AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.1.1.2

Mixtures

Past-paper questions

Tier	**Higher**
Question groups	**27**
Available paper years	**2018–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

5.1.1.2 Mixtures

Question 01

June 2018 | 8464/C/1H | Original Q8

0 8 This question is about iron.

Iron reacts with dilute hydrochloric acid to produce iron chloride solution and one other product.

0 8 . 1 Name the other product.

[1 mark]

0 8 . 2 Suggest how any unreacted iron can be separated from the mixture.

[1 mark]

Magnesium reacts with iron chloride solution.

$$3\ Mg + 2\ FeCl_3 \rightarrow 2\ Fe + 3\ MgCl_2$$

0 8 . 3 0.120 g of magnesium reacts with excess iron chloride solution.

Relative atomic masses (A_r): Mg = 24 Fe = 56

Calculate the mass of iron produced, in mg

[5 marks]

Mass of iron = _____ mg

Question 8 continues on the next page

5.1.1.2 Mixtures

Question 01 · continued

0 8 . 4 Explain which species is reduced in the reaction between magnesium and iron chloride.

$$3\ Mg + 2\ FeCl_3 \rightarrow 2\ Fe + 3\ MgCl_2$$

Your answer should include the half equation for the reduction.

[3 marks]

10

5.1.1.2 Mixtures

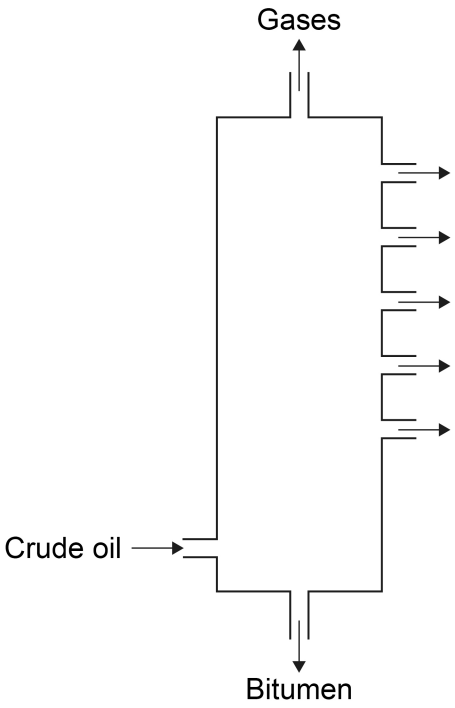
Question 02

0 1 Crude oil is a mixture of hydrocarbons.

0 1 . 1 The hydrocarbons in crude oil are separated into fractions by fractional distillation.

Figure 1 shows a fractional distillation column.

Figure 1



Crude oil vapour passes up the column.

Complete the sentence.

Choose the answer from the box.

[1 mark]

condenses	**dissolves**	**freezes**	**melts**

Each fraction _____ at a different level.

5.1.1.2 Mixtures

Question 02 · continued

0 1 . 2 Why do the fractions separate?

[1 mark]

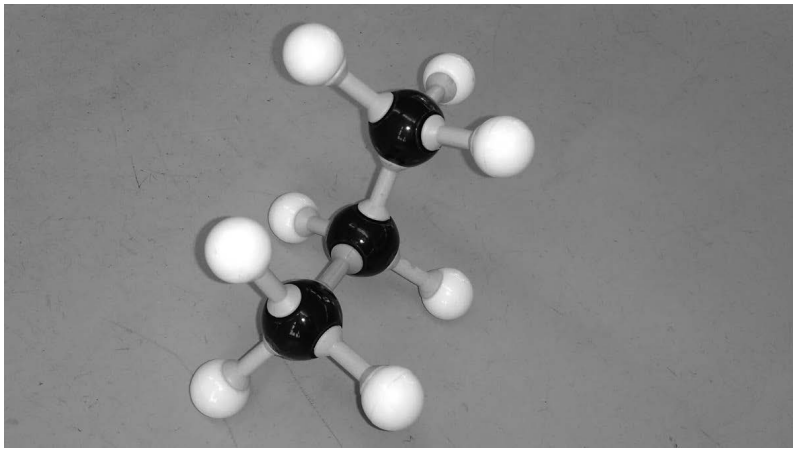
Tick **one** box.

- The fractions have different boiling points. ☐
- The fractions have different flammability. ☐
- The fractions have different melting points. ☐
- The fractions have different viscosity. ☐

Most of the hydrocarbons in crude oil are alkanes.

0 1 . 3 **Figure 2** represents an alkane molecule.

Figure 2



Name the alkane.

[1 mark]

Question 1 continues on the next page

5.1.1.2 Mixtures

Question 02 · continued

0 1 . 4 Methane (CH_4) is an alkane.

What is the general formula for alkanes?

[1 mark]

Tick **one** box.

- C_nH_n ☐
- C_nH_{2n} ☐
- C_nH_{2n-2} ☐
- C_nH_{2n+2} ☐

0 1 . 5 Alkanes burn in oxygen.

Balance the equation for methane burning.

[1 mark]

____ CH_4 + ____ O_2 → ____ CO_2 + ____ H_2O

0 1 . 6 Ethene is an alkene.

Which reagent is used to test for alkenes?

[1 mark]

Tick **one** box.

- Anhydrous copper sulfate ☐
- Bromine water ☐
- Damp litmus paper ☐
- Limewater ☐

5.1.1.2 Mixtures

Question 02 · continued

Table 1 shows data from a life cycle assessment (LCA) for the disposal of 10 000 biodegradable plastic bags.

Table 1

	Burning and using the energy to generate electricity	Landfill
Mass of carbon dioxide produced in kg	25	15
Mass of solid residue in kg	0.050	0.070
Mass of sulfur dioxide produced in kg	0.20	0.30

0 1 . 7 Why are life cycle assessments (LCA) done?

[1 mark]

0 1 . 8 Compare the **two** methods for the disposal of biodegradable plastic bags.

Use information from **Table 1**

[4 marks]

11

5.1.1.2 Mixtures

Question 03

0 5 This question is about electrolysis.

0 5 . 1 Some metals are extracted from molten compounds using electrolysis.

Why is electrolysis used to extract some metals?

[1 mark]

_____

_____

0 5 . 2 Aluminium is produced by electrolysis of a molten mixture.

What **two** substances does the molten mixture contain?

[2 marks]

1 _____

2 _____

0 5 . 3 Copper and chlorine are produced when molten copper chloride is electrolysed.

Complete the half equation for the reaction at each electrode.

[2 marks]

Half equation at negative electrode

Cu^{2+} _____ $\rightarrow$ _____

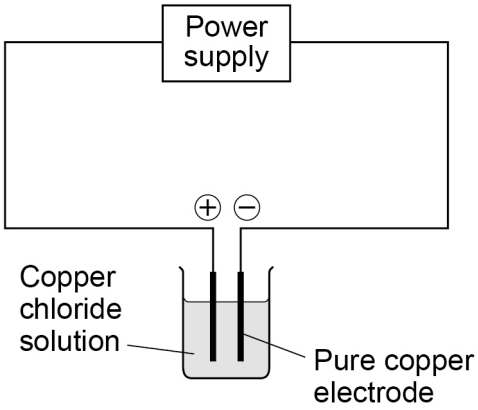
Half equation at positive electrode

$2\ Cl^{-} \rightarrow$ _____

Question 03 · continued

Figure 4 shows the apparatus a student used to electrolyse copper chloride solution.

Figure 4



The student:

- measured the mass of copper deposited on the negative electrode after 60 minutes
- compared the mass deposited with the expected value.

0 5 . 4 Suggest **two** reasons why the mass deposited was different from the expected value.

[2 marks]

1 _____

_____

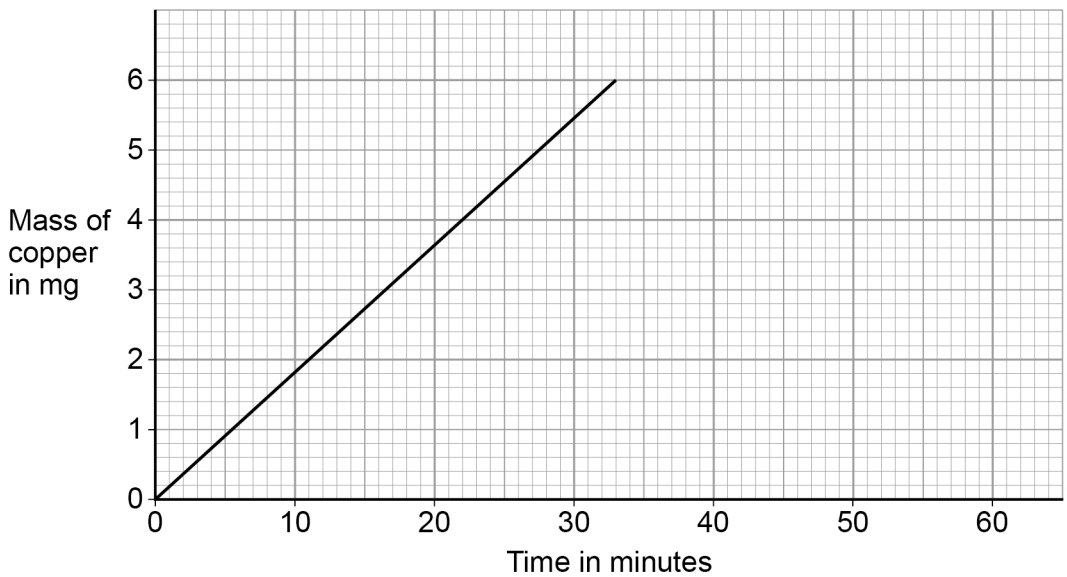
2 _____

_____

Question 5 continues on the next page

0 5 . 5 **Figure 5** shows the expected mass of copper produced each minute.

