Write your name, centre number and candidate number in the boxes below.

| Surname | Other names |
|---|---|
| | |

Centre number | | | | | |

Candidate number | | | | |

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# Experimental design and separation techniques

Time allowed: 1 hour 35 minutes

**Subject code** **0620**

# Chemistry

## Questions from Paper 3, Paper 4 and Paper 6

**You must have:** a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.

Total marks

**/ 76**

### Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.

### Information

- This paper has 10 questions worth 76 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

### Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

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Print at 100% (Actual size) so diagrams keep their real measurements.

**1** Give the name of the process that is used:

**(a)** to obtain water from aqueous sodium chloride

..... [1]

**(b)** to produce lead from molten lead(II) bromide

..... [1]

**(c)** to separate an insoluble solid from a liquid

..... [1]

**(d)** to separate the components of petroleum

..... [1]

**(e)** to separate a mixture of coloured dyes.

..... [1]

[Total: 5]

Separation and purification Click for more variations

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**2** Chromatography can be used to test for the purity of substances.

**(a) (i)** Describe **one** area in everyday life where purity of substances is important.

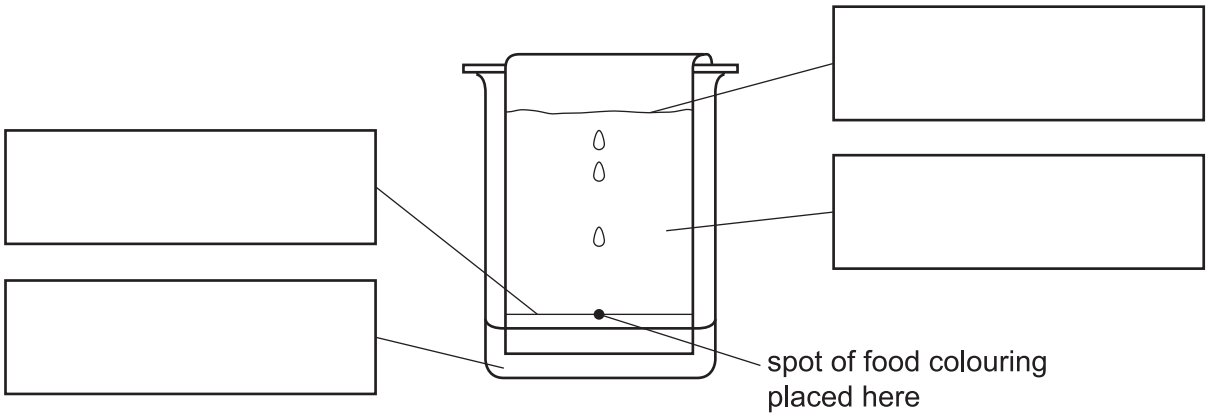
..... [1]

**(ii)** Mineral water contains dissolved salts such as magnesium chloride.
Which one of the following statements about mineral water is correct?
Tick **one** box.

| | |
|---|---|
| Mineral water boils at slightly above 100 °C. | ☐ |
| Mineral water is pure water. | ☐ |
| Mineral water boils at exactly 100 °C. | ☐ |
| Another name for mineral water is fizzy water. | ☐ |

[1]

**(b)** The diagram shows the apparatus used to separate different dyes in food colourings.

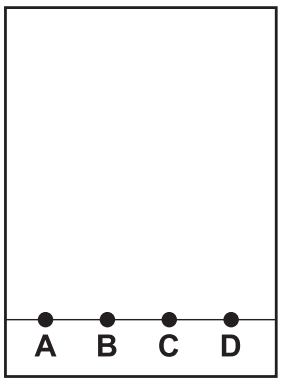



Label the diagram in the boxes provided using the words below.

