Cambridge Assessment International Education

Cambridge IGCSE™

1: Experimental techniques – Topic questions Paper 3

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
3	2016	June	31
4	2016	November	33
5	2016	June	32

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3 The table shows some properties of the Group I metals.

metal	density in g / cm^3	melting point / °C	boiling point / °C
lithium	0.53	181	1342
sodium		98	883
potassium	0.86	63	760
rubidium	1.53	39	686
caesium		29	669

(a) **(i)** Describe the trend in boiling points of the Group I metals.

..... [1]

(ii) Predict the density of caesium.

..... [1]

(iii) Deduce the state of caesium at 20 °C.

Explain your answer.

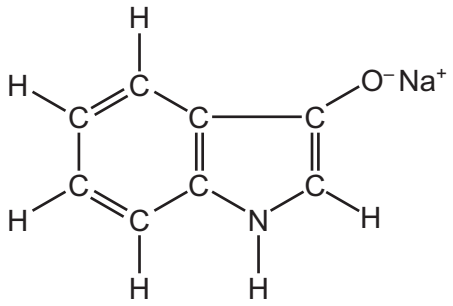
.....

..... [2]

(b) Complete the word equation for the reaction of rubidium with water.

rubidium + water → ..... + ... [2]

(c) The dye, indigotin, is formed when compound **F** is exposed to air.
The structure of compound **F** is shown below.



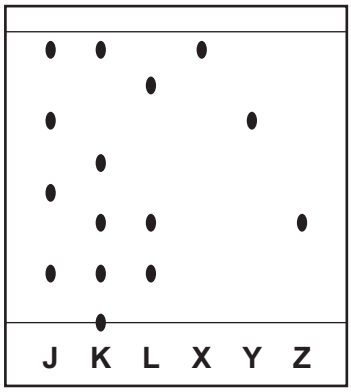
Complete the table and calculate the relative molecular mass of compound **F**.

type of atom	number of atoms	atomic mass	
carbon	8	12	8 × 12 = 96
hydrogen			
nitrogen	1	14	1 × 14 = 14
oxygen	1	16	1 × 16 = 16
sodium			

relative molecular mass = ... [2]

(d) Three dye mixtures, **J**, **K** and **L**, were spotted onto a piece of chromatography paper. Three pure dyes, **X**, **Y** and **Z**, were also spotted onto the same piece of paper.

The diagram shows the results of this chromatography.



(i) Suggest why the base line was drawn in pencil and **not** in ink.

..... [1]

(ii) Which dye mixture, **J**, **K** or **L**, contains a dye which did **not** move during this chromatography?

..... [1]

(iii) Which dye mixture, **J**, **K** or **L**, contains both dye **X** and dye **Y**?

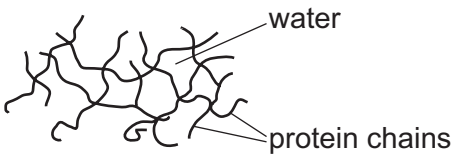
..... [1]

(iv) Which dye mixture, **J**, **K** or **L**, does **not** contain dye **Z**?

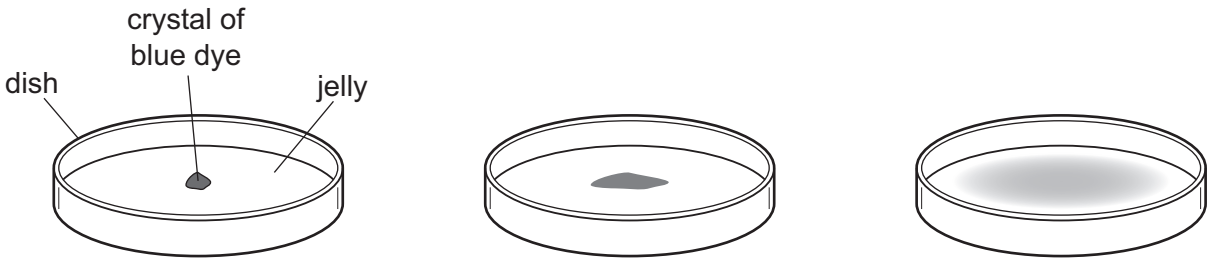
..... [1]

[Total: 12]

4 Jelly is a mixture of water and protein chains.



(a) A crystal of blue dye was placed on top of some jelly.
After 30 minutes some of the blue colour could be seen in the jelly.
After 1 day the blue colour had spread out further into the jelly.



