KS4 Atomic Structure

Task 1: Read the information on slides 2-8 and use it to answer questions 1 to 10 on the sheet. (40mins)

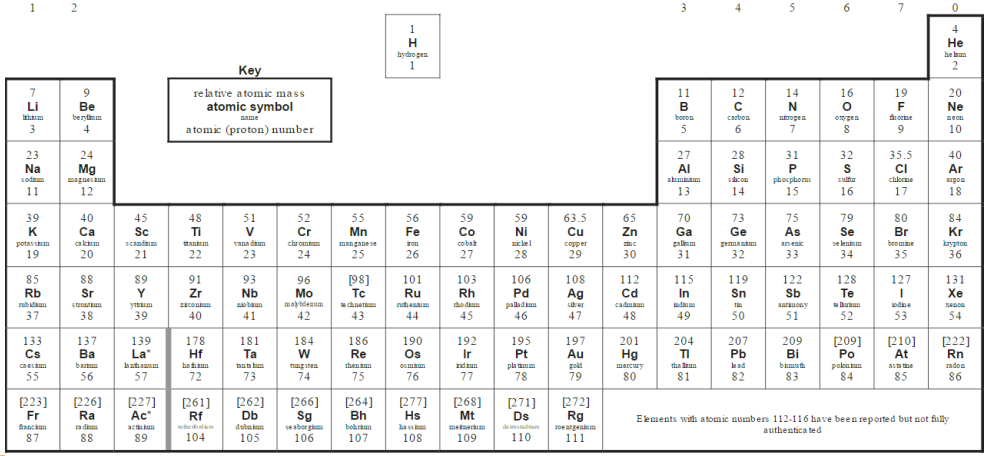
Task 2: Login to your Tassomai account and complete your daily goal of questions (15mins)

Atoms, elements, compounds and mixtures - PART 1

All substances are made of **atoms** that cannot be chemically broken down. It is the smallest part of an **element**.

Elements are made of only one type of atom. Each element has its own **symbol.**
e.g. Na is sodium.

There are about 100 different elements



Compounds contain more than one type of atom. They are formed from elements by **chemical reactions**, which always involve the formation of one or more new substance, often involving an **energy change**.

The components of a compound **cannot** be **separated** by **physical** means. They can be separated only by **chemical** means.

You need to:

- **Know the names and symbols for the first 20 elements and all of group 1, 7 and 0**
- **Name compounds when given the formulae or symbol equations**

magnesium ← $MgCl_2$ → chlorine

Magnesium chloride

Atoms, elements, compounds and mixtures - PART 1

Compounds contain **two or more** elements **chemically** combined in **fixed proportions** and can be represented by formulae using the symbols of atoms from which they formed.

Naming a compound with **two elements** (usually a metal and a non metal) apply these rules:

- The metal name does not change
- The non-metal's name ends in **ide**

For example:

Na_2S = sodium sulf**ide**

K_2O = potassium ox**ide**

When a compound contains a transition metal, the names become a bit more complicated. To distinguish them, Roman numerals indicate the charge on the metal ion

e.g. iron(II) chloride.

Naming a compound with a metal that reacts with ions that consist of **two or more** non-metal atoms covalently bonded together apply these rules:

- The metal name does not change
- The non-metal's name ends in **ate** if oxygen is present

For example: Na_2CO_3 = sodium carbon**ate**

KNO_3 = potassium nitr**ate**

Atoms, elements, compounds and mixtures - PART 1

Chemical equations: Show the **reactants** (what we start with) and the **products** (what we end with).
No **atoms** are **lost** or **made**. The **mass** of the **products** equals the **mass** of the **reactants**.

You need to:
- **Write word equations**
- **Balanced symbol equations**

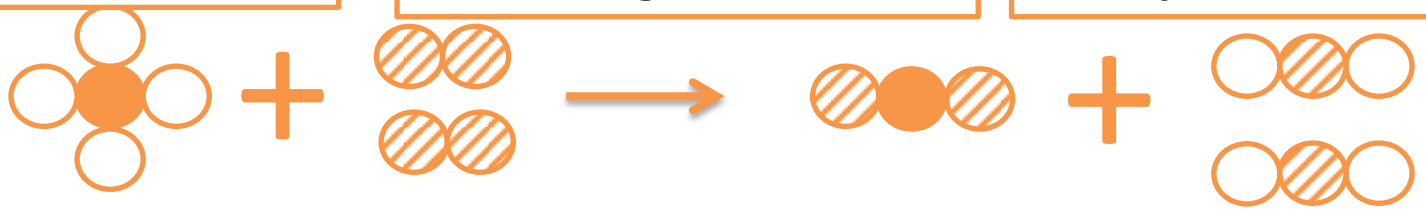
Word equation: methane + oxygen → carbon dioxide + water

Symbol equation: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

There are 4 hydrogens here, bonded together.