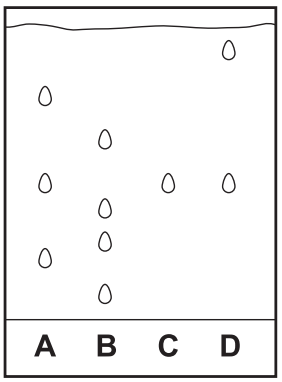
**chromatography paper** **origin line** **solvent** **solvent front** [2]

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**(c)** The diagram below shows the chromatography of four different food colourings, **A**, **B**, **C** and **D**.




at the start of the experiment




the final chromatogram

**(i)** Which food colouring, **A**, **B**, **C** or **D**, contains only one dye? ..... [1]

**(ii)** Which **three** food colourings have one dye in common? ..... [1]

**(iii)** Which food colouring contains the greatest number of dyes? ..... [1]

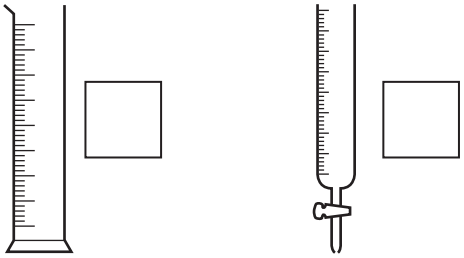
[Total: 7]

Chromatography Click for more variations

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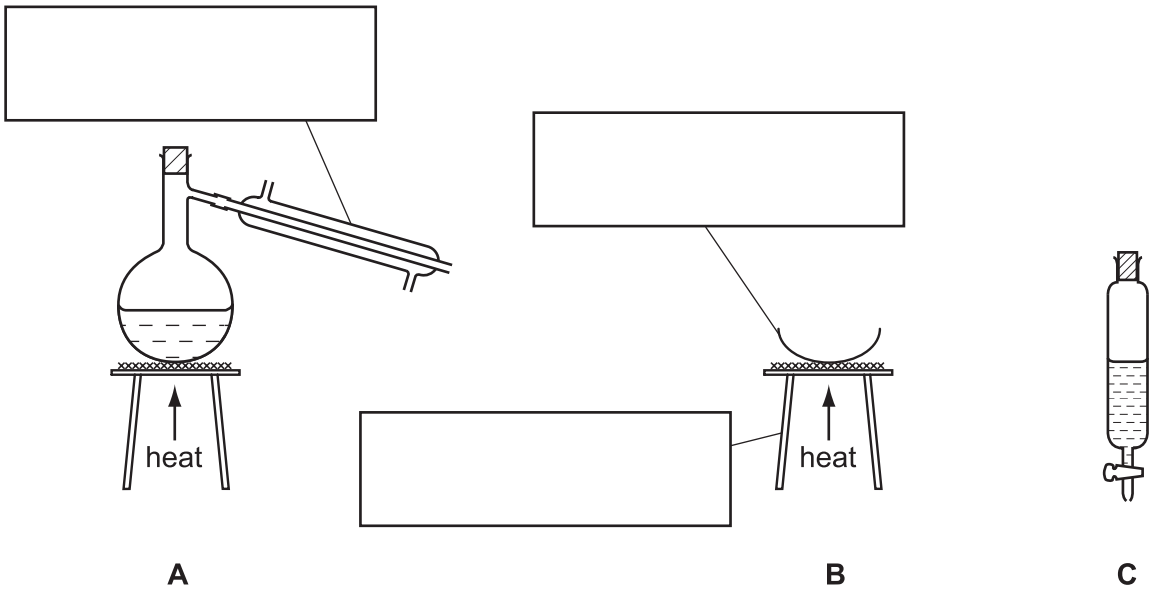
**3** A student separated an aqueous solution of sodium chloride.
She measured out 70 $cm^3$ of the solution and then obtained pure water from the solution.

