# States of matter, purity and separation

AQA GCSE Chemistry (8462) · Foundation and Higher

Show your working where needed. Check the worked answers when you finish.

Name _____ Date _____

## 1. Two particle models

Sketch how the particles of a crystalline solid are arranged. Describe how the arrangement and movement of those particles change if the solid melts.

## 2. Use the temperature data

At normal atmospheric pressure, substance X melts at −9 °C and boils at 48 °C. Substance Y melts at 23 °C and boils at 110 °C.

State the physical state of X and of Y at 15 °C and at 62 °C. Use the data to justify one of your choices.

## 3. Limits of a particle picture (Higher)

A pupil draws touching circles in fixed rows for a crystalline solid. Give one useful feature of the drawing. Identify two features of real particles or their behaviour that this picture leaves out.

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### 4. A fogged window

The air next to a cold window contains water vapour. Explain how droplets appear without liquid water being poured on the window. Use ideas about the energy and spacing of particles.

### 5. Recover both solids

A beaker contains insoluble chalk powder suspended in a solution of sodium chloride. Plan a separation that recovers chalk and sodium chloride crystals. Explain what happens to each substance at the first separation step.

### 6. Separate two liquids

Two liquids mix completely. P boils at 65 °C and Q boils at 78 °C. A pupil chooses filtration to obtain a sample rich in P. Explain why that will not work, choose a better method and predict which liquid the first fraction is richer in.

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### 7. Check the sample label

A reference sample of a pure compound melts sharply at 81 °C. Sample A melts sharply at 75 °C. Sample B starts to melt at 75 °C and finishes melting at 80 °C.

Which result is more consistent with a mixture? Explain why neither result supports the label ‘pure reference compound’.

### 8. Keep the solvent

A teacher needs to recover water from a solution containing a non-volatile dissolved solid. One pupil suggests heating the open solution and collecting the solid left behind. Describe an arrangement that collects the water instead, and explain how it works.

### 9. Extra challenge · Recover two useful samples

A class has a mixture of insoluble sand, water and dissolved salt. It needs dry sand and the greatest possible amount of water. Someone proposes evaporating the whole mixture in an open dish.

Describe a sequence that recovers the two samples. Explain how one stage depends on particle size and how the other depends on a change of state.

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# Worked answers

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### 1. Two particle models

Draw several rows of closely packed particles in a regular arrangement. In the solid the particles vibrate about fixed positions. In the liquid, the particles stay close together but are no longer in a regular arrangement. They can move past one another.

### 2. Use the temperature data

At 15 °C, X is a liquid and Y is a solid. At 62 °C, X is a gas and Y is a liquid.

For example, 62 °C is between Y's melting and boiling temperatures, so Y is liquid.

### 3. Limits of a particle picture (Higher)

It shows the close, ordered arrangement of a crystalline solid. The circles omit forces between particles and give every particle the same round form. A static diagram also omits vibration about fixed positions.

### 4. A fogged window

The water vapour transfers energy to the colder window. Some of the vapour condenses. The water molecules move closer together in the liquid droplets.

### 5. Recover both solids

Filter the mixture. Chalk stays as the residue because its particles are trapped by the filter. Dissolved sodium chloride passes through with the water.

Heat the filtrate to evaporate some water, then let the concentrated solution cool so crystals form. Collect the crystals and dry them.

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# Worked answers

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### 6. Separate two liquids

Both liquids pass through filter paper. Use fractional distillation. P has the lower boiling point, so the vapour that first reaches the condenser is richer in P. It condenses and is collected as a liquid.

### 7. Check the sample label

B is more consistent with a mixture because it melts over a range. A has a sharp melting point, but that point differs from the reference. B neither has a sharp melting point nor matches the reference value.

### 8. Keep the solvent

Use simple distillation. Heat the solution in the distillation flask so water vaporises. Pass the vapour through a water-cooled condenser and collect the liquid in a receiver. The non-volatile solid remains in the flask.

### 9. Extra challenge · Recover two useful samples

First filter the mixture. Sand stays in the filter because its solid grains cannot pass through the pores. Wash the residue with a little water if needed and dry it. The dissolved salt passes through in solution.

Distil the filtrate. Heat it to form water vapour, then cool the vapour to collect liquid water. The salt stays in the flask. Open evaporation lets water vapour escape, so it cannot recover the water.

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