Edexcel GCSE Chemistry

Topic 2: States of matter and mixtures

Methods of separating and purifying substances

Notes

2.5 Explain the difference between the use of 'pure' in chemistry compared with its everyday use and the differences in chemistry between a pure substance and a mixture

- A mixture:
  - Consists of 2 or more elements or compounds not chemically combined together
  - Chemical properties of each substance in the mixture are unchanged
- A pure substance = a single element or compound, not mixed with any other substance
- In everyday language, a pure substance = substance that has had nothing added to it, so it is unadulterated and in its natural state, e.g. pure milk

2.6 Interpret melting point data to distinguish between pure substances, which have a sharp melting point and mixtures, which melt over a range of temperatures

- Pure substances melt and boil at specific/exact temperatures, mixtures do not:
  - This means melting and boiling points data can be used to distinguish pure substances from mixtures (which melt over a range of temperatures due to them consisting of 2 or more elements or compounds)

2.7 Explain the experimental techniques for separation of mixtures by: simple distillation, fractional distillation, filtration, crystallisation, and paper chromatography

- Simple distillation:
  - Simple distillation is used to separate a solvent from a solution. It is useful for producing water from salt solution.
    - Simple distillation works because the dissolved solute has a much higher boiling point than the solvent.
    - When the solution is heated, solvent vapour evaporates from the solution. The gas moves away and is cooled and condensed.
    - The remaining solution becomes more concentrated in solute as the amount of solvent in it decreases.

- Fractional distillation:
  - Used to separate a pure liquid from a mixture of liquids
    - Works when the liquids have different boiling points
    - Commonly used to separate ethanol from water
    - (Taking the example of ethanol…) ethanol has a lower bp than water so it evaporates first. The ethanol vapour is then cooled and condensed inside the condenser to form a pure liquid.
    - Sequence of events in distillation is as follows: heating -> evaporating -> cooling -> condensing

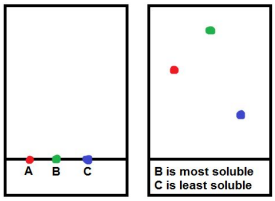
- Fractional distillation is also used to separate oil. The oil is heated in the fractionating column and the oil evaporates and condenses at a number of different temperatures.
- The many hydrocarbons in crude oil can be separated into fractions each of which contains molecules with a similar number of carbon atoms
- The fractionating column works continuously, heated crude oil is piped in at the bottom. The vaporised oil rises up the column and the various fractions are constantly tapped off at the different levels where they condense.
- The fractions can be processed to produce fuels and feedstock for the petrochemical industry.

- Filtration:
  - If you have produced e.g. a precipitate (which is an insoluble salt), you would want to separate the salt/precipitate from the salt solution.
    - You would do this by filtering the solution, leaving behind the precipitate on the filter paper

- Crystallisation:
  - If you were to have produced a soluble salt and you wanted to separate this salt from the solution that it was dissolved in
    - You would first warm the solution in an open container, allowing the solvent to evaporate, leaving a saturated solution
    - Allow this solution to cool
    - The solid will come out of the solution and crystals will start to grow, these can then be collected and allowed to dry

- Paper chromatography:
  - Chromatography…
    - Used to separate mixtures and give information to help identify substances
    - Involves a stationary phase and a mobile phase
    - Separation depends on the distribution of substances between the phases

- Rf value = distance moved by substance / distance moved by solvent (/ represents a dividing sign)
    - Different compounds have different Rf values in different solvents, which can be used to help identify the compounds
    - Compounds in a mixture may separate into different spots depending on the solvent but a pure compound will produce a single spot in all solvents

Paper Chromatography  	Analytical technique separating compounds by their relative speeds in a solvent as it spreads through paper. The more soluble a substance is, the further up the paper it travels. Separates different pigments in a coloured substance.
Pigment	Solid, coloured substance

2.8 Describe an appropriate experiment technique to separate a mixture, knowing the properties of the components of the mixture

- you need to identify which types of substance you have in the mixture and so which technique is most appropriate (from 2.7)

2.9 Describe paper chromatography as the separation of mixtures of soluble substances by running a solvent (mobile phase) through the mixture on the paper (the paper contains the stationary phase), which causes the substances to move at different rates over the paper

2.10 Interpret a paper chromatogram: to distinguish between pure and impure substances, to identify substances by comparison with known substances and to identify substances by calculation and use of Rf values

- pure substances: should only have one spot on a chromatogram
- impure substances/mixtures: will show up with more than one spot on a chromatogram
- to identify by comparing with known substances: carry out paper chromatography with both the known substance and substance you're testing on the same paper. If both spots are at the same height up the paper at the end then you know the substance you're testing is the same as the known substance.
- to identify by calculation of Rf values: you can calculate Rf values and then compare them to known values for different substances

2.11 Core practical: Investigate the composition of inks using simple distillation and paper chromatography

- see 2.7- same method

2.12 Describe how: waste and ground water can be made potable, including the need for sedimentation, filtration and chlorination, sea water can be made potable by using distillation and water used in analysis must not contain any dissolved salts

- potable water: it is suitable for drinking so must have:
  - low levels of microbes
  - low levels of contaminating substances
  - it is not the same as pure water but is still safe
- making waste and ground water potable:
  1. sedimentation: large insoluble particles will sink to the bottom of the water
  2. filtration: water is filtered through beds of sand which removes small insoluble particles
  3. chlorination: chlorine gas is put through water to kill microbes
- making sea water potable using distillation:
  1. filter the seawater
  2. boil it
  3. water vapour is cooled and condensed
- water used in analysis:
  - must be pure because any dissolved salts could react with the substances you are analysing, leaving you with a false result