Figure 5



Determine the expected mass of copper after 24 hours.

Use **Figure 5**.

[3 marks]

Mass = _____ mg

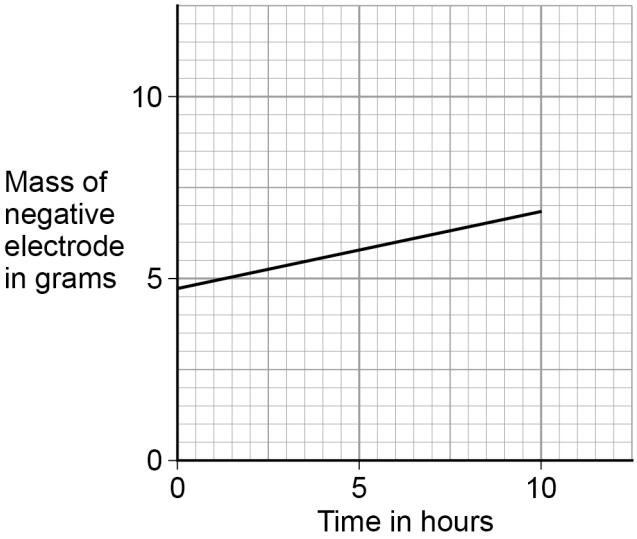
5.1.1.2 Mixtures

Question 03 · continued

Silver nitrate solution is electrolysed.

Figure 6 shows the change in mass of the negative electrode over 10 hours.

Figure 6



0 5 . 6 Determine the mass of the negative electrode at the start of the experiment.

Use **Figure 6**.

[1 mark]

0 5 . 7 Calculate the gradient of the line in **Figure 6**.

Give the unit.

[3 marks]

Gradient _____

Unit _____

14

5.1.1.2 Mixtures

Question 04

June 2019 | 8464/C/2H | Original Q3

0 3 This question is about chromatography of food colouring.

0 3 . 1 Food colouring is a formulation.

What is a formulation?

[1 mark]

0 3 . 2 Explain how paper chromatography separates the dyes in a food colouring.

Do **not** give details of how to do the experiment.

[2 marks]

0 3 . 3 Explain how the student could tell from the chromatogram that the food colouring contained more than one dye.

[2 marks]

Question 3 continues on the next page

5.1.1.2 Mixtures

Question 04 · continued

0 3 . 4 Explain how the student could use chromatography to identify unknown dyes in the food colouring.

[3 marks]

8

5.1.1.2 Mixtures

Question 05

November 2020 | 8464/C/1H | Original Q1

0 1 This question is about the extraction of aluminium.

0 1 . 1 An aluminium atom is represented as:

$$^{27}_{13}Al$$

Give the number of electrons and neutrons in the aluminium atom.

[2 marks]

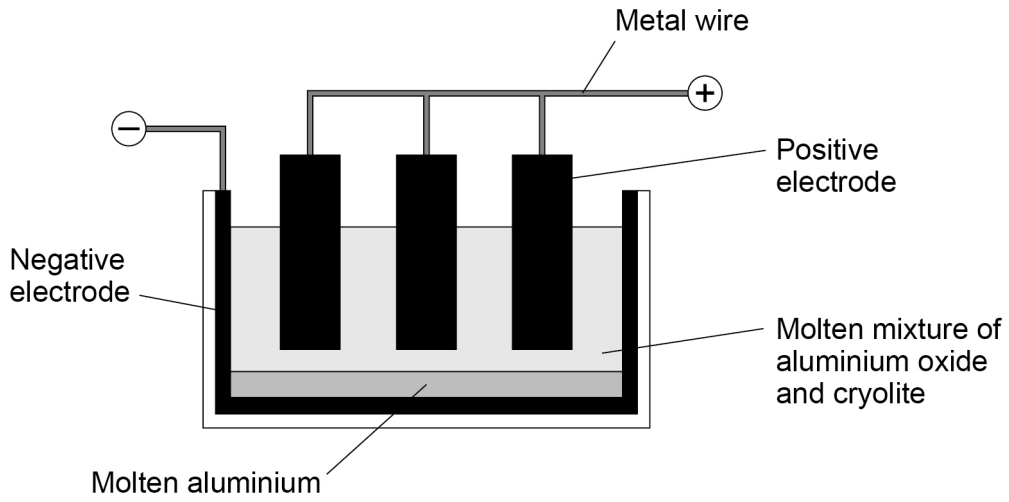
Number of electrons _____

Number of neutrons _____

Aluminium is extracted by the electrolysis of a molten mixture of aluminium oxide and cryolite.

Figure 1 shows the cell used for the electrolysis.

Figure 1



0 1 . 2 Aluminium is produced by the reduction of aluminium oxide (Al_2O_3).

What is meant by the term reduction?

[1 mark]

_____

_____

5.1.1.2 Mixtures

Question 05 · continued

0 1 . 3 Oxygen is formed at the positive carbon electrodes.

Explain why the positive carbon electrodes must be continually replaced.

[3 marks]

0 1 . 4 A substance conducts electricity because of free moving, charged particles.

What are the free moving, charged particles in a:

- carbon electrode (made from graphite)
- molten mixture of aluminium oxide and cryolite
- metal wire?

[3 marks]

Carbon electrode (made from graphite) _____

Molten mixture of aluminium oxide and cryolite _____

Metal wire _____

9

5.1.1.2 Mixtures

Question 06

November 2020 | 8464/C/1H | Original Q4

0 4 This question is about acids, alkalis and bases.

A student reacted zinc oxide powder with hydrochloric acid to produce zinc chloride solution.

0 4 . 1 Complete the equation for the reaction by writing the state symbols.

[2 marks]

$$ZnO(\quad) + 2\,HCl(\quad) \rightarrow ZnCl_2(\quad) + H_2O(\quad)$$

0 4 . 2 Give **one** way that the student could speed up the reaction between zinc oxide powder and hydrochloric acid.

[1 mark]

Hydrochloric acid was the limiting reactant.

0 4 . 3 How could the student know when all the hydrochloric acid has reacted?

[1 mark]

0 4 . 4 How could the student obtain zinc chloride solution from the reaction mixture when all the hydrochloric acid has reacted?

[1 mark]

5.1.1.2 Mixtures

Question 06 · continued

0 4 . 5 Describe how zinc chloride crystals are produced from zinc chloride solution.

[2 marks]

Sulfuric acid and sodium hydroxide react to produce sodium sulfate.

0 4 . 6 Sulfuric acid is gradually added to sodium hydroxide solution.

The pH of the mixture changes as the sulfuric acid is added until in excess.

Suggest the pH at:

- the start before sulfuric acid is added
- the end when sulfuric acid is in excess.

[2 marks]

pH at start = _____

pH at end = _____

0 4 . 7 Complete the symbol equation for the preparation of sodium sulfate.

You should balance the equation.

[2 marks]

_____ $NaOH$ + H_2SO_4 → _____ + _____

Question 4 continues on the next page

5.1.1.2 Mixtures

Question 06 · continued

0 4 . 8 A solution of hydrochloric acid had a hydrogen ion concentration of 1.0 mol/dm^3

Water was added to the hydrochloric acid until the pH increased by 1

What was the hydrogen ion concentration of the hydrochloric acid after water had been added?

[1 mark]

Tick (✓) **one** box.

100 mol/dm^3 ☐

10 mol/dm^3 ☐

0.10 mol/dm^3 ☐

0.010 mol/dm^3 ☐

12

5.1.1.2 Mixtures

Question 07

November 2020 | 8464/C/1H | Original Q5

0 5 A student investigated the temperature change when magnesium was added to copper sulfate solution.

This is the method used.

1. Pour 30 cm^3 of copper sulfate solution into a polystyrene cup.
2. Measure the temperature of copper sulfate solution every minute for 3 minutes.
3. Add magnesium on the fourth minute.
4. Measure the temperature of the mixture at 5 minutes and then every minute up to 14 minutes.

0 5 . 1 What is the dependent variable in this investigation?