Use the kinetic particle model of matter to explain these observations.

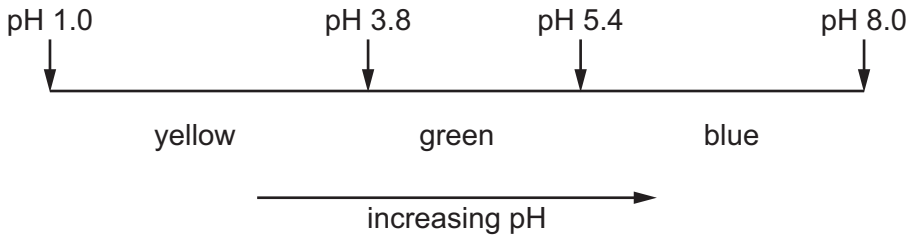
.....

.....

.....

..... [3]

(b) The diagram shows the colour changes of the indicator bromocresol green at different pH values.

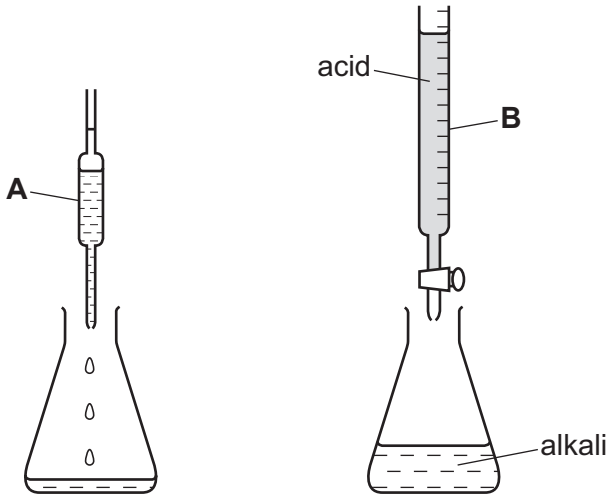


Predict the colour of bromocresol green

in pure water, ...

in a strongly acidic solution. .....
[2]

(c) The concentration of an alkali can be found by titrating it with an acid using the apparatus shown.



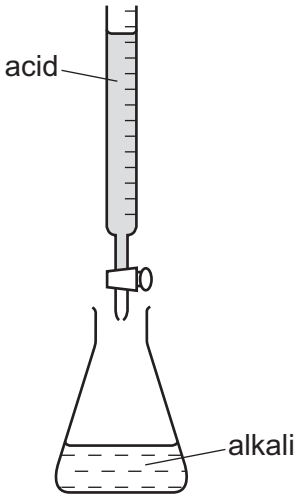
(i) State the names of the pieces of glassware labelled **A** and **B**.

A .....

B .....

[2]

(ii) Describe how you would carry out a titration using the apparatus shown.



.....

.....

.....

.....

.....

..... [3]

[Total: 10]

5 Chlorine, bromine and iodine are halogens.

(a) The melting point of bromine is –7 °C. The boiling point of bromine is +59 °C.

Deduce the state of bromine at +6 °C. Explain your answer.

.....

..... [2]

(b) **(i)** Complete the word equation for the reaction of chlorine with potassium iodide.

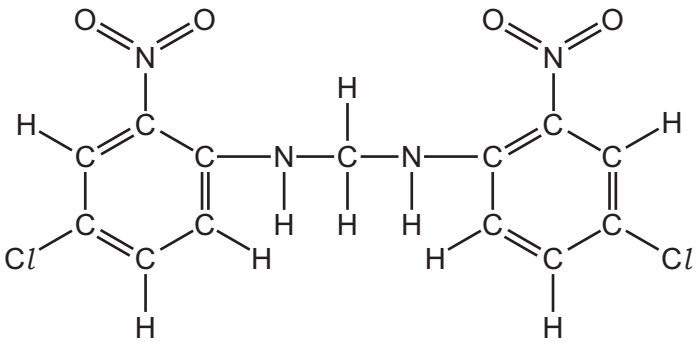
chlorine + potassium iodide → ..... + ... [2]

(ii) Suggest why iodine does **not** react with aqueous potassium bromide.

.....

..... [1]

(c) The structure of the dye Lithol fast yellow is shown.



