AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

# GCSE CHEMISTRY

**H**

Higher Tier Paper 2

Wednesday 12 June 2019 Morning Time allowed: 1 hour 45 minutes

**Materials**

For this paper you must have:
- a ruler
- a scientific calculator
- the periodic table (enclosed).

**Instructions**
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

**Information**
- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

| For Examiner's Use | |
|---|---|
| Question | Mark |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| **TOTAL** | |

Answer **all** questions in the spaces provided.

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**0 1** This question is about crude oil and hydrocarbons.

**Figure 1** shows a fractionating column used to separate crude oil into fractions.

**Figure 1**

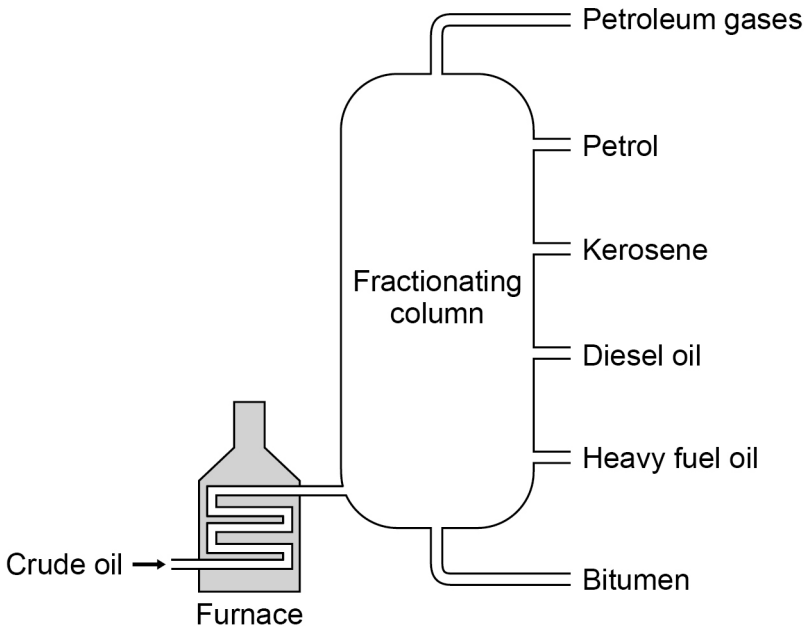


**Table 1** gives information about some of the fractions.

**Table 1**

| Fraction | Boiling point range in °C |
|---|---|
| Petroleum gases | Below 30 |
| Petrol | 40–110 |
| Kerosene | 180–260 |
| Diesel oil | 260–320 |
| Heavy fuel oil | 320–400 |
| Bitumen | 400–450 |

*Do not write outside the box*

**0 1 . 1** Suggest a suitable temperature for the furnace in **Figure 1**.

**[1 mark]**

_____ °C

**0 1 . 2** Explain why diesel oil collects above heavy fuel oil but below kerosene in the fractionating column.

Use **Table 1**.

**[2 marks]**

**0 1 . 3** Suggest **two** reasons why bitumen is **not** used as a fuel.

**[2 marks]**

1 _____

2 _____

**Question 1 continues on the next page**

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**0 1 . 4** Petrol contains mainly alkanes.

Which of the following compounds is an alkane?

**[1 mark]**

Tick (✓) **one** box.

$C_2H_4$ ☐

$C_4H_8$ ☐

$C_6H_{14}$ ☐

$C_8H_{16}$ ☐

Large hydrocarbon molecules in the diesel oil fraction are cracked to produce smaller hydrocarbon molecules.

**0 1 . 5** Describe the conditions needed to crack hydrocarbon molecules from the diesel oil fraction.

**[2 marks]**

*Do not write outside the box*

**0 1 . 6** Explain why large hydrocarbon molecules in the diesel oil fraction are cracked to produce smaller hydrocarbon molecules.

**[2 marks]**

**0 1 . 7** Complete the equation for the cracking of $C_{15}H_{32}$

**[1 mark]**

$$C_{15}H_{32} \rightarrow C_{12}H_{26} + \_\_\_\_\_$$

**11**

**Turn over for the next question**

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**0 2** This question is about lithium carbonate.