[1 mark]

Question 5 continues on the next page

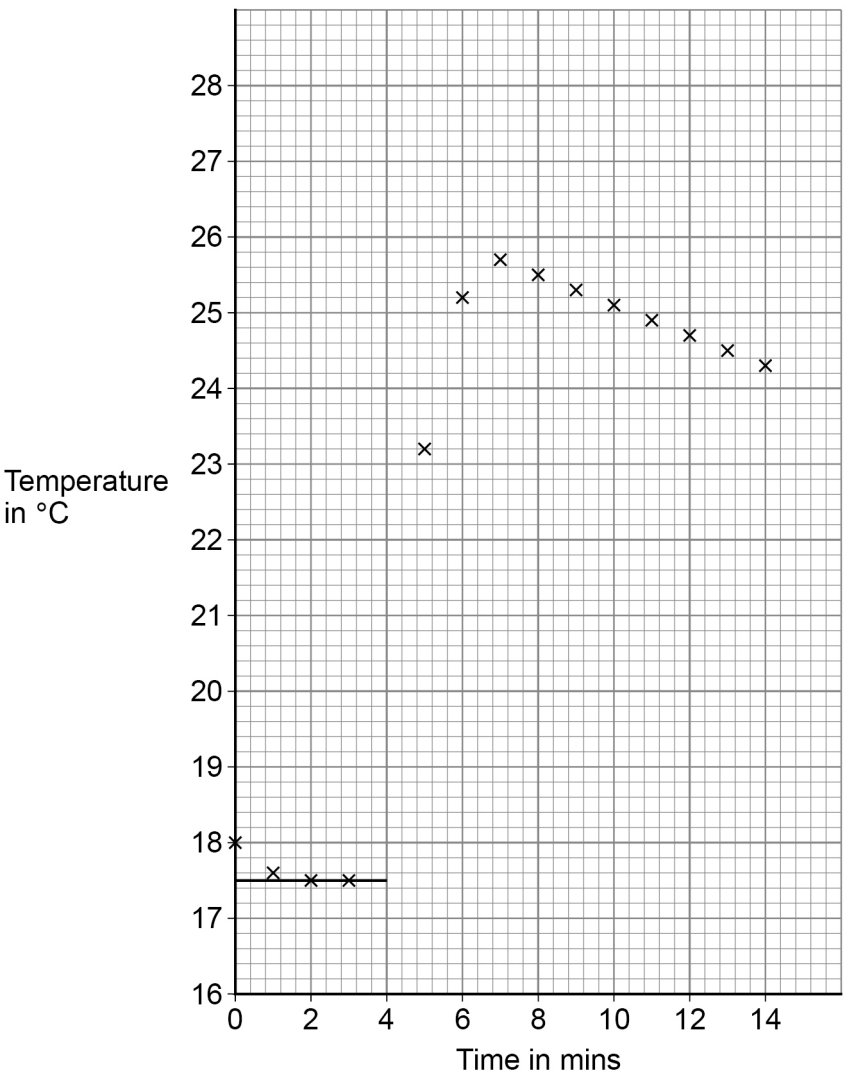
5.1.1.2 Mixtures

Question 07 · continued

The student used the results to plot a graph.

Figure 4 shows the graph.

Figure 4



5.1.1.2 Mixtures

Question 07 · continued

0 5 . 2 Suggest why the copper sulfate solution was left for four minutes before adding the magnesium.

[1 mark]

0 5 . 3 Complete **Figure 4** by:

- drawing a line of best fit through all the points after 7 minutes
- extending the line back to 4 minutes.

[2 marks]

0 5 . 4 The temperature change for the reaction is the temperature difference between the two graph lines at 4 minutes.

Determine the temperature change for the reaction.

Use **Figure 4**.

[2 marks]

Temperature change = _____ °C

0 5 . 5 Explain why the temperature of the mixture decreases after 7 minutes.

[2 marks]

Question 07 · continued

0 5 . 6 The student repeated the experiment with an unknown metal **Q** instead of magnesium.

All the other variables were kept the same.

The student recorded a smaller temperature change.

Suggest the identity of metal **Q**.

Give **one** reason for your answer.

[2 marks]

Metal **Q** _____

Reason _____

_____

0 5 . 7 A copper sulfate solution contained 0.100 moles of copper sulfate dissolved in 0.500 dm^3 of water.

Calculate the mass of copper sulfate in 30.0 cm^3 of this solution.

Relative formula mass (M_r): $CuSO_4$ = 159.5

[4 marks]

_____

_____

_____

_____

_____

_____

Mass = _____ g

14

5.1.1.2 Mixtures

Question 08

November 2020 | 8464/C/2H | Original Q5

0 5 This question is about crude oil and alkanes.

0 5 . 1 Describe how crude oil is formed.

[3 marks]

0 5 . 2 Describe how crude oil is separated into fractions by fractional distillation.

[4 marks]

5.1.1.2 Mixtures

Question 08 · continued

Table 2 shows the boiling points of three alkanes.

Table 2

Alkanes	Boiling point in °C
C_5H_{12}	36
$C_{10}H_{22}$	174
$C_{15}H_{32}$	271

0 5 . 3 What is the general formula for alkanes?

[1 mark]

0 5 . 4 Explain the trend in the boiling points of the alkanes.

[3 marks]

Question 5 continues on the next page

Question 08 · continued

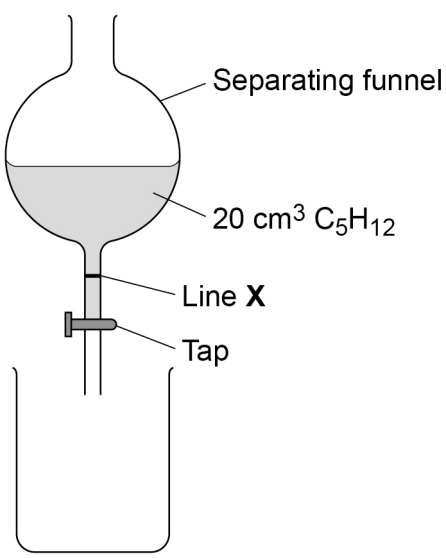
0 5 . 5 A student investigated one property of the alkanes C_5H_{12}, $C_{10}H_{22}$ and $C_{15}H_{32}$

This is the method used.

1. Pour 20 cm^3 of C_5H_{12} into a separating funnel.
2. Open the tap of the separating funnel and start a timer.
3. Stop the timer when the level of C_5H_{12} reaches line **X**.
4. Repeat steps 1 to 3 with $C_{10}H_{22}$ and $C_{15}H_{32}$

Figure 5 shows the apparatus used.

Figure 5



The level of C_5H_{12} takes 6.4 seconds to reach line **X**.

Predict the trend in times for the other two alkanes.

Give **one** reason for your answer.

[2 marks]

Trend _____

_____

Reason _____

_____

13

5.1.1.2 Mixtures

Question 09

November 2020 | 8464/C/2H | Original Q7

0 7 This question is about equilibrium.

0 7 . 1 Describe how a reaction reaches equilibrium.

[2 marks]

Nitrogen dioxide gas reacts to form dinitrogen tetraoxide gas.

The reaction is reversible.

The equation for the reaction is:

$$2\ NO_2(g) \rightleftharpoons N_2O_4(g)$$

0 7 . 2 Explain the effect on the equilibrium position of increasing the pressure.

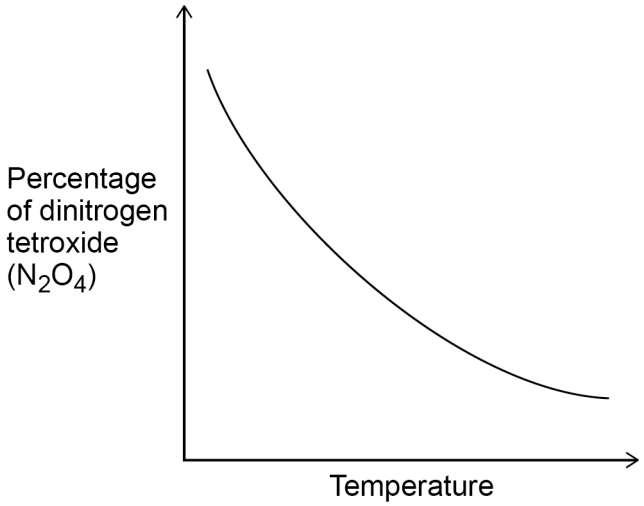
[2 marks]

5.1.1.2 Mixtures

Question 09 · continued

0 7 . 3 **Figure 7** shows the change in the percentage of dinitrogen tetroxide (N_2O_4) in the equilibrium mixture as the temperature of the equilibrium mixture is changed.

Figure 7



Explain the effect on the equilibrium position of increasing the temperature.

Use **Figure 7**.

[3 marks]

7

5.1.1.2 Mixtures

Question 10

November 2021 | 8464/C/1H | Original Q2

0 2 Acids react to produce salts.

Universal indicator is added to water and then nitric acid is added to the mixture.

0 2 . 1 Give the colour change when nitric acid is added to the mixture of universal indicator and water.

[1 mark]

Tick (✓) **one** box.

- Blue to red ☐
- Green to purple ☐
- Green to red ☐
- Red to purple ☐

0 2 . 2 What happens to the pH of water when nitric acid is added?

[1 mark]

Tick (✓) **one** box.

- Decreases ☐
- Stays the same ☐
- Increases ☐

0 2 . 3 What is the state symbol for nitric acid?

[1 mark]

5.1.1.2 Mixtures

Question 10 · continued

Zinc carbonate reacts with nitric acid.

The word equation for the reaction is:

zinc carbonate (white solid) + nitric acid → zinc nitrate (colourless solution) + water + carbon dioxide

0 2 . 4 Give **two** observations that would be made when zinc carbonate is added to nitric acid until the zinc carbonate is in excess.

[2 marks]

1 _____

_____

2 _____

_____

0 2 . 5 The formula of the zinc ion is Zn^{2+}

The formula of the nitrate ion is NO_3^-

What is the formula for zinc nitrate?

