

C1 & 2: States of matter and separating substances

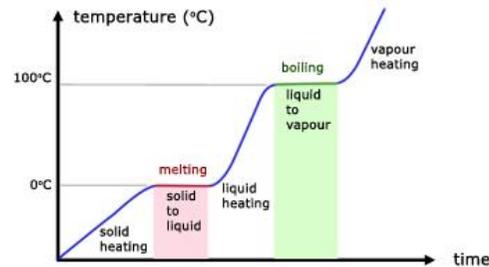
Lesson sequence

1. States of matter
2. Mixtures
3. Filtration and crystallisation
4. Paper chromatography
5. Distillation
6. Core practical – investigating inks (CP7)
7. Drinking water

1. States of matter

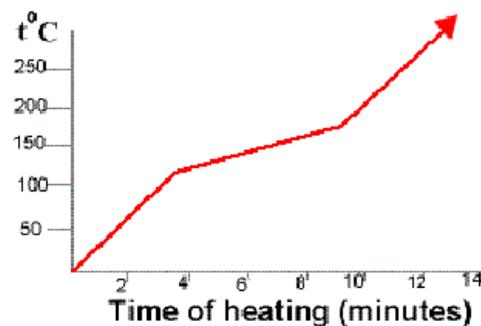
*Particle	The tiny pieces that all matter is made from.
*Atom	The smallest independent particle. Everything is made of atoms.
*Molecule	A particle made from two or more atoms bonded together.
*State of matter	Whether a substance is solid, liquid or gas.
*Particle model	A theory that uses the idea of particles to explain the differences between solids, liquids and gases.
*Solid	Particle arrangement: Regular pattern, touching each other. Particle movement: Vibrating around a fixed point.
*Liquid	Particle arrangement: Random, touching each other. Particle movement: Moving around
*Gas	Particle arrangement: Random Particle movement: Moving quickly
*State changes	Solid to liquid = melting Liquid to solid = freezing Liquid to gas = evaporating or boiling Gas to liquid = condensation Solid to gas = sublimation Gas to solid = deposition

****Heating curve for a pure substance**
Temperature rises as you heat a solid, levels out as it melts, continues rising once fully liquid, levels out whilst boiling and rises again once fully gas.



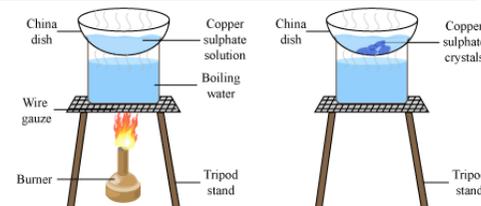
2. Mixtures

*Element	A substance made from only one type of atom.
*Compound	A substance made from two of more different elements bonded together.
*Mixture	A substance made of two of more substances (elements or compounds) mixed but not bonded together.
**Melting point of mixtures	Mixtures do not melt at a fixed temperature but melt gradually over a range of temperatures.
**Heating curves of mixtures	The flat sections of the heating curves of a pure substance are sloped for a mixture.



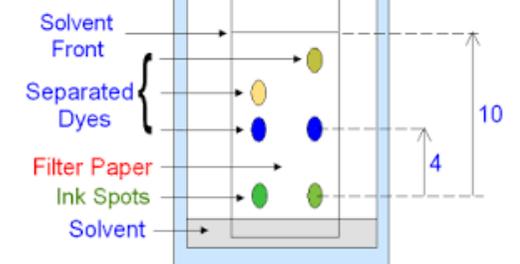
3. Filtration and crystallisation

*Dissolve	When a substance mixes with a liquid by breaking down into individual particles (atoms or molecules).
*Soluble	When a substance can be dissolved by a liquid.
*Insoluble	When a substance can't be dissolved by a liquid.
*Filtration	A method of separating a mixture of a liquid and an insoluble solid by passing it through a filter paper.
**Residue	The solid that gets left behind in the filter paper.
**Filtrate	The liquid that passes through the filter paper.
**How filtration works	The filter paper contains many tiny holes. The water molecules are small enough to pass through the holes, the solid particles are too big and get trapped.
*Solution	A mixture of a solute dissolved in a solvent.
**Solvent	A liquid that has dissolved a substance, for example water.
**Solute	A solid that has been dissolved, for example salt.
*Crystallisation	A method of collecting the dissolved solid from a solution by heating it so that the solvent evaporates away.
**Risks of crystallisation	As the solvent boils away, the hot solution can spit, so you should wear safety goggles to protect your eyes.