Lithium carbonate is used in medicines.

**Figure 2** shows a tablet containing lithium carbonate.

**Figure 2**

**0 2 . 1** Lithium carbonate contains lithium ions and carbonate ions.

A student tested the tablet for lithium ions and for carbonate ions.

The student used:

- a metal wire
- dilute hydrochloric acid
- limewater.

Plan an investigation to show the presence of lithium ions **and** of carbonate ions in the tablet.

You should include the results of the tests for the ions.

**[6 marks]**

*Do not write outside the box*

**0 2 . 2** The tablet also contains other substances.

The substances in tablets are present in fixed amounts.

What name is given to mixtures like tablets?

**[1 mark]**

**0 2 . 3** The tablet has a mass of 1.20 g and contains 700 mg of lithium carbonate.

Calculate the percentage by mass of lithium carbonate in this tablet.

**[3 marks]**

Percentage by mass of lithium carbonate = _____ %

**10**

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**ANSWER IN THE SPACES PROVIDED**

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**0 3** This question is about rate of reaction.

A student investigated the rate of the reaction between magnesium and dilute hydrochloric acid.

The equation for the reaction is:

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

**0 3 . 1** Which state symbol in the equation for the reaction does **not** represent one of the three states of matter?

**[1 mark]**

The student determined the rate of production of hydrogen gas.

**0 3 . 2** What **two** pieces of measuring apparatus could the student use to find the rate of production of hydrogen gas?

**[2 marks]**

1 _____

2 _____

**Question 3 continues on the next page**

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**Table 2** shows the results of the investigation.

**Table 2**

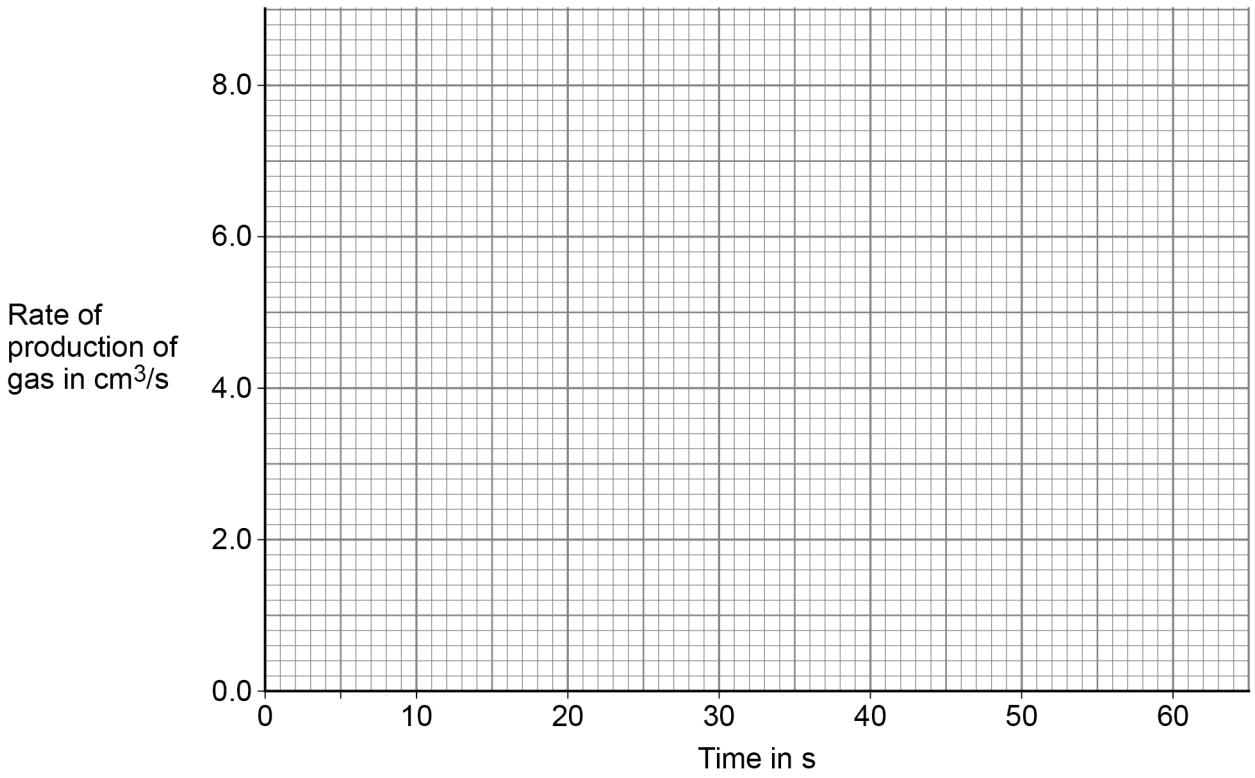
| Time in s | Rate of production of gas in $cm^3/s$ |
|---|---|
| 10 | 6.9 |
| 20 | 3.9 |
| 30 | 2.0 |
| 40 | 0.9 |
| 50 | 0.3 |
| 60 | 0.0 |