[1 mark]

Tick (✓) **one** box.

- $ZnNO_3$ ☐
- $Zn(NO_3)_2$ ☐
- Zn_2NO_3 ☐
- $Zn_2(NO_3)_2$ ☐

Question 2 continues on the next page

5.1.1.2 Mixtures

Question 10 · continued

0 2 . 6 Acids react with insoluble metal oxides to produce salts.

Plan a method to produce a pure, dry sample of the soluble salt copper chloride from an acid and a metal oxide.

[6 marks]

12

5.1.1.2 Mixtures

Question 11

November 2021 | 8464/C/1H | Original Q7

0 7 Methane, ethane, propane and butane all react with oxygen to produce carbon dioxide and water.

0 7 . 1 Suggest why a mixture of methane and oxygen does **not** react at room temperature.

Answer in terms of particles.

[2 marks]

0 7 . 2 **Table 3** shows the energy released when methane, ethane and propane react with oxygen to produce carbon dioxide and water.

Table 3

	Compound reacted with oxygen		
	Methane	Ethane	Propane
Formula of compound	CH_4	C_2H_6	C_3H_8
Energy released in kJ/mol	680	1160	1640

Predict the energy released when butane (C_4H_{10}) reacts with oxygen to produce carbon dioxide and water.

[1 mark]

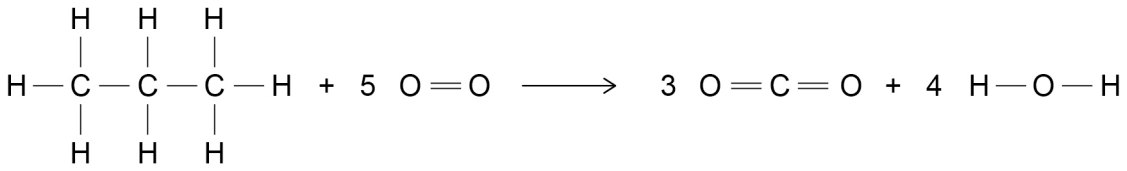
Energy released = _____ kJ/mol

5.1.1.2 Mixtures

Question 11 · continued

0 7 . 3 Propane reacts with oxygen to produce carbon dioxide and water.

The displayed formula equation for the reaction is:



The reaction is exothermic.

In the reaction, the energy released when forming new bonds is 1640 kJ/mol greater than the energy needed when breaking bonds.

Table 4 shows bond energies.

Table 4

Bond	**H–C**	**C–C**	**O=O**	**C=O**	**O–H**
Bond energy in kJ/mol	410	**X**	500	740	460

Calculate the C—C bond energy (**X**).

[5 marks]

X = _____ kJ/mol

8

5.1.1.2 Mixtures

Question 12

November 2021 | 8464/C/2H | Original Q3

0 3 The methods used to produce potable water depend upon available sources of water.

0 3 . 1 Suggest how copper sulfate can be used as a test for the presence of water.

[3 marks]

The boiling point is used to check the purity of a sample of water.

0 3 . 2 In chemistry, what is meant by a 'pure substance'?

[1 mark]

5.1.1.2 Mixtures

Question 12 · continued

0 3 . 3 The boiling point of a 250 g sample of water was 100.60 °C.

The boiling point of pure water in a data book is 100.00 °C.

Each 1% of impurity increases the boiling point of water by 0.12 °C.

Calculate the mass of the impurity in the sample of water.

[3 marks]

Mass of the impurity = _____ g

0 3 . 4 Explain how distillation is used to obtain potable water from salty water.

[4 marks]

Question 3 continues on the next page

5.1.1.2 Mixtures

Question 12 · continued

0 3 . 5 Obtaining potable water from salty water is more expensive than obtaining potable water from ground water.

Explain why.

Refer to the processes used in both methods in your answer.

[2 marks]

13

5.1.1.2 Mixtures

Question 13

November 2021 | 8464/C/2H | Original Q6

0 6 Ammonia is produced when a mixture of nitrogen and hydrogen reacts.

The equation for the reaction is:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

0 6 . 1 Nitrogen is obtained from the air.

The mixture of nitrogen and hydrogen must **not** contain carbon dioxide and oxygen.

Explain how a sample can be tested to show that carbon dioxide is **not** present in the mixture.

[2 marks]

0 6 . 2 A catalyst is used in the reaction.

Explain how a catalyst increases the rate of a reaction.

[2 marks]

Question 6 continues on the next page

Question 13 · continued

The equation for the reaction to produce ammonia is repeated here.

$$N_2\,(g) + 3\,H_2\,(g) \rightleftharpoons 2\,NH_3\,(g)$$

0 6 . 3 The reaction reaches equilibrium.

Explain how an equilibrium is reached.

[2 marks]

0 6 . 4 Suggest how the catalyst affects the equilibrium position.

Give **one** reason for your answer.

[2 marks]

0 6 . 5 What is the effect of increasing the pressure on the reaction to produce ammonia?

[1 mark]

Tick (✓) **one** box.

The yield of ammonia decreases. ☐

The yield of ammonia stays the same. ☐

The yield of ammonia increases. ☐

5.1.1.2 Mixtures

Question 13 · continued

November 2021 | 8464/C/2H | Original Q6

0 6 . 6 The forward reaction is exothermic.

Explain the effect of increasing the temperature on the yield of ammonia gas produced at equilibrium.

[2 marks]

11

5.1.1.2 Mixtures

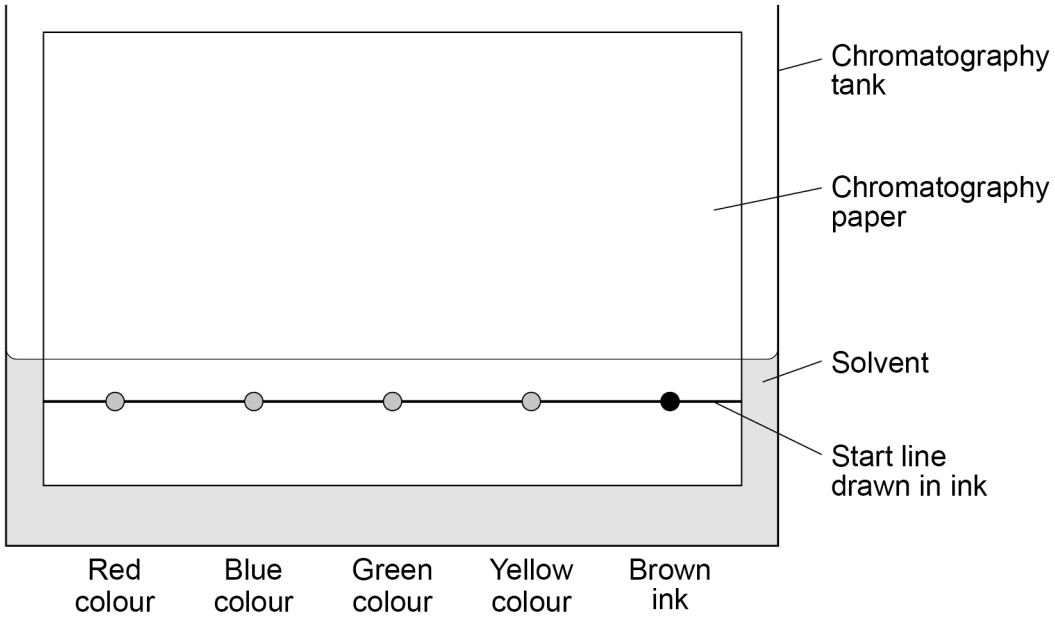
Question 14

June 2022 | 8464/C/2H | Original Q1

0 1 A student investigated the colours in a brown ink using chromatography.

0 1 . 1 **Figure 1** shows the apparatus used.

Figure 1



Give **two** errors made by the student.

Describe the problem each error would cause.

[4 marks]

Error 1 _____

_____

Problem 1 _____

_____

Error 2 _____

_____

Problem 2 _____

_____

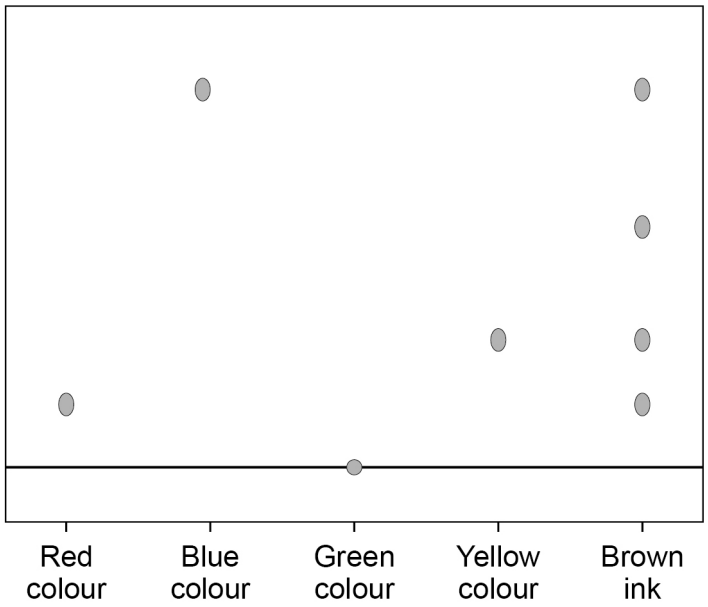
5.1.1.2 Mixtures

Question 14 · continued

A different student set up the apparatus correctly.