There are 2 molecules of oxygen not bonded together.

There are 4 hydrogens here. You multiply the big number by the little number.



Equations MUST balance
- **We can ONLY add BIG numbers to the front of a substance**
- **We can tell elements within a compound by BIG letters**
- **We can check an equation is balanced by counting the number of each type of atom on either side**

Atoms, elements, compounds and mixtures - PART 1

We can add **state symbols** to a symbol equation to show whether the reactants and products in a chemical reaction are solids, gases, liquids or dissolved in water.

Solid = s
Liquid = l
Gas = g
Aqueous (dissolved in water) = aq

Word equation: **sodium + water → sodium hydroxide + hydrogen**

Symbol equation: **$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$**

The reaction between copper sulfate and sodium hydroxide is:

copper sulfate + sodium hydroxide → sodium sulfate + copper hydroxide

$CuSO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + Cu(OH)_2(s)$

You can tell that the copper hydroxide forms a solid (the precipitate) because its state symbol is (s) for solid, rather than (aq) for aqueous (dissolved in water).

HT only – write balanced half equations and ionic equations

The reaction can also be shown by an **ionic equation**:

$Cu^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s)$

Atoms, elements, compounds and mixtures - PART 2

A mixture consists of **two or more** elements or compounds **not** chemically combined together. The chemical properties of each substance in the mixture are **unchanged**.

Solvent	the liquid in which a solute dissolves
Solute	the substance that dissolves in a liquid to form a solution
Solution	is the mixture formed when a solute has dissolved in a solvent
Soluble	describes a substance that will dissolve
Insoluble	describes a substance that will not dissolve

FILTRATION: This technique separates substances that are insoluble in a solvent from those that are soluble

Mixtures can be separated by **physical processes** including:

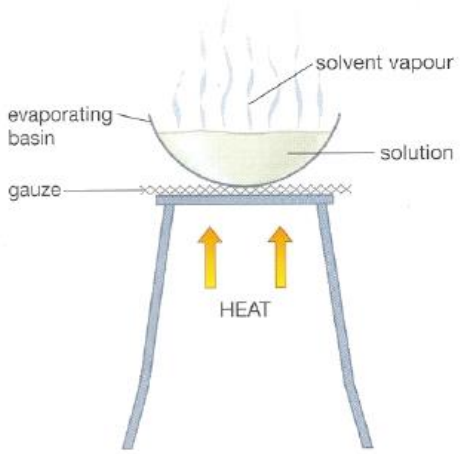
1. Filtration
2. Crystallisation
3. Simple distillation
4. Fractional distillation
5. Chromatography

These physical processes do not involve chemical reactions and no new substances are made.

Atoms, elements, compounds and mixtures - PART 2

Crystallisation

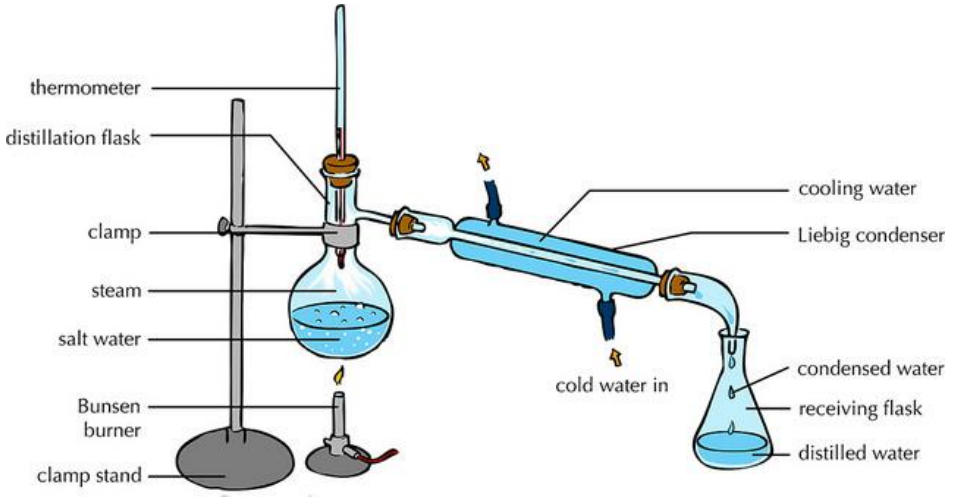
This technique separates a soluble substance from a solvent by evaporation