**0 3 . 3** Plot the data from **Table 2** on **Figure 3**.

You should draw a line of best fit.

**[3 marks]**

**Figure 3**



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**0 3 . 4** Give **three** conclusions that can be drawn about the rate of reaction between magnesium and dilute hydrochloric acid in this investigation.

Use data from **Figure 3** and **Table 2**.

**[3 marks]**

1 _____

_____

2 _____

_____

3 _____

_____

**0 3 . 5** The student repeated the investigation using dilute hydrochloric acid at a higher temperature.

All the other variables were kept the same.

Which **two** statements are correct?

**[2 marks]**

Tick (✓) **two** boxes.

More bubbles were produced in the first 10 seconds. ☐

The activation energy for the reaction was higher. ☐

The magnesium was used up more quickly. ☐

The reaction finished at the same time. ☐

The total volume of gas collected was greater. ☐

**11**

*Do not write outside the box*

**0 4** This question is about the corrosion of metals.

The corrosion of iron is called rusting.

**0 4 . 1** A student investigated the rusting of iron.

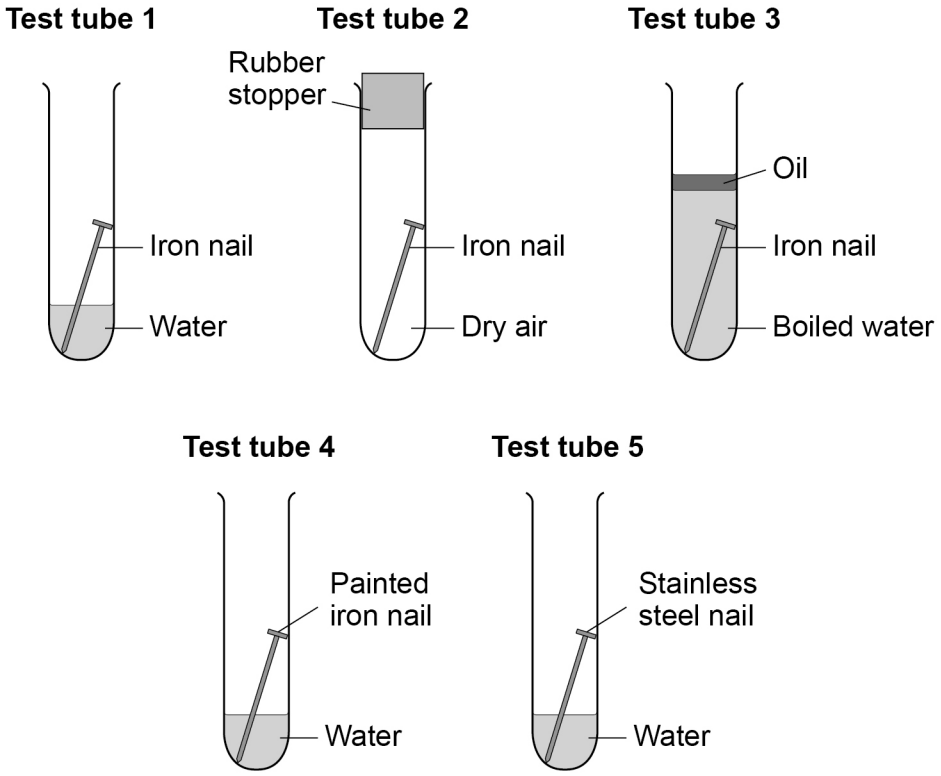
This is the method used.