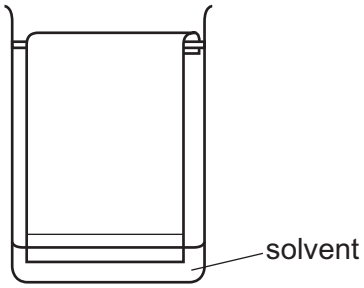
Complete the table and calculate the relative molecular mass of Lithol fast yellow.

type of atom	number of atoms	atomic mass	
carbon	13	12	13 × 12 = 156
hydrogen	10	1	10 × 1 = 10
nitrogen	4	14	4 × 14 = 56
oxygen			
chlorine			

relative molecular mass = ... [2]

(d) Chromatography is used to separate a mixture of dyes.

(i) Draw a cross on the diagram to show where the mixture of dyes is placed at the start of the chromatography.



[1]

(ii) Suggest a suitable solvent that could be used.

..... [1]

(iii) Describe what you would observe as the experiment proceeds.

.....

..... [1]

[Total: 10]

Question	Answer	Marks
3 (a) (i)	decreases down the Group I / increases up the Group I;	**1**
3 (a) (ii)	1.88 (1.60–2.50) (g/cm^3)	**1**
3 (a) (iii)	solid; 20 °C is below the melting point / the melting point is above 20 °C	**2** 1 1
3 (b)	rubidium hydroxide; hydrogen;	**2** 1 1
3 (c)	155; (1 mark for hydrogen = (6 × 1) = 6 / sodium = (1 × 23) = 23)	**2**
3 (d) (i)	pencil will not smear / pencil line will not move / ink will smear / ink will undergo chromatography / ink would spread / ink would travel upwards / pencil mark would not spread;	**1**
3 (d) (ii)	K;	**1**
3 (d) (iii)	J;	**1**
3 (d) (iv)	J;	**1**
		Total: 12
4 (a)	any 3 from: • diffusion • particles move / motion of particles • (movement is) random / in any direction / in all directions • particles spread out / particles mix • particles move from high to low concentration	**3**
4 (b)	*in pure water:* blue *in a strongly acidic solution:* yellow	**1** **1**
4 (c) (i)	**A** (volumetric) pipette **B** burette	**1** **1**
4 (c) (iii)	add (a few drops of) indicator to the flask slowly add acid (from the burette) into the alkali (until indicator) changes colour / until (alkali) neutralised / until neutral	**1** **1** **1**
		Total: 10

Continues on next page …

Question	Answer	Marks
5 (a)	liquid; 6 °C is higher than the melting point and lower than the boiling point / 6 °C is between the melting point and the boiling point;	**2** 1 1
5 (b) (i)	potassium chloride; iodine;	**2** 1 1
5 (b) (ii)	iodine is less reactive than bromine / bromine is more reactive than iodine;	**1**
5 (c)	357 (1 mark for 1 correct row, e.g. (4 × 16 =) 64 or (2 × 35.5) = 71)	**2**
5 (d) (i)	cross shown on baseline;	**1**
5 (d) (ii)	ethanol / other organic solvent	**1**
5 (d) (iii)	dyes move up the paper and separate;	**1**
		Total: 10

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2: Particles, atomic structure, ionic bonding and the Periodic Table – Topic questions Paper 3

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

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Question	Year	Series	Paper number
1	2016	June	31
1	2016	June	32
4	2016	March	32

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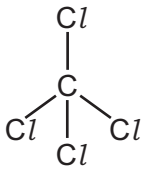
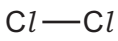
1 The structures of some substances containing chlorine are shown.

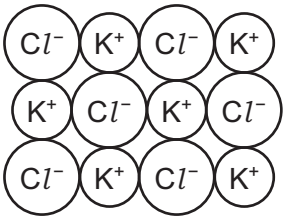
A



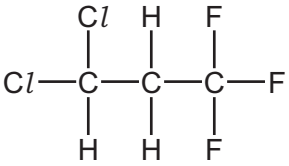
B



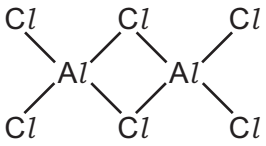
C



D



E



(a) Answer the following questions about these substances.

(i) Which substance is a diatomic molecule?

..... [1]

(ii) Which substance represents part of an ionic structure?

..... [1]

(iii) Which substance is an element?

Explain your answer.

.....

..... [2]

(iv) Determine the simplest formula for substance **D**.

..... [1]

(b) The symbols for two isotopes of chlorine are shown.

$^{35}_{17}Cl$ $^{37}_{17}Cl$

(i) How do these two isotopes differ in their atomic structure?

