ₄ ⁻		Phosphate ion	PO ₄ ³⁻
	Cyanide ion	CN ⁻			
Ethanoate ion	CH ₃ COO ⁻				

Question 1

Find the number of ions in 0.300 moles of CaF₂.

Question 2

Find the number of ions in 0.203 moles of CaO.

Question 3

Find the number of aluminium ions in 0.200 moles of $\text{Al}_2(\text{SO}_4)_3$.

Question 4 (Tricky question!!)

Find the number of Cl ions in 0.300 moles of $\text{CH}_3\text{CH}_2\text{Cl}$.

Question 5

Find the **number of mole** of aluminium ions in 3.0 moles of Al_2O_3 .

Question 6

Find the **number of mole** of nitrate ions in 2.0 moles of $\text{Mg}(\text{NO}_3)_2$.

Question 7

Find the **number of moles** of Al_2O_3 in 1.204×10^{24} Al_2O_3 molecules.

Question 8

Find the **number of moles** of Na_2O if there are 2.408×10^{23} Na atoms.

Question 9

Find the **number of moles** of atom in 2.00 moles of NH₃.

Question 10

Find the **number of moles** of Zn if there are 1.234×10^{23} Zn atoms.

MCQ

1. How many atoms of nitrogen are there in 0.50 mol of $(\text{NH}_4)_2\text{CO}_3$?
 - A. 1
 - B. 2
 - C. 3.01×10^{23}
 - D. 6.02×10^{23}

2. How many atoms are present in 0.10 mol of $\text{PtCl}_2(\text{NH}_3)_2$?
 - A. 6.0×10^{22}
 - B. 3.0×10^{23}
 - C. 6.6×10^{23}
 - D. 6.6×10^{24}

3. Which amount of the following compounds contains the least number of ions?
 - A. 2 mol of NaOH
 - B. 1 mol of NH_4Cl
 - C. 2 mol of CaCl_2
 - D. 1 mol of Al_2O_3

4. What is the total number of hydrogen atoms in 1.0 mol of benzamide, $\text{C}_6\text{H}_5\text{CONH}_2$?
 - A. 7
 - B. 6.0×10^{23}
 - C. 3.0×10^{24}
 - D. 4.2×10^{24}

5. What is the number of ions in 0.20 mol of $(\text{NH}_4)_3\text{PO}_4$?
- A. 8.0×10^{-1}
B. 1.2×10^{23}
C. 4.8×10^{23}
D. 2.4×10^{24}
6. How many oxygen atoms are in 0.100 mol of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$?
- A. 5.42×10^{22}
B. 6.02×10^{22}
C. 2.41×10^{23}
D. 5.42×10^{23}
7. What is the amount, in moles, of sulfate ions in 100 cm^3 of $0.020 \text{ mol dm}^{-3} \text{ FeSO}_4(\text{aq})$?
- A. 2.0×10^{-3}
B. 2.0×10^{-2}
C. 2.0×10^{-1}
D. 2.0
8. How many atoms of hydrogen are in 0.500 mol of CH_3OH molecules?
- A. 1.20×10^{23}
B. 3.01×10^{23}
C. 6.02×10^{23}
D. 1.20×10^{24}