1. Set up the test tubes as shown in **Figure 4**.

2. Leave the test tubes for 1 week.

3. Examine the nails for signs of rust.

**Figure 4**




Explain what would happen to the nails in each of the test tubes.

**[5 marks]**

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**0 4 . 2** Magnesium is fixed to some steel ships.

Explain how this prevents the steel from rusting.

**[2 marks]**

**0 4 . 3** Explain why aluminium window frames do **not** corrode after they are made.

**[2 marks]**

**9**

*Do not write outside the box*

**0 5** This question is about combustion of fuels.

**0 5 . 1** Some central heating boilers use wood as a fuel.

Suggest **two** reasons why wood is more sustainable than natural gas as a fuel for central heating boilers.

**[2 marks]**

1 _____

_____

2 _____

_____

Natural gas is mainly methane.

When methane burns it can produce both carbon monoxide and carbon dioxide.

**0 5 . 2** Explain the process by which carbon monoxide can be produced when methane is burned.

**[2 marks]**

_____

_____

_____

_____

**0 5 . 3** Balance the equation for the combustion of methane to produce carbon monoxide.

**[1 mark]**

$$\_\_\_\ CH_4(g) + \_\_\_\ O_2(g) \rightarrow \_\_\_\ CO(g) + \_\_\_\ H_2O(l)$$

*Do not write outside the box*

**0 5 . 4** Propane burns to form carbon dioxide and water.

The equation for the reaction is:

$$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$$

3.60 $dm^3$ carbon dioxide is produced when a sample of propane is burned in 7.25 $dm^3$ oxygen.

Calculate the volume of unreacted oxygen.

Give your answer in $cm^3$

**[4 marks]**

Volume of unreacted oxygen = _____ $cm^3$

9

**Turn over for the next question**

*Do not write outside the box*

**0 6** **Figure 5** shows a surfer on a surfboard.

**Figure 5**

Surfboards are made from polymers.

Surfboards have a poly(styrene) core and an outer skin.

**0 6 . 1** **Figure 6** shows the displayed structural formula of poly(styrene).

**Figure 6**

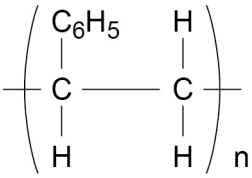
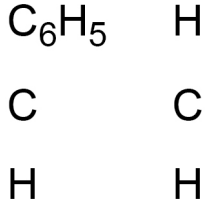



**Figure 7** shows an incomplete displayed structural formula of the monomer styrene.

Complete **Figure 7**.

**[2 marks]**

**Figure 7**



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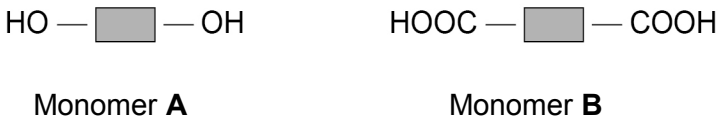
The outer skin of surfboards contains a polyester.

Two monomers, **A** and **B**, are needed to make the polyester.

**Figure 8** shows how these two monomers are represented.

**Figure 8**




Monomer **A** Monomer **B**

**0 6 . 2** Name the functional group in monomer **B**.

**[1 mark]**

**0 6 . 3** Monomers **A** and **B** join together to produce a polyester and a small molecule.

Name the small molecule.

**[1 mark]**

**0 6 . 4** Why does this type of polyester melt when it is heated?

**[2 marks]**

*Do not write outside the box*

The outer skin of surfboards is a composite material.

The composite material contains glass fibres surrounded by a polyester.