Example - crystallisation of sodium chloride from salt solution

Simple distillation

This technique separates a liquid from a mixture by evaporation follow by condensation

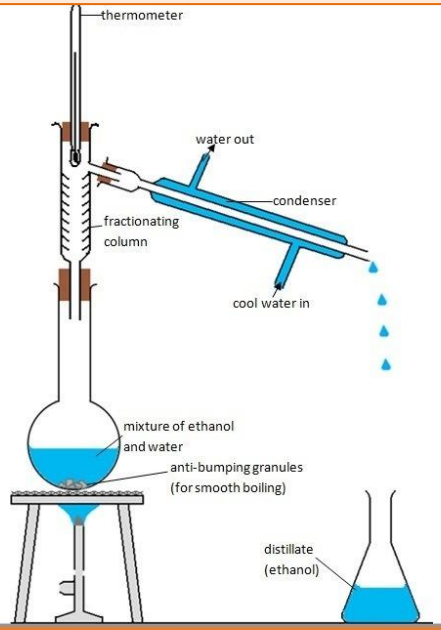


Example - obtaining water from sea water

Atoms, elements, compounds and mixtures - PART 2

Fractional distillation

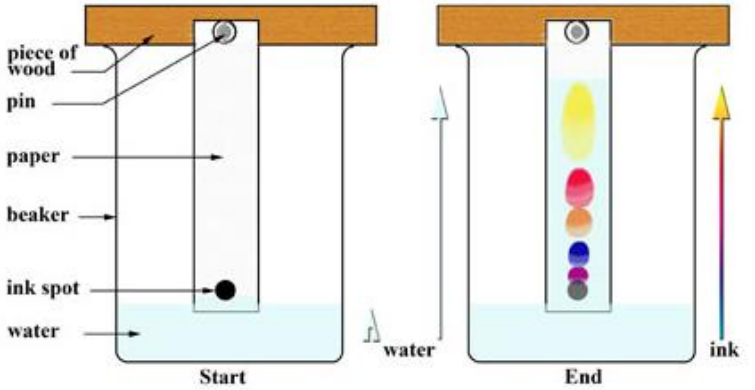
This technique separates a mixture into a number of different parts, called **fractions**. Substances with **high** boiling points **condense at the bottom** and substances with **low** boiling points **condense at the top**.
Fractional distillation works because the different substances in the mixture have different boiling points.



Example - obtaining ethanol from a mixture of ethanol and water

Chromatography

This technique separates small amounts of dissolved substances by running a solvent along absorbent paper



Example - separating the different colours in ink

QuestionIT!

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AnswerIT!

Atoms, elements, compounds and mixtures PART 1 – QuestionIT

1. Around how many different types of elements are there in the periodic table?
   1000
2. What does it mean if a compound ends in –ide?
   Contains 2 elements; usually metal and non-metal.
3. What does it mean if a compound ends in –ate?
   Contains 3 or more elements, 1 of which is always oxygen.
4. What does a chemical reaction involve?
   The formation of one or more new substances; usually with an energy change.
5. Name the following substances:
   - NaCl **Sodium chloride.**
   - $NaSO_4$ **Sodium sulfate.**

6. Why is it useful to have symbols for atoms of different elements?
   When elements join together to form a compound, it tells you how many atoms there are.

7. What is the difference between an element and a compound?
   Elements contain one type of atom and compounds contain more than one type.

8. Why is it difficult to separate a compound?
   A compounds elements are chemically joined together.

9. Solid sodium reacts with water to form a sodium hydroxide solution and hydrogen gas.

a) Write a word equation to represent this reaction.

Sodium + water → sodium hydroxide + hydrogen

b) Give the balance symbol equation for the reaction.