Figure 2 shows the results.

Figure 2



0 1 . 2 Give **two** conclusions the student can make from **Figure 2** about the four colours in the brown ink.

[2 marks]

1 _____

_____

2 _____

_____

Question 1 continues on the next page

5.1.1.2 Mixtures

Question 14 · continued

0 1 . 3 Why was the green colour still on the start line at the end of the experiment?

[1 mark]

Tick (✓) **one** box.

- The experiment was left for too long. ☐
- The green colour was insoluble in the solvent. ☐
- The green spot contained too many colours. ☐
- The green spot was too small. ☐

0 1 . 4 A student calculated the R_f value of a colour to be 0.24

The colour moved 1.8 cm from the start line.

Calculate the distance the solvent moved.

Use the equation:

$$R_f = \frac{\text{distance moved by colour}}{\text{distance moved by solvent}}$$

[3 marks]

Distance moved by solvent = _____ cm

10

5.1.1.2 Mixtures

Question 15

June 2023 | 8464/C/1H | Original Q6

0 6 Acids react with some metals to produce soluble salts.

A student adds magnesium to hydrochloric acid until no more acid reacts and excess magnesium remains.

The equation for the reaction is:

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

0 6 . 1 Describe how solid magnesium chloride is obtained from the reaction mixture.

[2 marks]

0 6 . 2 The reaction between magnesium and hydrochloric acid is a redox reaction.

Explain what happens to the magnesium atoms in this reaction.

[2 marks]

5.1.1.2 Mixtures

Question 15 · continued

0 6 . 3 0.72 g of magnesium is added to 100 cm^3 of hydrochloric acid.

The hydrochloric acid is in excess.

Calculate the concentration of the magnesium chloride ($MgCl_2$) solution produced in g/dm^3.

Relative atomic mass (A_r): Mg = 24

Relative formula mass (M_r): $MgCl_2$ = 95

[6 marks]

Concentration = _____ g/dm^3

10

5.1.1.2 Mixtures

Question 16

June 2023 | 8464/C/2H | Original Q1

0 1 The combustion of fuels is a source of atmospheric pollutants.

0 1 . 1 Methane is a fuel.

Balance the equation for the combustion of methane.

[1 mark]

$$CH_4 + ____ O_2 \rightarrow CO_2 + ____ H_2O$$

0 1 . 2 Many fuels are mixtures.

Petrol and diesel are mixtures of hydrocarbons.

Table 1 shows properties of petrol and of diesel.

Table 1

	Petrol	**Diesel**
Range of number of carbon atoms in a hydrocarbon molecule	4 to 12	12 to 20
Range of boiling points in °C	40 to 205	250 to 350

Compare the properties of petrol and diesel.

Use **Table 1**.

[2 marks]

5.1.1.2 Mixtures

Question 16 · continued

0 1 . 3 The gases released when a fuel is burned in car engines may include:

- oxides of nitrogen
- carbon monoxide
- water vapour.

Which chemical element do all these gases contain?

[1 mark]

Tick (✓) **one** box.

Carbon ☐

Hydrogen ☐

Nitrogen ☐

Oxygen ☐

0 1 . 4 When diesel burns in car engines, oxides of nitrogen are produced.

Where does the nitrogen come from?

[1 mark]

0 1 . 5 When diesel burns, particulates may be produced.

What environmental effect do particulates from burning diesel cause?

[1 mark]

5.1.1.2 Mixtures

Question 16 · continued

0 1 . 6 Carbon monoxide may be produced when diesel burns.

Give **one** reason why carbon monoxide is difficult to detect.

[1 mark]

0 1 . 7 Explain why water vapour and **not** liquid water is produced when diesel burns.

[2 marks]

0 1 . 8 Sulfur is a common impurity in diesel.

Explain why this causes an environmental problem.

[3 marks]

12

5.1.1.2 Mixtures

Question 17

June 2023 | 8464/C/2H | Original Q2

0 2 Chromatography is used to separate mixtures.

Chromatography involves a mobile phase and one other phase.

0 2 . 1 What is the other phase in chromatography?

[1 mark]

Tick (✓) **one** box.

- Moving phase ☐
- Recycled phase ☐
- Stationary phase ☐
- Viscous phase ☐

0 2 . 2 Why do the substances in the mixture separate in the mobile phase?

[1 mark]

_____

_____

0 2 . 3 How many spots will be produced on the chromatogram of a pure compound?

[1 mark]

Number of spots = _____

5.1.1.2 Mixtures

Question 17 · continued

0 2 . 4 In a chromatography experiment, a blue colour moved 4.77 cm.

The solvent moved 5.30 cm.

Calculate the R_f value for the blue colour.

[2 marks]

R_f value = _____

Question 2 continues on the next page

5.1.1.2 Mixtures

Question 17 · continued

0 2 . 5 Black ink is a mixture of several colours.

Plan an experiment using paper chromatography to:

- separate the colours in black ink
- identify the colours from their R_f values.

[6 marks]

11

5.1.1.2 Mixtures

Question 18

June 2023 | 8464/C/2H | Original Q3

0 3 Crude oil is a mixture of many different compounds.

0 3 . 1 Give **two** reasons why crude oil is **not** a formulation.

[2 marks]

1 _____

_____

2 _____

_____

0 3 . 2 Describe how crude oil is separated into fractions.

[4 marks]

_____

_____

_____

_____

_____

_____

_____

_____

0 3 . 3 The fractions from crude oil contain alkanes.

Explain why alkanes are cracked.

[2 marks]

_____

_____

_____

_____

5.1.1.2 Mixtures

Question 18 · continued

Cracking produces a mixture of products.

0 3 . 4 An equation for cracking decane ($C_{10}H_{22}$) is:

$$C_{10}H_{22}(l) \rightarrow C_{10}H_{20}(l) + H_2(g)$$

Describe a test to identify the gas produced in the reaction.

[2 marks]

Test _____

_____

Result _____

_____

0 3 . 5 Alkenes are produced in cracking.

The general formula for the homologous series of alkenes is C_nH_{2n}

Which formula represents an alkene?

[1 mark]

Tick (✓) **one** box.

C_2H_2 ☐

C_2H_4 ☐

C_2H_6 ☐

C_3H_8 ☐

11

5.1.1.2 Mixtures

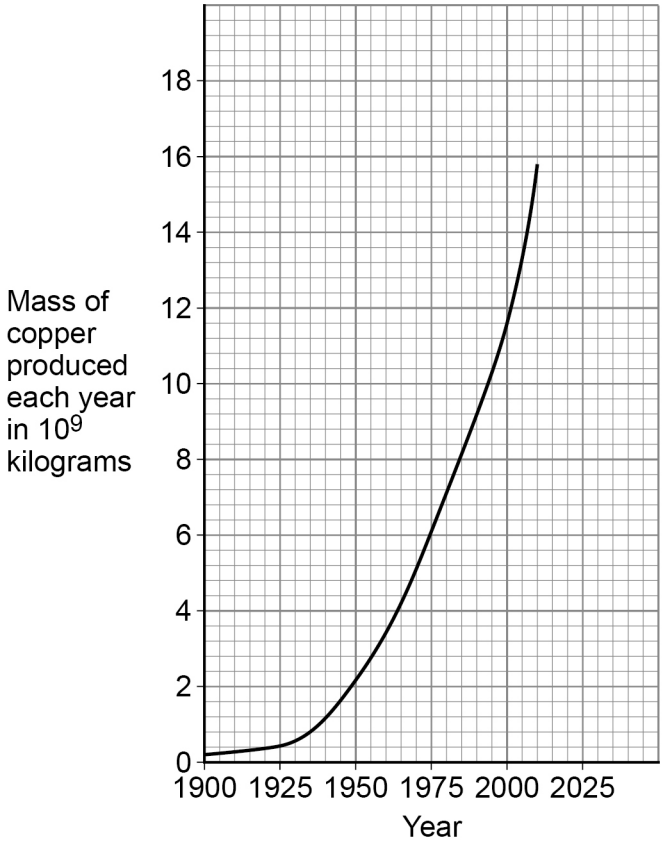
Question 19

June 2024 | 8464/C/1H | Original Q1

0 1 Copper is a useful metal.

0 1 . 1 **Figure 1** shows the mass of copper produced between 1900 and 2010.

Figure 1



Give **two** conclusions that can be made from **Figure 1**.

[2 marks]

1 _____

_____

2 _____

_____

Question 1 continues on the next page

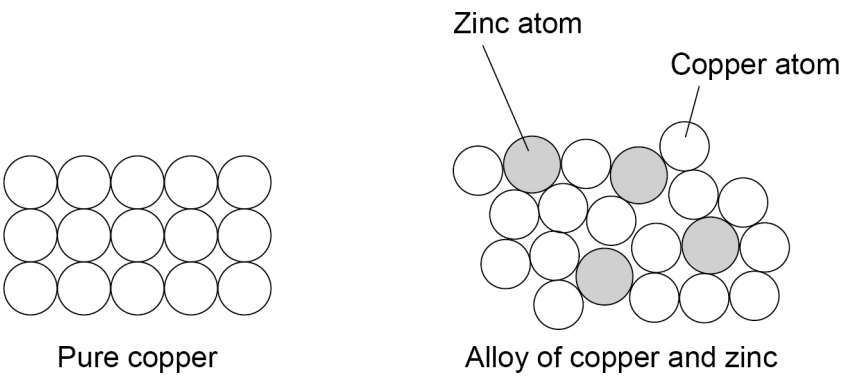
5.1.1.2 Mixtures

Question 19 · continued

Mixtures of copper and zinc are heated to produce alloys.