**0 6 . 5** Draw **one** line from each material to the description of that material.

**[2 marks]**

| **Material** | **Description of the material** |
|---|---|
| | Hydrocarbon |
| Glass fibres | Matrix |
| | Monomer |
| Polyester | Polypeptide |
| | Reinforcement |

**0 6 . 6** The outer skin makes the surfboard more expensive.

Suggest **two** reasons why an outer skin is added to the poly(styrene) core.

**[2 marks]**

1 _____

_____

2 _____

_____

**10**

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**Turn over for the next question**

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**0 7** A large amount of aluminium sulfate was accidentally added to the drinking water supply at a water treatment works.

**0 7 . 1** Describe a test to show that the drinking water contained aluminium ions.

Give the result of the test.

**[3 marks]**

Test _____

_____

Result _____

_____

_____

_____

**0 7 . 2** Describe a test to show that the drinking water contained sulfate ions.

Give the result of the test.

**[2 marks]**

Test _____

_____

Result _____

_____

*Do not write outside the box*

**0 7 . 3** Plan an investigation to find the total mass of dissolved solids in a 100 $cm^3$ sample of the drinking water.

Your investigation should produce valid results.

**[4 marks]**

9

**Turn over for the next question**

*Do not write outside the box*

**0 8** Titan is a moon of the planet Saturn.

**Table 3** shows the percentages of the gases in the atmosphere of Titan.

**Table 3**

| Gas | Percentage of gas in atmosphere (%) |
|---|---|
| Nitrogen | 98.4 |
| Methane | 1.4 |
| Other gases | 0.2 |

**0 8 . 1** Some scientists think that living organisms could have evolved on Titan.

Explain why these organisms could **not** have evolved in the same way that life is thought to have evolved on Earth.

Use **Table 3**.

**[3 marks]**

*Do not write outside the box*

**0 8 . 2** Saturn has other moons.

The other moons of Saturn have no atmosphere.

Titan is warmer than the other moons of Saturn because its atmosphere contains the greenhouse gas methane.

Explain how this greenhouse gas keeps Titan warmer than the other moons of Saturn.

**[3 marks]**

**0 8 . 3** The atmosphere of Titan contains small amounts of propene.

Describe a test to show that propene is an unsaturated hydrocarbon.

Give the result of the test.

**[2 marks]**

Test _____

Result _____

8

**Turn over ►**

*Do not write outside the box*

**0 9** Some students investigated the rate of decomposition of hydrogen peroxide, $H_2O_2$

The equation for the reaction is:

$$2\,H_2O_2(aq) \rightarrow 2\,H_2O(l) + O_2(g)$$

The catalyst for the reaction is manganese dioxide.

**0 9 . 1** Describe a test to identify the gas produced in the reaction.

Give the result of the test.

**[2 marks]**

Test _____

_____

Result _____

_____

*Do not write outside the box*

Student **A** investigated the effect of the particle size of manganese dioxide on the rate of the reaction.

This is the method used.

1. Measure 25 $cm^3$ of 0.3 $mol/dm^3$ hydrogen peroxide solution into a conical flask.

2. Add a spatula of fine manganese dioxide powder to the conical flask.

3. Measure the volume of gas produced every minute for 10 minutes.

4. Repeat steps 1 to 3 with some coarse manganese dioxide lumps.

**0 9 . 2** The method student **A** used did **not** give valid results.

What **two** improvements could student **A** make to the method to give valid results?

**[2 marks]**

Tick (✓) **two** boxes.