$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$

HT only:

10. When magnesium reacts with sulfuric acid, the hydrogen ions in the acid will be displaced from the solution by magnesium. Balance the following ionic equation.

$$Mg(s) + \mathbf{2}H^+(aq) \rightarrow Mg^{2+}(aq) + H_2(g)$$

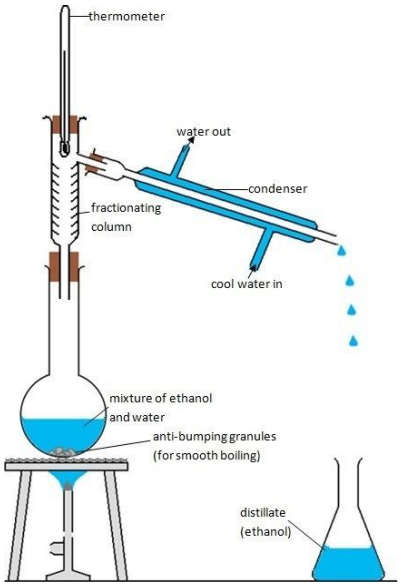
Atoms, elements, compounds and mixtures PART 2 – QuestionIT

1. What is the difference between a compound and a mixture?
   The substances in a mixture are not chemically bonded together, but they are in a compound.

2. Describe the method used to collect the salt from a mixture of sand and salt.
   Add water and stir to dissolve the salt. Use filtration to remove the sand. Heat the water (gently) to allow the salt to crystallise (to avoid dryness).

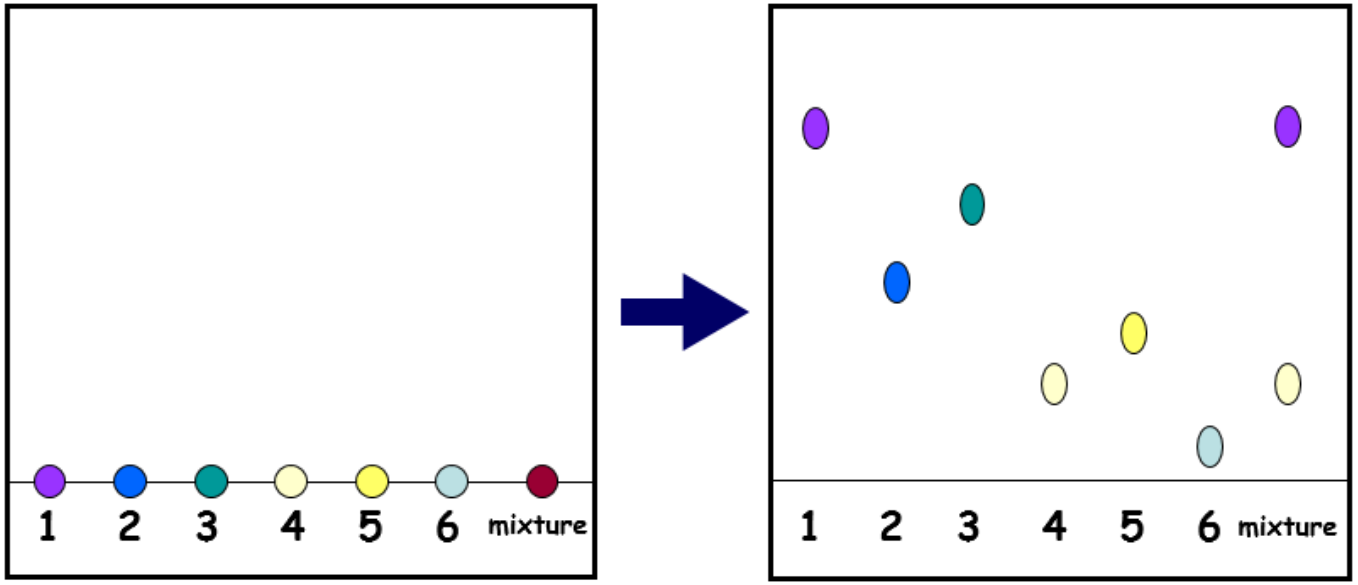
3. What process is used to purify seawater to obtain usable water?
   Simple distillation.

4. Describe how the following equipment is used to separate water and ethanol.



The ethanol and water mixture are heated. Ethanol has a boiling point of 78°C and will vaporise first. The gas passes over the fractionating column and into the condenser. Here it will condense, turning back into it's liquid state.

5. A mixture and six colours are tested using chromatography. The following chromatogram was produced:



a) What can you conclude about the mixture?

The mixture is made up from substance 1 and 4.

b) Why do the inks separate to produce a chromatogram?

The separation depends on how soluble the chemical is in the solvent and how strongly the chemical is attracted to the paper.