0 1 . 2 **Figure 2** represents the structures of pure copper and of an alloy of copper and zinc.

Figure 2



Explain why the alloy of copper and zinc is harder than pure copper.

Use **Figure 2**.

[3 marks]

5.1.1.2 Mixtures

Question 19 · continued

0 1 . 3 A 5.25 g sample of an alloy of copper and zinc contains 13.5% zinc by mass.

Calculate the mass of **copper** in the 5.25 g sample.

Give your answer to 3 significant figures.

[4 marks]

Mass of **copper** (3 significant figures) = _____ g

9

Turn over for the next question

5.1.1.2 Mixtures

Question 20

June 2024 | 8464/C/1H | Original Q4

0 4 Nitric acid (HNO_3) is a strong acid.

0 4 . 1 What is meant by a 'strong acid'?

[1 mark]

0 4 . 2 Nitric acid is used as a dilute aqueous solution.

What is meant by 'dilute aqueous solution'?

[1 mark]

Question 4 continues on the next page

5.1.1.2 Mixtures

Question 20 · continued

0 4 . 3 10 cm^3 of a nitric acid solution has a pH of 1

Water is added to the nitric acid solution to change the pH of the nitric acid solution to pH 3

How does the hydrogen ion concentration change?

[1 mark]

Tick (✓) **one** box.

- Decreases by a factor of 100 ☐
- Decreases by a factor of 10 ☐
- Increases by a factor of 10 ☐
- Increases by a factor of 100 ☐

0 4 . 4 Write the **ionic** equation for the reaction between an acid and an alkali.

[1 mark]

_____ + _____ → _____

5.1.1.2 Mixtures

Question 20 · continued

The equation shows the reaction between magnesium carbonate and nitric acid.

$$MgCO_3 + 2\,HNO_3 \rightarrow Mg(NO_3)_2 + H_2O + CO_2$$

0 4 . 5 What is the ratio of the number of moles of magnesium carbonate to the number of moles of nitric acid in the reaction?

[1 mark]

Tick (✓) **one** box.

1 : 1 ☐

1 : 2 ☐

2 : 1 ☐

2 : 2 ☐

0 4 . 6 A student mixed some magnesium carbonate with excess nitric acid.

The student then added two drops of universal indicator to the solution.

What colour was the solution after the addition of universal indicator?

[1 mark]

Tick (✓) **one** box.

Red ☐

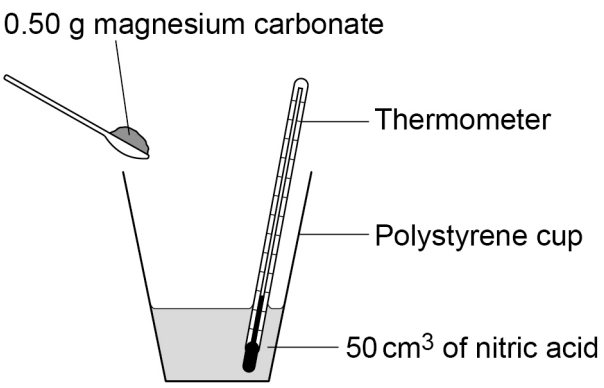
Green ☐

Blue ☐

A student investigated the temperature change when different masses of magnesium carbonate were reacted with excess nitric acid.

Figure 6 shows the apparatus.

Figure 6



This is the method used.

1. Pour 50 cm^3 of nitric acid into a polystyrene cup.
2. Measure the temperature of the solution.
3. Add 0.50 g of magnesium carbonate.
4. Stir the mixture.
5. Measure the temperature.
6. Repeat steps 1 to 5 with different masses of magnesium carbonate.

0 4 . 7 Give **two** improvements to the **method** to produce more accurate results.

Do **not** refer to improvements to the apparatus in your answer.

[2 marks]

1 _____

_____

2 _____

_____

8

5.1.1.2 Mixtures

Question 21

June 2024 | 8464/C/2H | Original Q1

0 1 Alkanes and alkenes are hydrocarbons.

0 1 . 1 Define the term 'hydrocarbon'.

[1 mark]

0 1 . 2 The general formula for alkanes is C_nH_{2n+2}

Determine the formula of the alkane with 10 carbon atoms.

[1 mark]

Formula = _____

Question 1 continues on the next page

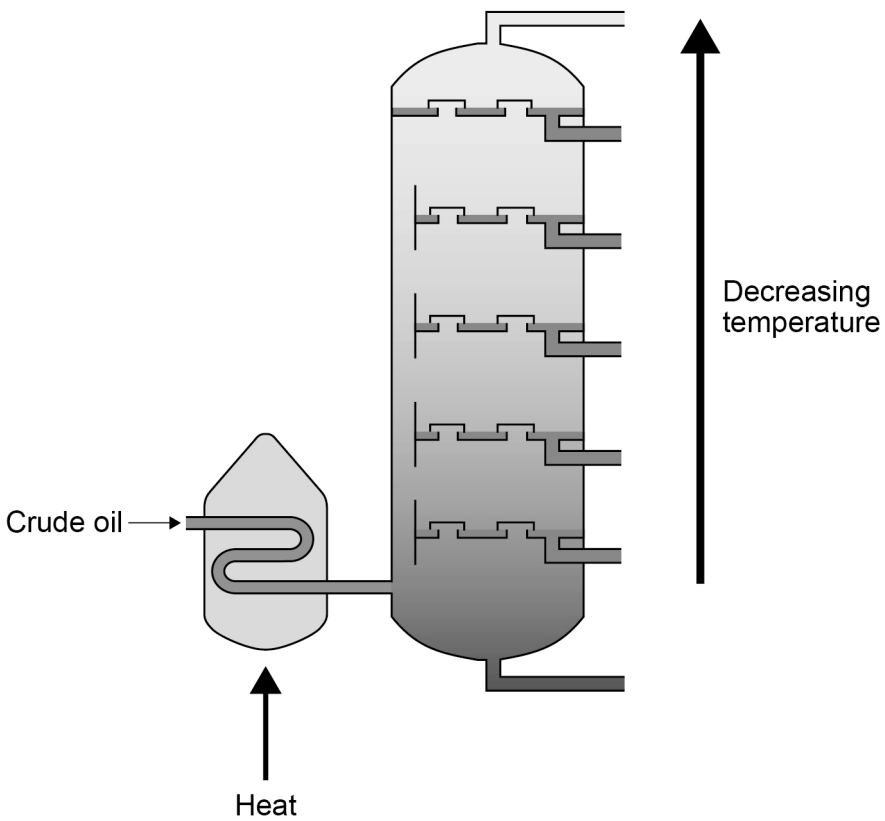
5.1.1.2 Mixtures

Question 21 · continued

0 1 . 3 Crude oil is a mixture of hydrocarbons.

Figure 1 represents industrial equipment used to separate crude oil into fractions.

Figure 1



Explain how crude oil is separated into fractions.

Use **Figure 1**.

[4 marks]

5.1.1.2 Mixtures

Question 21 · continued

0 1 . 4 The alkane molecule $C_{14}H_{30}$ can be cracked to produce smaller molecules.

Balance the equation for the reaction.

[1 mark]

$$C_{14}H_{30} \rightarrow C_8H_{18} + ____ C_3H_6$$

Question 1 continues on the next page

Question 21 · continued

Propene (C_3H_6) is an alkene.

0 1 . 5 Describe the test for alkenes.

Give the result.

[2 marks]

Test _____

_____

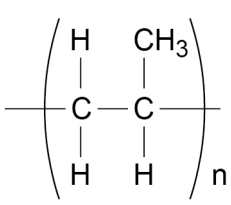
Result _____

_____

0 1 . 6 Poly(propene) is made from propene.

Figure 2 represents the repeating unit of poly(propene).

Figure 2



What type of substance is poly(propene)?

[1 mark]

_____

10

5.1.1.2 Mixtures

Question 22

June 2024 | 8464/C/2H | Original Q4

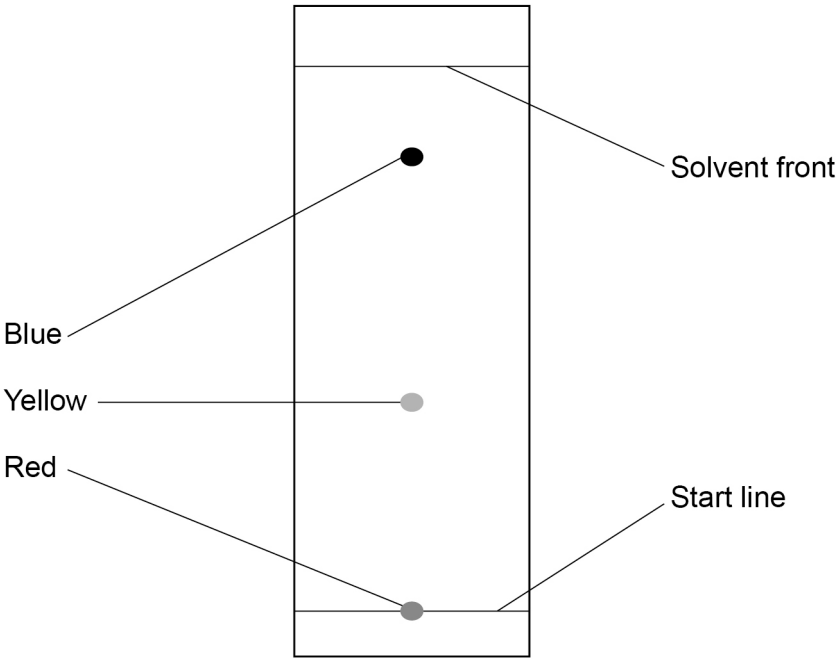
0 4 Printer ink is a mixture of chemicals.