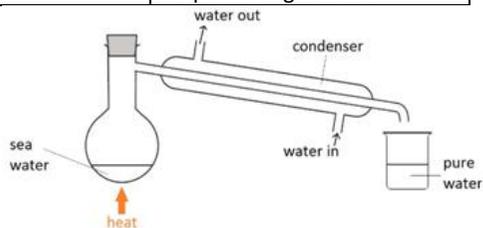


4. Paper chromatography

*Paper chromatography	A method of separating out mixtures of liquids to show what is in them, by letting them travel up a piece of chromatography paper.
*Chromatography method	<ol style="list-style-type: none"> 1. Draw pencil line on paper 2. Place sample spot on line 3. Place paper in solvent, with solvent below pencil line. 4. Allow solvent to soak up the paper 5. Stop when solvent near top, and mark how far it gets.
**Stationary phase	The substance the solvent moves through – usually paper (Note: technically it is a thin layer of water from air that is bound to the paper molecules)
**Mobile phase	The solvent.
**R_f (retardation factor)	$R_f = \text{spot distance} / \text{solvent distance}$
**Uses of R_f	R _f enables you to identify a substance because for a given solvent and stationary phases, it is unique to each substance.
**Uses of chromatography	<ul style="list-style-type: none"> - To tell between pure and impure substances - To identify substances by comparison with known ones - To identify substances by calculating R_f.



5. Distillation	
*Distillation	A method used to collect pure liquid from a solution, such as getting pure water from seawater.
**Condenser	A glass tube surrounded by a glass jacket containing cold tap water. Used to condense gases back to liquids.
**How distillation works	The solution is heated until it is hot enough for the solvent to boil. The solvent is then passed through a cool condenser where it turns back to liquid. The solute does not get hot enough to evaporate and stays where it is.
**Anti-bumping granules	Jagged grains of glass that are added during distillation to prevent violent boiling.
*Fractional distillation	A type of distillation used to separate mixtures of two or more liquids.
**How fractional distillation works	The liquid with the lowest boiling point boils first and can be collected, then the next boils and so on.
**Fractionating column	A tall glass column used during fractional distillation that gives a better separation of the liquids by producing a temperature gradient.



1. Structure of atoms	
*Particle	The tiny pieces that all matter is made from.
*Atom	The smallest independent particle. Everything is made of atoms.
**Size of atoms	About 1×10^{-10} m in diameter.
**Dalton's model of atoms	<ul style="list-style-type: none"> - Tiny hard spheres - Can't be broken down - Can't be created or destroyed - Atoms of an element are identical - Different elements have different atoms
*Subatomic particles	Smaller particles that atoms are made from.
*Proton	Mass = 1 Charge = +1 Location = nucleus
*Neutron	Mass = 1 Charge = 0 Location = nucleus
*Electron	Mass = $1/1835$ (negligible) Charge = -1 Location = shells orbiting nucleus
*Nucleus	Central part of an atom, 100,000 times smaller than the overall atom

2. Detailed structure of atoms	
**Alpha particle	Small positively charged particle made of two protons and two neutrons.
**Scattering	When particles bounce back or change direction.
**Rutherford's experiment	Fired alpha particles at gold leaf, used a phosphor-coated screen to track where they went.
**Rutherford's results	Most alpha particles went through, some scattered (changed direction).
**Rutherford's explanation	Scattered particles hit a solid nucleus. Most did not hit it, therefore nucleus is small
*Atomic number	The bottom number on the periodic table, gives the number of protons and electrons.

*Atomic mass	The top number on the periodic table, gives the total protons and neutrons together.
*Number of protons	The atomic number.
*Number of electrons	The atomic number.
*Number of neutrons	Atomic mass minus atomic number.
*Number of protons and electrons	Equal, because each negative electron is attracted to a positive proton in the nucleus.

3. Isotopes	
**Isotopes	Atoms with the same number of protons but different number of neutrons.
**Describing isotopes	Mass after the name (e.g. boron-10) or superscript mass before the symbol (^{10}B).
**Relative atomic mass, A_r	The weighted average of the masses of all of the isotopes of an element.
***Isotopic abundance	The percentage of an element that is made of a particular isotope.
***Calculating A_r	<ul style="list-style-type: none"> - Multiply each mass by the decimal % - Add these up Note: (decimal % = $\%/100$)