..... [1]

(ii) Determine the number of neutrons present in one atom of the isotope $^{35}_{17}Cl$.

..... [1]

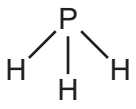
(iii) Draw the electronic structure of a chlorine atom. Show all shells and all electrons.

[2]

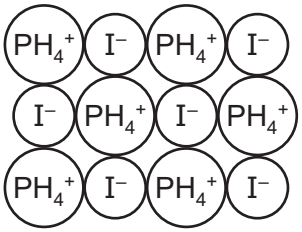
[Total: 9]

1 The structures of some substances containing phosphorus are shown.

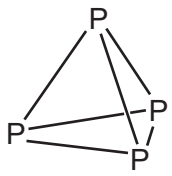
A



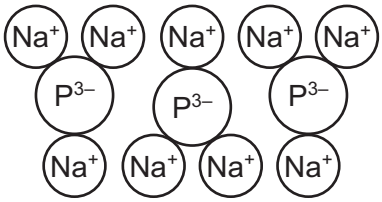
B



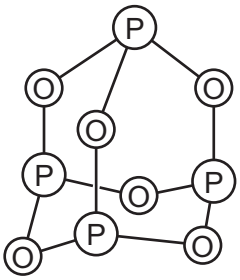
C



D



E



(a) Answer the following questions about these substances.

(i) Which **two** of these substances are ionic?

..... and ..... [1]

(ii) Which **one** of these substances is an element?

Explain your answer.

.....

..... [2]

(iii) Determine the simplest formula for substance **D**.

..... [1]

(b) Phosphorus has one naturally occurring isotope. $^{31}_{15}P$

(i) Determine the number of neutrons present in one atom of the isotope P.

..... [1]

(ii) How many electrons are there in the outer shell of one phosphorus atom?

..... [1]

(iii) Determine the **total** number of electrons present in a phosphorus molecule, P_4.

..... [1]

(c) What type of oxide is phosphorus(V) oxide?

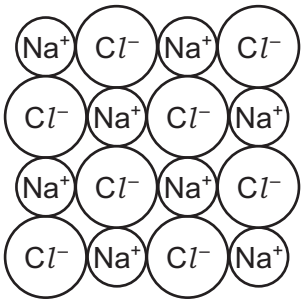
Explain your answer.

.....

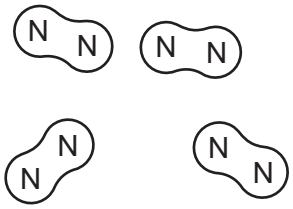
..... [2]

[Total: 9]

4 The structures of sodium chloride and nitrogen are shown below.



sodium chloride



nitrogen

(a) Describe the structure and bonding of these two substances and the differences in
- their volatility,
- their electrical conductivity.

.....

.....

.....

.....

.....

..... [5]

(b) Ammonia is manufactured by reacting nitrogen with hydrogen using a catalyst.

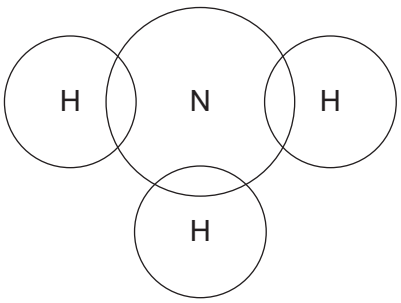
(i) What is the purpose of the catalyst?

..... [1]

(ii) Complete the chemical equation for this reaction.

$$N_2 + ...H_2 \rightarrow .....NH_3$$ [2]

(iii) Complete the electronic structure of a molecule of ammonia.
Show only the outer electrons.



[2]

(iv) Ammonia reacts with copper(II) oxide.

$$2NH_3 + 3CuO \rightarrow 3Cu + 3H_2O + N_2$$

Which compound is reduced in this reaction?
Explain your answer.

.....

