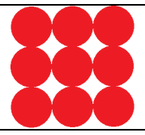
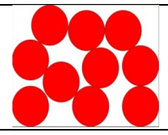
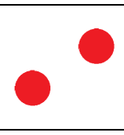
The content on this sheet is assessed on paper 1 only.

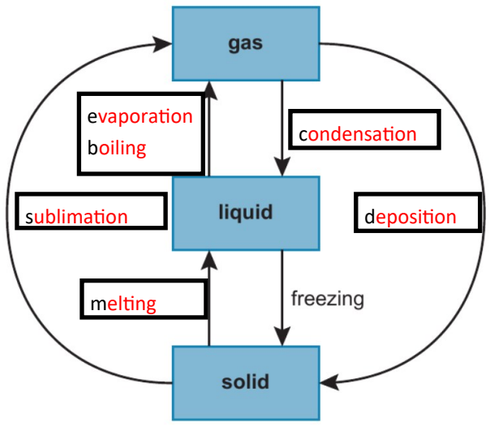
Purifying Substances

* Indicates that these are some examples only: you could be asked about any substance / reaction.

2.1 – Solids, liquids and gases

Name	Solid	Liquid	Gas
Particle diagram			
Particle arrangement	Regular / ordered Close together	Random Close together	Random Spread out
Particle movement	Vibrate Fixed positions	Move past each other; Random	Fill the space Random
Particle energy	Low	Medium	Very high

2.2 – Changing state



2.3—Particle change

Referring to the table above, explain what happens when:

a) a solid becomes a liquid.

Particles gain energy, start moving past each other, become randomly arranged.

b) a gas becomes a liquid.

Particles lose energy, come closer together.

2.4—Predicting states of matter

You must be able to use melting and boiling points to work out whether a substance will be a solid, liquid or gas at a certain temperature. The rules are:

a) If the temperature is higher than the boiling point, it will be a gas.

b) If the temperature is between the melting and boiling points, the substance will be a liquid.

c) If the temperature is lower than the melting point, it will be a solid

Ammonia	
Boiling point (˚C)	- 33
Melting point (˚C)	- 77

At...	Ammonia will be a...
- 20 ˚C	Gas
- 50 ˚C	Liquid
- 80 ˚C	Solid

2.5—Pure and impure

In chemistry, a pure substance is one which only contains only one type of substance.

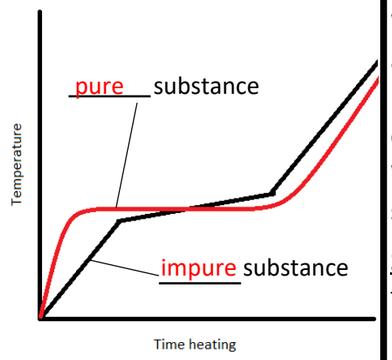
An impure substance (also called a mixture) contains more than 1 type of substance.

2.6—Melting point data

Use the graph to explain how we can determine between pure and impure substances.

Pure substances have a fixed melting point, as all of the particles change state at the same time.

In an impure substance, each part has a different melting point, and so it will change temperature over a range.



2.7—Separation techniques

a) Simple distillation can be used to separate a liquid from a solid, or another liquid with a very different boiling point.

This technique involves evaporating and then condensing the liquid, until it is collected. The liquid collected is called the distillate.

b) Fractional distillation is used to separate two or more liquids with very similar boiling points. The substances are continuously evaporated and condensed until they separate into fractions & are collected.

c) Filtration is used to separate an insoluble solid from a liquid.

The liquid collected is called the filtrate, and the solid is the residue.

d) Crystallisation is used to separate a soluble solid from a liquid, in order to form solid crystals. The liquid is heated, and then left to evaporate slowly: slower evaporation forms larger crystals.

e) Paper chromatography is used to separate a mixture of soluble colours, for example in a pen or food sample (details below).

2.8—Separation methods

Sand from water: filtration

Sodium chloride salt from water (collect salt crystals): crystallisation

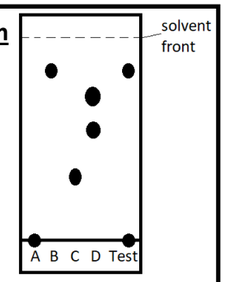
Sodium chloride from water (collect the salt **&** water): simple distillation

Crude oil: fractional distillation

2.9—Paper chromatography

A pencil line is drawn on a piece of chromatography paper (which contains the stationary phase). We draw the line with this as graphite is insoluble in solvents. A spot of the test substance(s) is put on the line, and the solvent (the mobile phase) is passed through the sample(s). The samples separate as they move up the paper at different speeds/rates.

2.10 a & b— Interpreting a paper chromatogram



Which of the substances A-D:

a) contained most colours? D

b) was insoluble in the solvent? A

c) has the highest R_f value? B

Which of the substance(s) A-D is/are in the Test substance? A and B

2.10c—Calculating R_f values

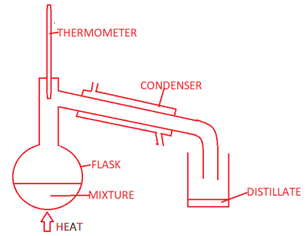
The R_f value can be calculated by: $R_f = \frac{distance\ travelled\ by\ spot}{distance\ travelled\ by\ solvent\ front}$

Use this to calculate the R_f value of substance C to 2 significant figures. 0.36 (approx.)

An R_f value can never be bigger than which numerical value? 1

2.11—CP1—Identification of inks by simple distillation & paper chromatography

Sketch a labelled diagram of simple distillation apparatus.



Describe the safety precautions needed when performing simple distillation:

Wear safety glasses to protect eyes. Allow hot objects to cool before handling, or use tongs.

Suggest a safety precaution to take if performing paper chromatography where ethanol (which is flammable) is the solvent:

Keep away from flames.

2.12a—Potable water

Waste and ground water goes through three main stages to make it drinkable (potable): 1) sedimentation: all of the large solids are allowed to settle out. 2) filtration: all of the smaller solid particles are removed. 3) chlorination: chlorine is added to kill bacteria / microorganisms in the water.

2.12b—Distillation of sea water (desalination)

Sea water can be distilled to make potable water. However, the large amounts of energy required mean that this process is not cost-effective.

2.12c—Water for chemical analysis

Pure (deionised/distilled) water must be used for chemical analysis, as dissolved salts could cause inaccurate results.