Potable water

5.10.1.2 · Chemistry · revision notes

What potable water is, how it is produced in the UK from fresh water, and how salty water can be desalinated. This subtopic includes the water purification required practical (pH, dissolved solids and distillation), so expect method questions and calculations as well as 'give reasons' questions on Paper 2.

Key facts

- Potable water = water that is safe to drink (low levels of dissolved salts and microbes)
- UK: choose a fresh water source → filter beds → sterilise
- Sterilising agents (kill microbes): chlorine, ozone, UV light
- Dissolved solids (g/dm^3) = mass of residue (g) ÷ volume of sample (dm^3)
- Pure water: pH 7, boils at 100 °C, leaves no residue
- Pure water = only H_2O molecules; potable water is NOT pure
- Filter beds remove solid particles
- Desalination: distillation or reverse osmosis (membranes); both need large amounts of energy
- 1 dm^3 = 1000 cm^3

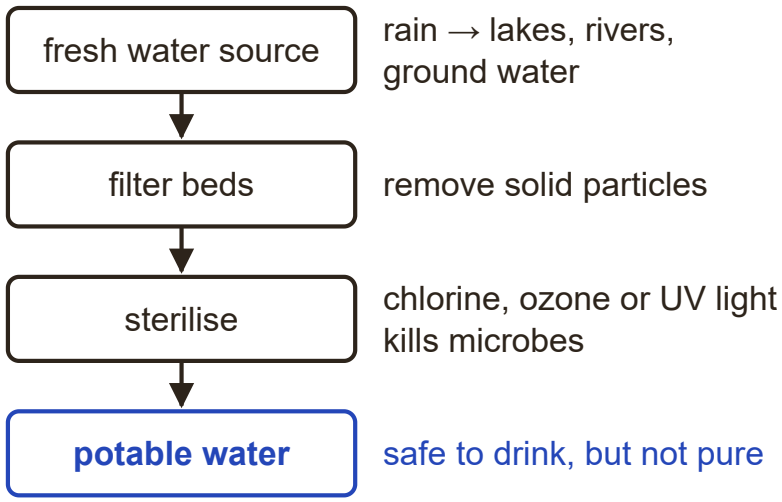
Notes

Potable water and pure water

- **Potable water** is water that is safe to drink. It must have sufficiently low levels of **dissolved salts** and **microbes**.
- Potable water is **not pure** in the chemical sense, because it contains dissolved substances. **Pure** water contains only water molecules, H_2O.
- The method used to produce potable water depends on the supplies of water available and on local conditions.

Producing potable water in the UK

- Rain provides **fresh water** (low levels of dissolved substances). It collects in the ground (**ground water**) and in lakes and rivers.
- Step 1: **choose a suitable source** of fresh water.
- Step 2: pass the water through **filter beds** to remove solid particles.
- Step 3: **sterilise** the water to kill microbes. Sterilising agents are **chlorine**, **ozone** or **ultraviolet (UV) light**.



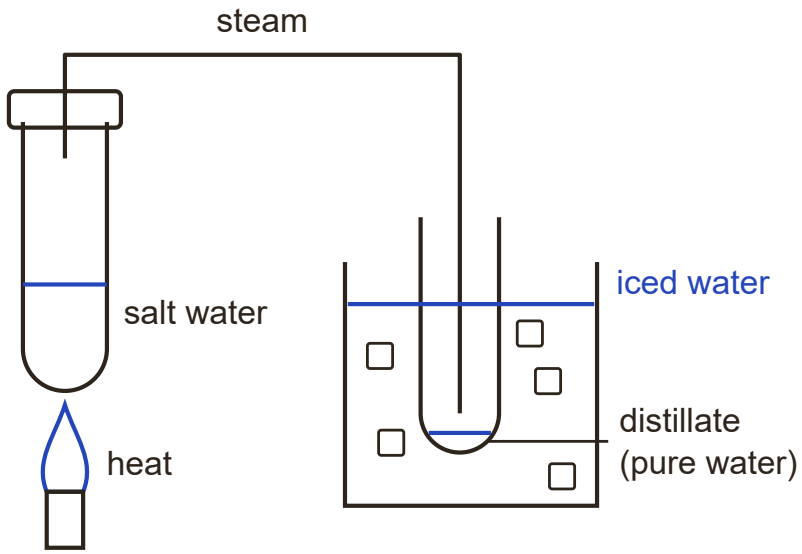
Fresh water only needs filtering and sterilising.

Desalination

- If fresh water is scarce, salty water or sea water can be **desalinated** (the dissolved salts are removed).
- **Distillation**: the water is boiled and the steam is condensed, leaving the salts behind.
- **Reverse osmosis**: salty water is forced at high pressure through a **membrane** that lets water through but not the salts.
- Both processes need **large amounts of energy**, so desalination is expensive. It is used mainly in dry countries with little fresh water.

Required practical: analysing and purifying water

- **pH**: use universal indicator paper and a colour chart, or a pH meter.
- **Dissolved solids**: weigh an empty evaporating basin, add a measured volume of the water, heat gently until all the water has evaporated, then reweigh. Heat and reweigh again until the mass stays the same (constant mass). Mass of solids = final mass − mass of empty basin.
- **Distillation**: heat the salty water; the steam passes into a condenser (or a delivery tube leading into a test tube in iced water), where it condenses. Collect the liquid (the distillate).



