Introduction to the particulate nature of matter

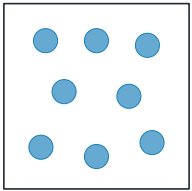
Structure 1.1 · SL

Why is sea water not a pure substance?

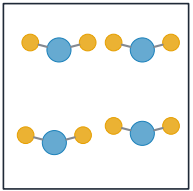
A physical separation can recover components without splitting water into its elements.

- **Distillation** can collect water from a simplified non-volatile salt solution.
- Condense the vapour; real samples may contain volatile contaminants.
- Classify matter, choose separation, interpret states and temperature.

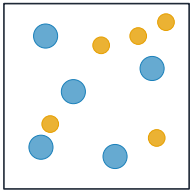
Elements, compounds and mixtures



element
only one
type of atom



compound
different
atoms bonded
in a fixed ratio



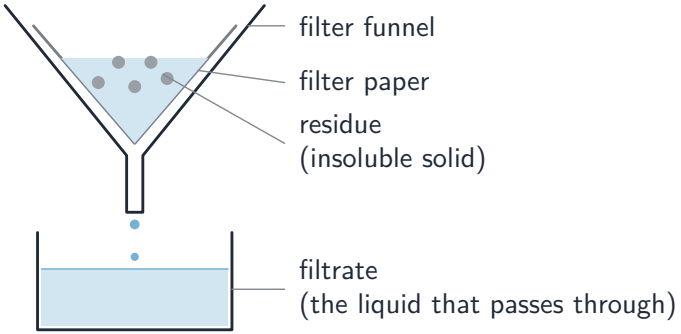
mixture
different particles,
variable
proportions

Uniform appearance does not by itself establish a pure substance.

Choosing a separation method

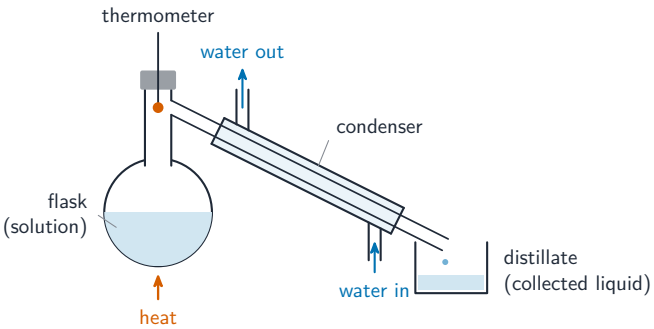
Mixture	Method	Property
sand in water	**filtration**	particle size
salt in water, keep salt	**crystallization**	solvent evaporates
salt in water, keep water	**distillation**	boiling point
ethanol and water	fractional distillation	boiling point

Filtration and crystallization



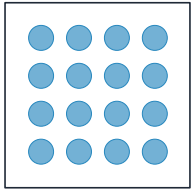
Dissolved solute passes through a suitable filter; some can remain in the mother liquor.

Distillation

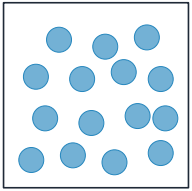


A volatile **mixture** can give an enriched fraction without complete **purity**.

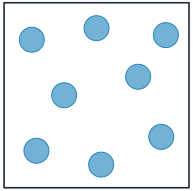
Particles in the three states



crystalline solid
close, ordered
vibrate in place



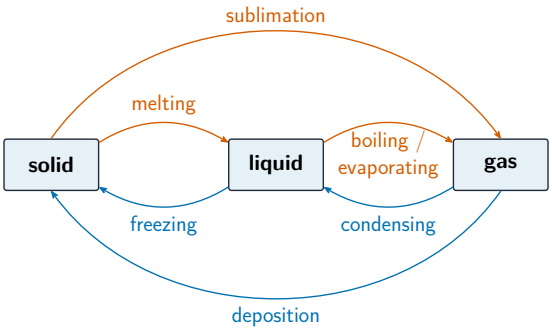
liquid
close, random
slide past
each other



gas
far apart,
random
move freely

A simple state diagram does not describe every solid's structure.

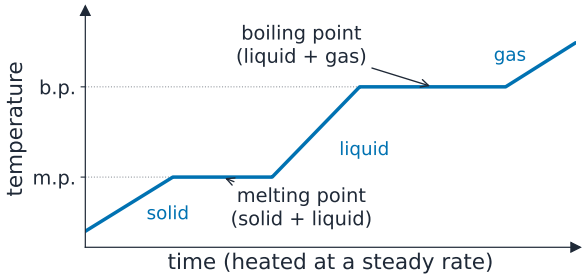
Changes of state



orange: particles gain energy blue: particles lose energy

Dry ice sublimes; frost on a window is **deposition**.

The heating curve



plateau: attractions overcome; temperature constant

A plateau assumes suitable fixed pressure and near-equilibrium conditions.

Check: evaporation or boiling?

Your turn

Which statement describes evaporation, not boiling?

A. It happens throughout the liquid.
B. It happens only at one temperature.
C. It happens at the surface, at any temperature.
D. It forms bubbles inside the liquid.

The kelvin scale

- For an ideal gas, mean translational kinetic energy is proportional to T.
- Exact Celsius offset: 273.15; whole-kelvin estimates may use 273.
- Temperature intervals and ratios require different treatment.

$$T/\mathrm{K} = \theta/^{\circ}\mathrm{C} + 273.15$$

20→40 °C is 293.15→313.15 K: mean energy rises about 6.82%, rather than doubling.

State symbols describe the sample

> Aqueous means dissolved in water; it is not a synonym for liquid.

- (s), (l), (g): solid, liquid and gas.
- $H_2O(l) \rightarrow H_2O(g)$: molecular identity retained.
- $NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$: dissolved ions.

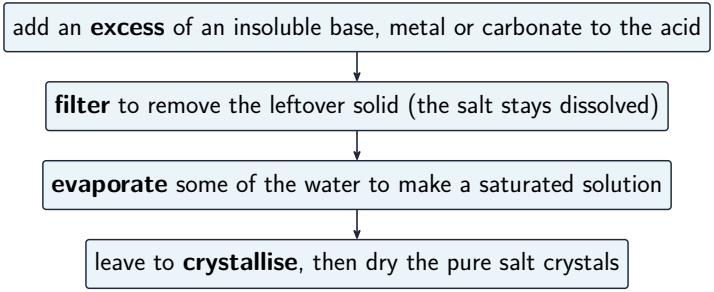
An invented salt recovery

1. **Initial.** 12.0 g **mixture** contains 7.50 g salt
2. **Sand.** $12.0 - 7.50 = 4.50$ g
3. **Recovery.** $6.60 \,/\, 7.50 \times 100 = 88.0\%$

Decision

Loss in transfer or mother liquor need not imply a chemical reaction.

Making a salt from an insoluble base



> The excess makes sure all the acid reacts

Exam tips

> Name the property a separation method uses.

- Identify composition and the particle model; use state symbols.
- Name the property and conditions used for a separation.
- Convert to kelvin before comparing average kinetic energies.

Check yourself

Try these

Classify air, copper, sea water and sodium chloride.

Describe how to get dry copper(II) sulfate crystals from a mixture with sand.

Explain why the temperature is constant while ice melts.

Convert -40 °C to K and 373 K to °C.