**(a)** Which of these pieces of apparatus is most suitable to measure 70 $cm^3$ of the solution?
Tick **one** box.



[1]

**(b)** **(i)** Complete the empty boxes to name the pieces of apparatus below.




**A** **B** **C**

[3]

**(ii)** Which method of separation, **A**, **B** or **C**, would be most suitable to obtain pure water from the solution?

apparatus ..... [1]

**(c)** Describe how crystals of sodium chloride could be quickly obtained from the solution.

.....

.....

..... [2]

[Total: 7]

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Practical skills: planning, apparatus, measuring and results Click for more variations

**4** When a mixture of calcium hydroxide and ammonium chloride is heated, ammonia gas is made.

calcium hydroxide + ammonium chloride → calcium chloride + water + ammonia

Ammonia gas is soluble in water and toxic. Ammonia gas reacts with hot copper(II) oxide to make nitrogen.

ammonia + copper(II) oxide → copper + water + nitrogen

A student makes nitrogen using the apparatus shown in Fig. 1.1.

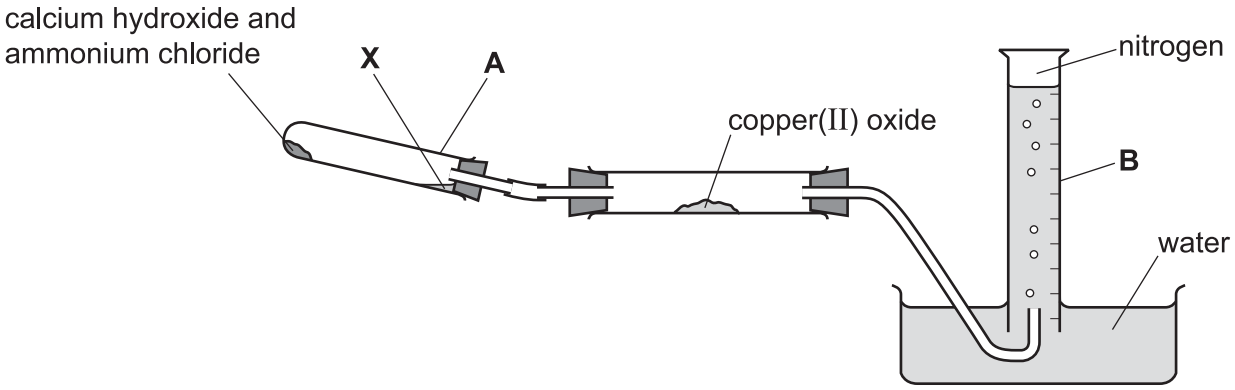



**Fig. 1.1**

**(a)** Name the items of apparatus labelled **A** and **B** in Fig. 1.1.

**A** .....

**B** .....
[2]

**(b)** The apparatus needs to be heated in two places.

On Fig. 1.1, draw arrows in **two** places to show where the apparatus should be heated during the experiment. [2]

**(c)** During the reaction, a colourless liquid collects at the point marked **X** in Fig. 1.1.

Suggest the identity of the colourless liquid.

..... [1]

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**(d)** Some of the ammonia gas passes over the copper(II) oxide without reacting.

Suggest why none of this ammonia gas is collected in the item of apparatus labelled **B** in Fig. 1.1.

.....

..... [1]

**(e)** The student does not collect the first few bubbles of gas.

Suggest why the first few bubbles of gas are **not** collected.

.....

..... [1]

**(f)** Explain why this experiment should be carried out in a fume cupboard.

.....

..... [1]

[Total: 8]

Practical skills: planning, apparatus, measuring and results Click for more variations

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**5** A black dye can be obtained from some plant roots.

Plan an investigation to determine how many different coloured substances are contained in a black dye obtained from plant roots.

You must include how the results you obtain will tell you how many different coloured substances are contained in the black dye.

You have access to plant roots and all normal laboratory apparatus.

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..... [6]

Practical skills: planning, apparatus, measuring and results Click for more variations

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**6** Cobalt, manganese and nickel are metals. They react with dilute hydrochloric acid to form hydrogen gas.