The steam condenses in the cold tube; the salts stay behind.

- Check that the distillate is pure: pH 7, no solid left when a sample is evaporated, and it boils at 100 °C.

How to answer each type of question

Describe the treatment of fresh water, with reasons 2 to 4 marks **Grade 5**

1. Name each step in order.
2. Say what each step does: filter beds remove solid particles; sterilising kills microbes.
3. Name a sterilising agent: chlorine, ozone or UV light.

Example. In the UK, most potable water is produced from the fresh water in lakes and rivers. Describe how the fresh water is treated to make it potable. Give a reason for each step. (4 marks)

Model answer. The water is passed through filter beds (1) to remove solid particles (1). It is then sterilised using chlorine / ozone / UV light (1) to kill microbes (1).

Explain the difference between potable and pure water 2 marks **Grade 4**

1. Say what pure water contains: only water molecules (one substance).
2. Say what potable water contains: dissolved substances, so it is a mixture, but it is safe to drink.

Example. A bottle of spring water has a label that lists the calcium, magnesium and sodium ions in the water.
Explain why a chemist would say that the spring water is not pure. (2 marks)

Model answer. Pure water contains only water molecules / only one substance (1). The spring water also contains dissolved substances (calcium, magnesium and sodium ions), so it is a mixture (1).

Required practical: method and calculation 3 to 6 marks **Grade 5**

1. Dissolved solids: weigh the empty basin, add a measured volume, evaporate, reweigh and subtract.
2. Convert cm^3 to dm^3 (÷ 1000) before dividing to get g/dm^3.
3. Distillation: heat so the water boils, condense the steam in a condenser, collect the distillate.
4. Name the equipment: evaporating basin, balance, condenser, universal indicator or pH meter.

Example. A student evaporated 25.0 cm^3 of sea water to dryness in an evaporating basin. The table shows the results.

Measurement	Mass (g)
Empty evaporating basin	42.36
Basin and solid after heating	43.24

(a) Calculate the mass of dissolved solids in 1 dm^3 of the sea water. (3 marks)
(b) Describe how the student could obtain a sample of pure water from the sea water. (2 marks)

Model answer.

(a) Mass of solid = 43.24 − 42.36 = 0.88 g (1); volume = 25.0 ÷ 1000 = 0.0250 dm^3 (1); 0.88 ÷ 0.0250 = 35.2 g/dm^3 (1)

(b) Heat the sea water so that the water boils (1); cool the steam in a condenser so that it condenses, and collect the liquid (1).

Compare producing potable water from different supplies 3 to 4 marks **Grade 7**

1. Say what fresh (or ground) water needs: filtering and sterilising only.
2. Say what salty water needs as well: desalination by distillation or reverse osmosis.
3. Link desalination to its large energy use and so its cost.
4. Finish with which is easier or cheaper, and why.

Example. Country A has plenty of rain and large lakes. Country B has very little rain but a long coastline.
Explain why producing potable water is likely to be more expensive in country B. (3 marks)

Model answer. Country A can use fresh water, which only needs filtering and sterilising (1). Country B must use sea water, which has to be desalinated by distillation or reverse osmosis (1). Desalination needs large amounts of energy, so it costs more (1).

Don't lose marks

- Writing that potable water is pure. It is safe to drink but contains dissolved substances.
- Saying filter beds remove dissolved salts or kill microbes. They remove solid particles only.
- Writing that chlorine 'cleans' the water. Say it sterilises the water, killing microbes.
- Forgetting to convert cm^3 to dm^3 when calculating g/dm^3.
- Saying desalination is rarely used because it is 'difficult'. The key point is that it needs large amounts of energy, so it is expensive.

More tips

Memory tricks

- Potable is linked to 'potion': something you drink.
- UK recipe in three words: source, filter, sterilise.
- Filter = solids out; sterilise = microbes killed.
- Sense check: sea water has roughly 35 g of dissolved salts per dm^3. If you get thousands, check your cm^3 to dm^3 conversion.

Exam technique

- For reason questions, give the step AND what it does: 'filtration' alone rarely scores, but 'filter beds remove solid particles' does.
- In practical questions, say what you measure and how: 'weigh the empty evaporating basin first' earns credit.
- The best evidence that a distillate is pure water is that it boils at exactly 100 °C.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 **State what potable water means**
Potable water is water that is safe to drink.

Grade 4 **Explain why potable water is not pure**

It contains dissolved substances, whereas pure water contains only water molecules.

Grade 4

List the steps in treating fresh water

Choose a suitable source of fresh water, pass it through filter beds, then sterilise it.

Grade 5

Give reasons for each treatment step

Filter beds remove solid particles; sterilising with chlorine, ozone or ultraviolet light kills microbes.

Grade 5

Name two methods of desalination

Distillation, and processes that use membranes such as reverse osmosis.

Grade 5

Describe the water purification required practical

Test the pH, find the mass of dissolved solids by evaporation, and purify the water by distillation.

Grade 5

Calculate dissolved solids from practical results

Mass of dried residue ÷ volume of the sample, e.g. in g/dm^3 after converting cm^3 to dm^3.

Grade 7

Compare treating ground water and salty water

Ground water only needs filtering and sterilising; salty water must be desalinated, which needs large amounts of energy.

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