Measure the increase in mass of the conical flask and contents. ☐

Measure the volume of gas produced every 2 minutes. ☐

Place the conical flask in a water bath at constant temperature. ☐

Use 0.05 $mol/dm^3$ hydrogen peroxide solution. ☐

Use a mass of 1 g manganese dioxide each time. ☐

**Question 9 continues on the next page**

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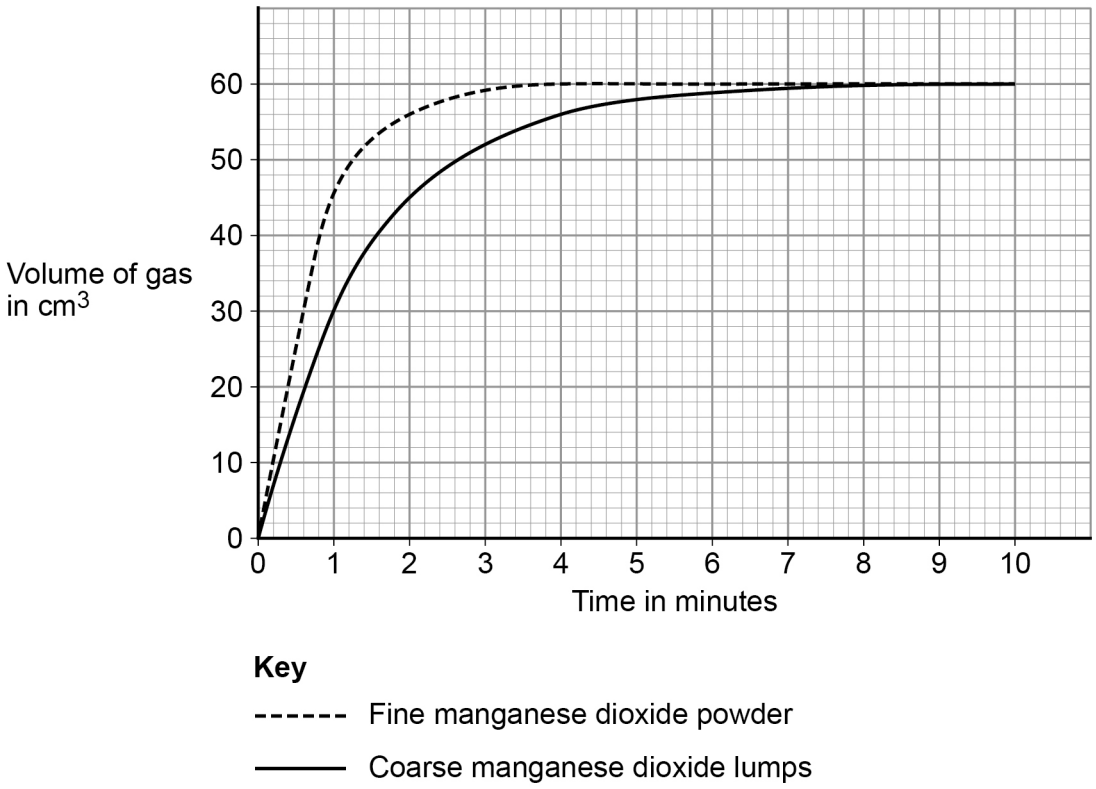
Student **B** used a method which gave valid results.

**Figure 9** shows student **B**'s results.

**Figure 9**




**0 9 . 3** Determine the mean rate of reaction in $cm^3/s$ between 2 and 4 minutes for coarse manganese dioxide lumps.

Give your answer to 2 significant figures.

Use data from **Figure 9**.

**[3 marks]**

Mean rate of reaction = _____ $cm^3/s$

*Do not write outside the box*

Hydrogen peroxide molecules must collide with manganese dioxide particles for catalysis to take place.

**0 9 . 4** Student **B** repeated the experiment with coarse lumps of manganese dioxide.

Student **B** used the same volume of 0.2 mol/dm$^3$ hydrogen peroxide instead of 0.3 mol/dm$^3$ hydrogen peroxide.

Sketch on **Figure 9** the curve you would expect to see.

Assume that the reaction is complete after 9 minutes.

**[2 marks]**

**0 9 . 5** The rate of reaction is different when manganese dioxide is used as a fine powder rather than coarse lumps.

Explain why.

You should answer in terms of collision theory.

**[2 marks]**

**11**

**Turn over for the next question**

*Do not write outside the box*

**1 0** This question is about reversible reactions and equilibrium.

Hydrogen is used to produce ammonia in the Haber process.

The hydrogen is made in two stages.