Plan an investigation to find the order of reactivity of these three metals.

You are provided with:
- samples of each metal
- dilute hydrochloric acid
- common laboratory apparatus.

Your plan must make it clear how your investigation will be a fair test and how you will use your results to place the metals in order of reactivity.

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..... [6]

Practical skills: planning, apparatus, measuring and results Click for more variations

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7 A **mixture** contains three compounds:

- liquid ethanol
- solid sodium chloride
- solid zinc carbonate.

Table 4.1 gives some information about these three compounds.

**Table 4.1**

| name of compound | solubility in water | solubility in ethanol |
|---|---|---|
| ethanol | soluble | |
| sodium chloride | soluble | insoluble |
| zinc carbonate | insoluble | insoluble |

Describe how to obtain a pure sample of each of the three compounds, ethanol, sodium chloride and zinc carbonate, from the mixture.

You are provided with common laboratory apparatus.

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..... [6]

Separation and purification Click for more variations

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**8** Magnesium sulfate is a salt. Magnesium sulfate is soluble in water.

The solubility of a salt is the mass of the salt, in g, that dissolves in 100 $cm^3$ of water at a specified temperature.

Plan an investigation to determine the solubility of magnesium sulfate in water at 50 °C. Your plan must include how the solubility of magnesium sulfate, in g per 100 $cm^3$ of water, can be found.

You are provided with solid magnesium sulfate, distilled water and common laboratory apparatus.

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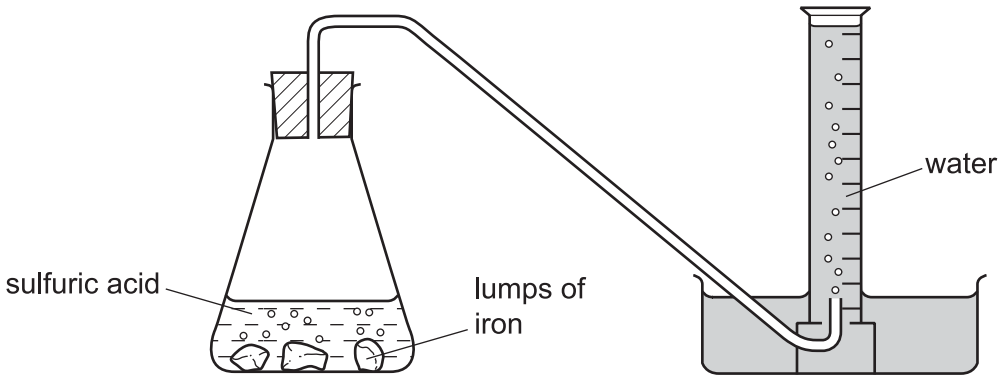
Practical skills: planning, apparatus, measuring and results Click for more variations

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**9** A student investigated the reaction of lumps of iron with sulfuric acid.

$$Fe(s) + H_2SO_4(aq) \rightarrow FeSO_4(aq) + H_2(g)$$

She used the apparatus shown below.




**(a) (i)** Describe how this apparatus can be used to investigate the rate of this reaction.

.....

.....

..... [3]

**(ii)** Describe how the rate of reaction would differ if smaller lumps of iron were used. All other conditions remain the same.

..... [1]

**(b)** The student investigated the effect of temperature on the reaction rate.

**(i)** State **three** factors which the student should keep the same in each experiment.

1. .....

2. .....

3. .....

[3]

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**(ii)** The table shows how the rate of reaction changed with temperature.

| temperature /°C | rate of reaction in $cm^3/s$ |
|---|---|
| 20 | 2.2 |
| 30 | 4.4 |
| 40 | 8.8 |
| 50 | 17.6 |

Use the information in the table to describe how the rate of reaction changed with temperature.

.....

..... [2]

**(c)** Iron(II) sulfate can be prepared by adding excess iron to sulfuric acid.

Describe how you could obtain pure dry crystals of iron(II) sulfate from the reaction mixture in the conical flask.