A student used chromatography to investigate the colours in a printer ink.

The student put a spot of the printer ink on the start line.

Figure 4 shows the results.

Figure 4



Not to scale

0 4 . 1 Explain why the red colour did **not** move from the start line.

[2 marks]

Question 4 continues on the next page

5.1.1.2 Mixtures

Question 22 · continued

0 4 . 2 The blue colour moved 6.4 cm up the chromatogram.

The R_f value of the blue colour is 0.87

Calculate the distance moved by the solvent.

Give your answer to 2 significant figures.

[4 marks]

Distance moved by the solvent (2 significant figures) = _____ cm

5.1.1.2 Mixtures

Question 22 · continued

There were four colours in the printer ink.

0 4 . 3 Suggest **one** reason why only three colours were visible on the chromatogram.

[1 mark]

0 4 . 4 Suggest how the student could use chromatography to show there were four colours in the printer ink.

[1 mark]

8

5.1.1.2 Mixtures

Question 23

June 2024 | 8464/C/2H | Original Q6

0 6 The Earth's natural resources are used to manufacture useful products.

One useful product is potable water.

Potable water can be produced from sea water by distillation.

0 6 . 1 Give **one disadvantage** of using distillation to produce potable water.

[1 mark]

0 6 . 2 Describe **one** other method to produce potable water from sea water.

[2 marks]

Question 6 continues on the next page

Question 23 · continued

A student investigated the mass of dissolved solids in a 100 cm^3 sample of sea water.

This is the method used.

1. Weigh an evaporating basin.
2. Measure 100 cm^3 of sea water.
3. Pour the sea water into the evaporating basin.
4. Heat the evaporating basin.
5. Weigh the evaporating basin and contents.
6. Calculate the mass of dissolved solids in the sea water.

0 6 . 3 Explain how repeating steps 4 and 5 would improve this method.

[2 marks]

0 6 . 4 The total mass of dissolved solids in a 100 cm^3 sample of sea water is 3.50 g.

The percentage of sodium chloride in the dissolved solids is 77.8%.

Calculate the mass of sodium chloride dissolved in the 100 cm^3 sample of sea water.

[2 marks]

Mass of sodium chloride = _____ g

5.1.1.2 Mixtures

Question 23 · continued

Biological methods are used to extract metal compounds from metal ores.

0 6 . 5 One method of producing copper from low-grade copper ores is by using bacteria.

The bacteria produce leachate solutions that contain copper compounds.

Give **two** methods that can be used to extract copper from these leachate solutions.

[2 marks]

1 _____

_____

2 _____

_____

Question 6 continues on the next page

5.1.1.2 Mixtures

Question 23 · continued

Phytomining uses plants to absorb metal compounds from low-grade ores.

0 6 . 6 Describe how the metal compounds are obtained from the plants.

[3 marks]

0 6 . 7 Nickel is produced by phytomining.

One hectare of plants produces 215 kg of nickel.

Determine the area required to produce 750 kg of nickel.

Give your answer in m^2.

One hectare = 10 000 m^2

[3 marks]

Area required = _____ m^2

15

5.1.1.2 Mixtures

Question 24

June 2025 | 8464/C/1H | Original Q2

0 2 A student investigated an exothermic reaction.

The student reacted solid calcium oxide with water to produce calcium hydroxide.

0 2 . 1 What is meant by an 'exothermic' reaction?

[1 mark]

0 2 . 2 The formula of calcium hydroxide is $Ca(OH)_2$

Calculate the percentage by mass of oxygen in calcium hydroxide.

Relative atomic mass (A_r): O = 16

Relative formula mass (M_r): $Ca(OH)_2$ = 74

[3 marks]

Percentage = _____ %

Question 2 continues on the next page

5.1.1.2 Mixtures

Question 24 · continued

0 2 . 3 When solid calcium oxide is added to water, the temperature of the reaction mixture changes.

Plan a method to investigate how changing the mass of calcium oxide affects the temperature change of the reaction mixture.

[6 marks]

Extra space

10

5.1.1.2 Mixtures

Question 25

0 4 This question is about metals.

0 4 . 1 Iron is extracted from iron oxide by reduction with carbon.

Why can iron be extracted by reduction with carbon?

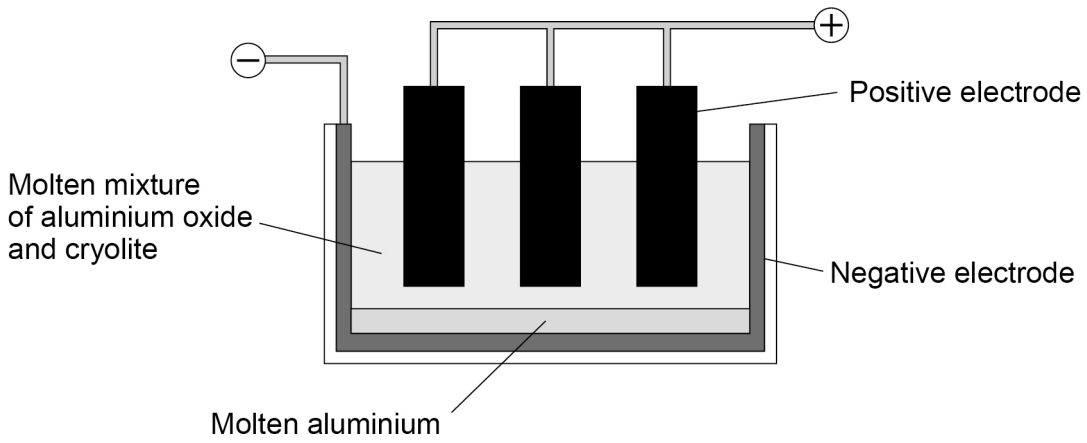
Answer in terms of reactivity.

[1 mark]

Aluminium is extracted by the electrolysis of aluminium oxide.

Figure 4 shows the apparatus used to extract aluminium.

Figure 4



5.1.1.2 Mixtures

Question 25 · continued

0 4 . 2 Explain why a mixture of aluminium oxide and cryolite is used as the electrolyte instead of only aluminium oxide.

[2 marks]

0 4 . 3 Oxygen gas is produced at the positive electrode.

Write a balanced half equation for the production of oxygen at the positive electrode.

[2 marks]

_____ → _____ + _____

Question 4 continues on the next page

5.1.1.2 Mixtures

Question 25 · continued

Chromium is extracted by reacting chromium oxide with aluminium.

The equation for the reaction is:

$$Cr_2O_3 + 2\,Al \rightarrow Al_2O_3 + 2\,Cr$$

0 4 . 4 Which substance in the equation is reduced?

[1 mark]

Table 3 shows the relative cost of extracting equal masses of aluminium, chromium and iron.

Table 3

Metal	Relative cost of extraction
Aluminium	2
Chromium	20
Iron	1

0 4 . 5 Give **one** reason for the difference in the cost of extracting aluminium and **iron**.

Use **Table 3**.

[1 mark]

5.1.1.2 Mixtures

Question 25 · continued

0 4 . 6 Give **one** reason for the difference in the cost of extracting aluminium and **chromium**.

Use **Table 3**.

[1 mark]

0 4 . 7 Metals are mixed together to form alloys.

Explain why alloys are harder than pure metals.

[3 marks]

11

5.1.1.2 Mixtures

Question 26

0 4 This question is about methanol.

0 4 . 1 Methanol is used in screenwash.

Screenwash is used to keep car windscreens clean.

Screenwash is a formulation.

Define the term 'formulation'.

[1 mark]

Question 4 continues on the next page

Question 26 · continued

Carbon monoxide and hydrogen are used to produce methanol.

The conditions used in the production of methanol are:

- high temperature
- high pressure
- a catalyst.

The equation for the reaction is:

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

91 kJ/mol of energy is transferred during the exothermic forward reaction.

0 4 . 2 How much energy is transferred when methanol is decomposed into carbon monoxide and hydrogen?

[1 mark]

Tick (✓) **one** box.

< 91 kJ/mol ☐

91 kJ/mol ☐

> 91 kJ/mol ☐

0 4 . 3 A scientist developed a principle to predict the effect of changing conditions on a system at equilibrium.

What was the name of the scientist?

[1 mark]

_____

Question 26 · continued

0 4 . 4 What is the effect of increasing the temperature on the proportion of methanol in the equilibrium mixture?