**Stage 1** is the reaction of methane and steam to produce carbon monoxide and hydrogen.

The equation for the reaction is:

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$

**1 0 . 1** Calculate the atom economy for the formation of hydrogen in **stage 1**.

Relative atomic masses ($A_r$): H = 1 C = 12 O = 16

**[2 marks]**

Atom economy = _____ %

*Do not write outside the box*

**1 0 . 2** Explain why a low pressure is used in **stage 1**.

Give your answer in terms of equilibrium.

**[2 marks]**

**1 0 . 3** **Stage 2** uses the carbon monoxide produced in **stage 1**.

The carbon monoxide is reacted with more steam to produce carbon dioxide and more hydrogen.

The equation for the reaction in **stage 2** is:

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

What is the effect of increasing the pressure on the equilibrium yield of hydrogen in **stage 2**?

**[1 mark]**

**Question 10 continues on the next page**

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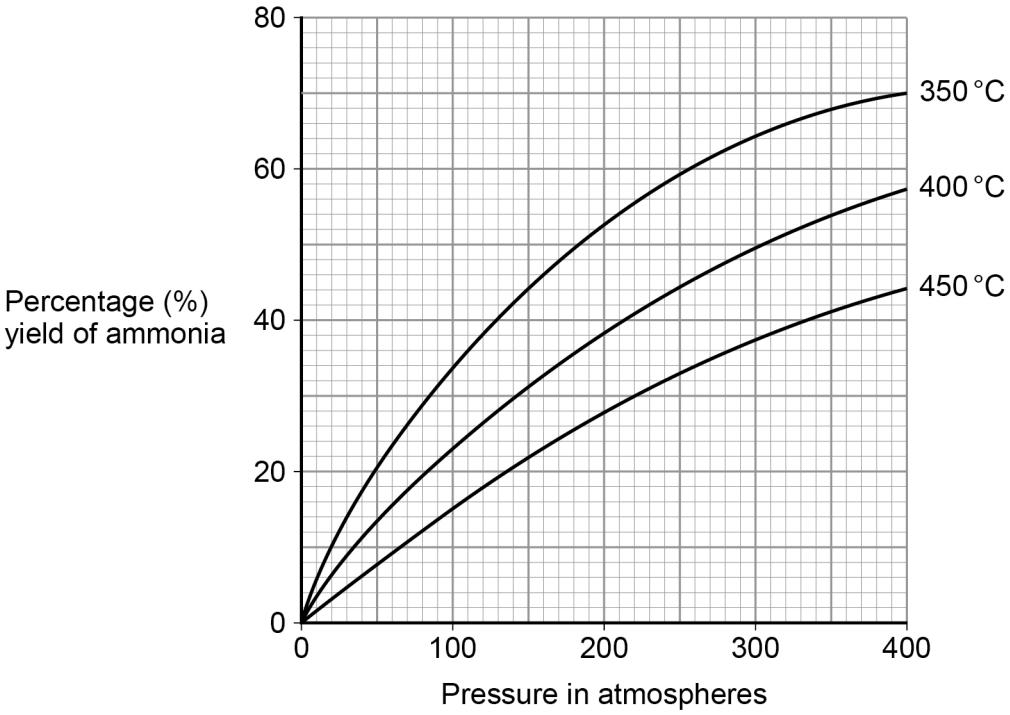
**Figure 10** shows the percentage yield of ammonia produced at different temperatures and pressures in the Haber process.

**Figure 10**




A temperature of 450 °C and a pressure of 200 atmospheres are used in the Haber process.

**1 0 . 4** A student suggested that a temperature of 350 °C and a pressure of 285 atmospheres could be used instead of those used in the Haber process.

Determine how many times greater the percentage yield of ammonia obtained would be.

Use **Figure 10**.

**[3 marks]**

Percentage yield = _____ times greater

*Do not write outside the box*

**1 0 . 5** A pressure of 285 atmospheres is **not** used in the Haber process instead of 200 atmospheres.

Give **one** reason why.

**[1 mark]**

**1 0 . 6** How does **Figure 10** show that the forward reaction in the Haber process is exothermic?

**[1 mark]**

**1 0 . 7** World production of ammonia is now about 30 times greater than it was in 1950.

Suggest why the demand for ammonia has increased.

**[2 marks]**

**12**

**END OF QUESTIONS**

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