.....

.....

.....

..... [3]

[Total: 12]

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Rates of reaction Click for more variations

**10** Substances can be classified as elements, compounds or mixtures.

**(a)** What is meant by the term *compound*?

.....

.....

..... [2]

**(b)** Mixtures can be separated by physical processes.

A sequence of physical processes can be used to separate common salt (sodium chloride) from a mixture containing sand and common salt only.

Give the order and the correct scientific term for the physical processes used to separate the common salt from the mixture.

1 .....

2 .....

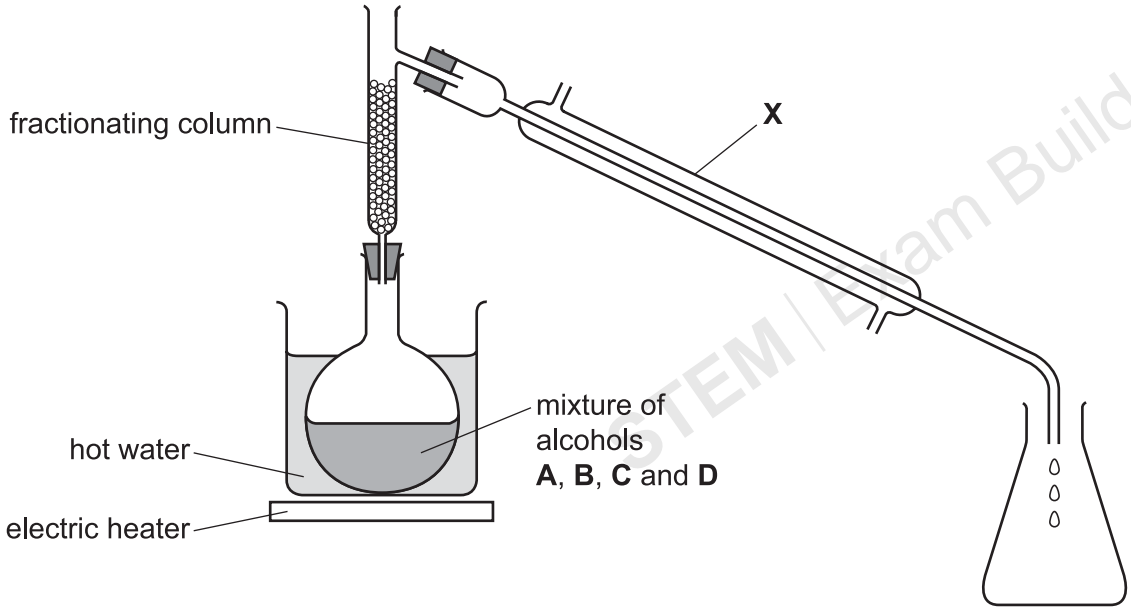
3 .....

[4]

The boiling points of four different alcohols, **A**, **B**, **C** and **D**, are shown.

| alcohol | **A** | **B** | **C** | **D** |
|---|---|---|---|---|
| boiling point / °C | 56 | 78 | 122 | 160 |

**(c)** A student suggested that the apparatus shown could be used to separate the mixture of alcohols.




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**(i)** Apparatus **X** needs to have cold water flowing through it.

- Draw an arrow on the diagram to show where the cold water enters apparatus **X**.
- Name apparatus **X**.

.....

[2]

**(ii)** Part of the fractionating column is missing. This means that the experiment will not work.

- Draw on the diagram the part of the fractionating column which is missing.
- Explain why the experiment will **not** work with this part of the fractionating column missing.

.....

.....

[2]

**(iii)** Suggest why a Bunsen burner is **not** used to heat the flask.

..... [1]

**(iv)** A hot water bath cannot be used to separate alcohols **C** and **D**.

Explain why.

.....

.....

..... [2]

[Total: 13]

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