[1 mark]

Tick (✓) **one** box.

The proportion of methanol decreases. ☐

The proportion of methanol stays the same. ☐

The proportion of methanol increases. ☐

0 4 . 5 What is the effect of using a catalyst on the proportion of methanol in the equilibrium mixture?

[1 mark]

Tick (✓) **one** box.

The proportion of methanol decreases. ☐

The proportion of methanol stays the same. ☐

The proportion of methanol increases. ☐

0 4 . 6 Explain the effect of increasing the pressure on the proportion of methanol in the equilibrium mixture.

[3 marks]

5.1.1.2 Mixtures

Question 26 · continued

0 4 . 7 Explain the effect of using a catalyst on the **rate** of production of methanol.

[3 marks]

0 4 . 8 The catalyst allows the reaction to take place at a lower temperature.

Explain **one** advantage of using a lower temperature in the production of methanol.

Do **not** refer to the position of equilibrium in your answer.

[2 marks]

0 4 . 9 Methanol (CH_3OH) can also be produced by reacting carbon dioxide with hydrogen.

Water is the other product of the reaction.

Write a balanced equation for the reaction.

[2 marks]

_____ + _____ → _____ + _____

15

5.1.1.2 Mixtures

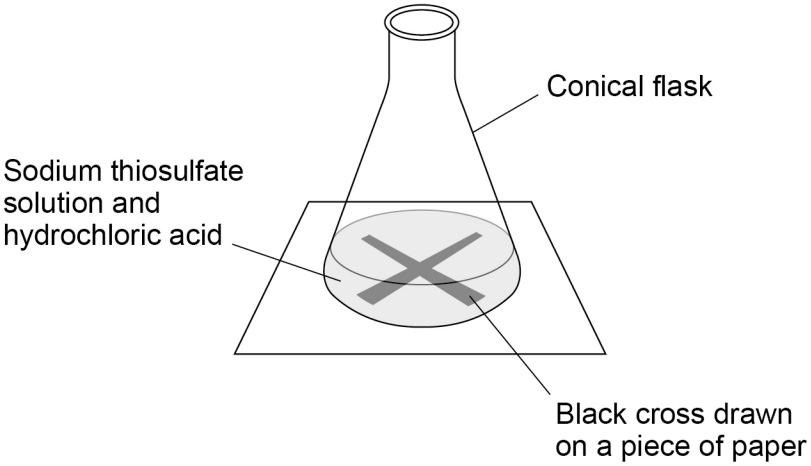
Question 27

0 5 Students investigated the effect of changing the concentration on the rate of chemical reactions.

A student reacted sodium thiosulfate solution with hydrochloric acid.

Figure 3 shows the apparatus.

Figure 3



This is the method used.

1. Measure 50 cm^3 of sodium thiosulfate solution into a conical flask.

2. Put the conical flask on a black cross drawn on a piece of paper.

3. Add 10 cm^3 of hydrochloric acid to the conical flask.

4. Start a timer.

5. Stop the timer when the cross is no longer visible.

6. Record the time taken.

7. Repeat steps 1 to 6 using different concentrations of sodium thiosulfate solution.

5.1.1.2 Mixtures

Question 27 · continued

0 5 . 1 What is the dependent variable in this investigation?

[1 mark]

0 5 . 2 The equation for the reaction is:

$$Na_2S_2O_3(aq) + 2\,HCl(aq) \rightarrow 2\,NaCl(aq) + S(s) + SO_2(g) + H_2O(l)$$

The mixture becomes cloudy as the reaction takes place.

Explain why the mixture becomes cloudy.

[2 marks]

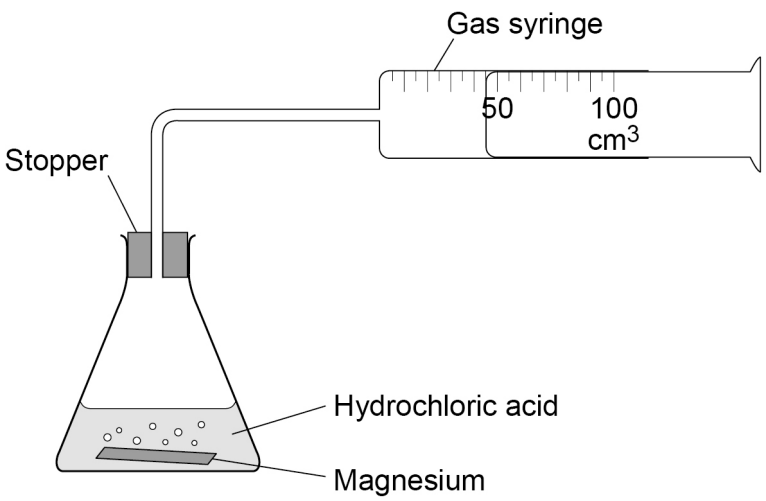
0 5 . 3 Explain the effect of changing the concentration of the sodium thiosulfate solution on the rate of reaction.

[3 marks]

A different student reacted magnesium with hydrochloric acid.

Figure 4 shows the apparatus.

Figure 4



This is the method used.

1. Measure 50 cm^3 of hydrochloric acid into a conical flask.
2. Add 0.1 g of magnesium ribbon to the conical flask.
3. Insert the stopper into the conical flask as quickly as possible.
4. Start a timer.
5. Record the volume of gas collected every 20 seconds for 5 minutes.
6. Repeat steps 1 to 5 using different concentrations of hydrochloric acid.

0 5 . 4 Why is the stopper inserted into the conical flask as quickly as possible in step 3?

[1 mark]

5.1.1.2 Mixtures

Question 27 · continued

0 5 . 5 The equation for the reaction of magnesium with hydrochloric acid is:

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

Describe a test for the gas produced in the reaction.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

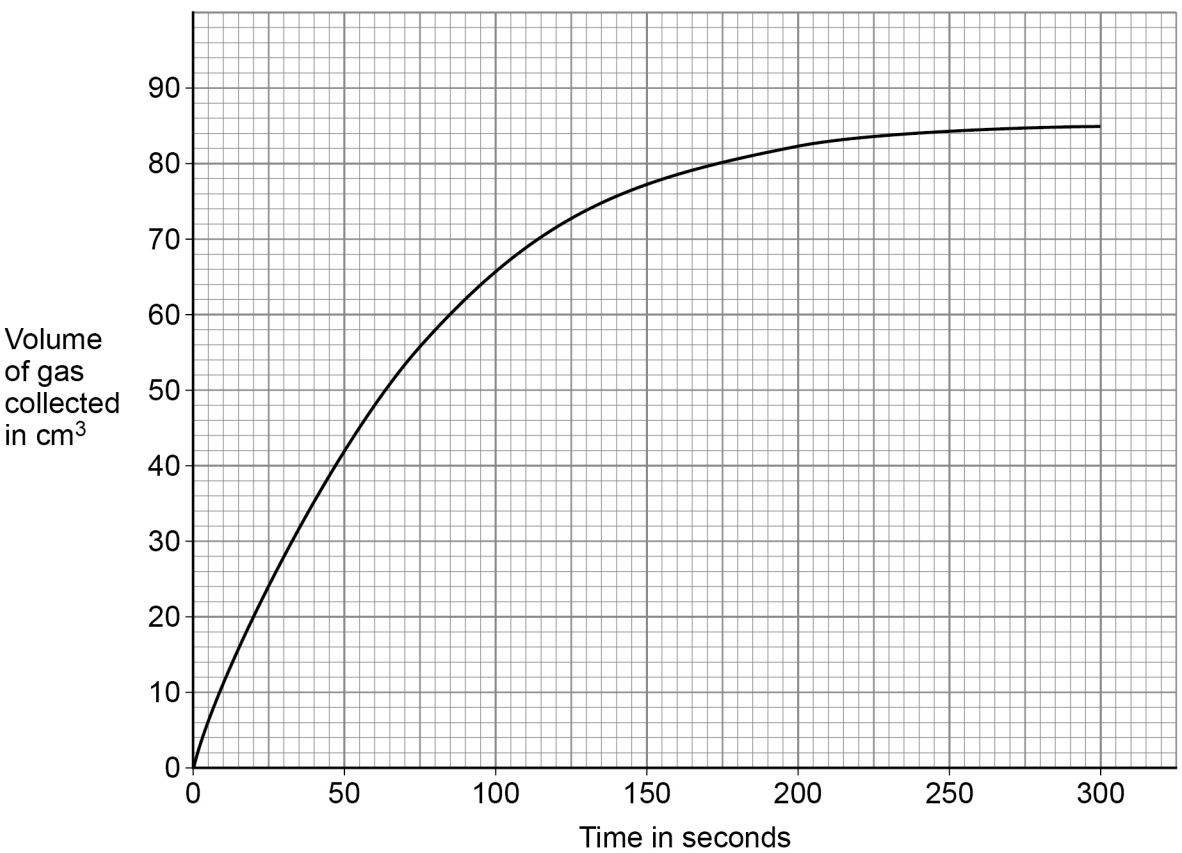
Question 5 continues on the next page

5.1.1.2 Mixtures

Question 27 · continued

0 5 . 6 **Figure 5** shows the results for one concentration of hydrochloric acid.

Figure 5



Determine the rate of reaction at 75 seconds.

[4 marks]

Rate = _____ cm^3/s

13