..... [2]

[Total: 12]

Question	Answer	Marks
1 (a) (i)	B / chlorine / Cl_2;	**1**
1 (a) (ii)	C / KCl / potassium chloride;	**1**
1 (a) (iii)	B; has only one type of atom;	**2** 1 1
1 (a) (iv)	$C_3H_3F_3Cl_2$;	**1**
1 (b) (i)	different number of neutrons / different mass numbers / different numbers of nucleons;	**1**
1 (b) (ii)	18;	**1**
1 (b) (iii)	7 electrons in the outer shell; first shell has 2 electrons and second shell has 8 electrons;	**2** 1 1
		Total: 9
1 (a) (i)	B and D	**1**
1 (a) (ii)	C; has only one type of atom;	**2** 1 1
1 (a) (iii)	Na_3P;	**1**
1 (b) (i)	16;	**1**
1 (b) (ii)	5;	**1**
1 (b) (iii)	60;	**1**
1 (c)	acidic; because phosphorus is a non-metal / it is a non-metal oxide / it would react with bases / neutralises bases / phosphorus is on the right-hand side of the Periodic Table;	**2** 1 1
		Total: 9

Continues on next page …

Question	Answer	Marks
4 (a)	Up for four from: • sodium chloride is ionic; • sodium chloride has a giant structure / lattice; • sodium chloride is not volatile / has a high boiling point; • sodium chloride does not conduct (electricity) when solid / conducts when molten / conducts when aqueous; Up to four from: • nitrogen is molecular; • nitrogen has covalent bonds; • nitrogen is volatile / has a low boiling point; • nitrogen does not conduct (electricity);	**5**
4 (b) (i)	speeds up (rate of) reaction;	**1**
4 (b) (ii)	3(H_2); 2(NH_3);	**2**
4 (b) (iii)	3 bonding pairs of electrons (between N and H) and no extra electrons on H; 2 non-bonding electrons on N atom;	**2**
4 (b) (iv)	copper oxide / CuO; oxygen removed (from copper oxide) / oxidation number of copper decreases / copper ions gains electrons;	**2**
		Total: 12

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3: Air and water – Topic questions

Paper 3

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2	2016	November	31
2	2016	November	33
8	2016	June	33

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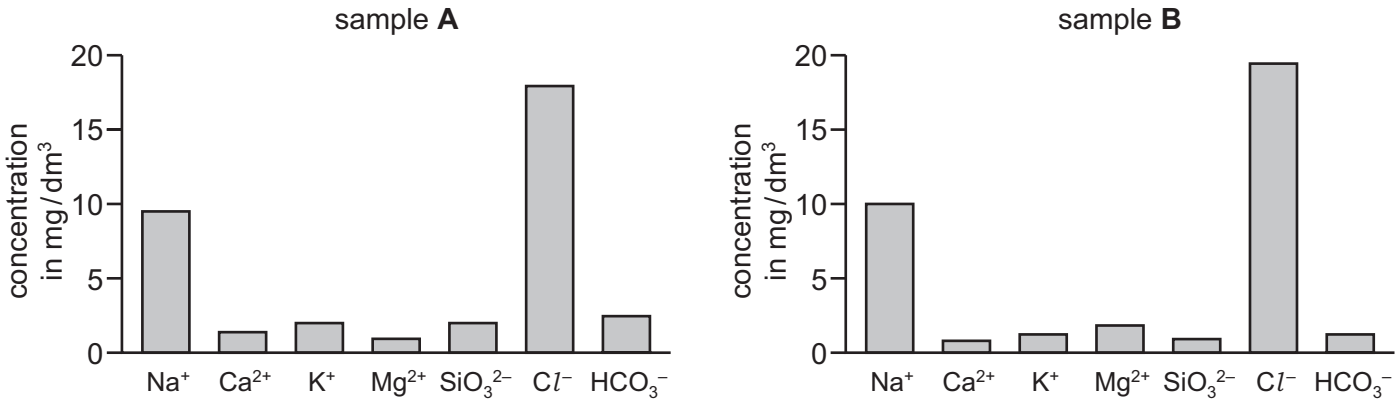
2 The bar charts compare the concentrations of the main ions in two samples of seawater, sample **A** and sample **B**.



(a) Use the information in the bar charts to answer the following questions.

(i) Describe **two** differences in the composition of the seawater in sample **A** and sample **B**.

.....

.....

..... [2]

(ii) Which positive ion has the lowest concentration in sample **A**?

..... [1]

(iii) Calculate the mass of sodium ions in 200 cm^3 of sample **B**.
Show all your working. [1 dm^3 = 1000 cm^3]

mass = ... mg [2]

(b) Describe a test for sodium ions.

test .....

result .....
[2]

(c) River water contains small particles of clay. When these particles are viewed under a microscope they show a random, jumpy motion even when the water is still.

What name is given to this type of movement?

..... [1]

(d) Carbon dioxide dissolves in water to form a mixture which contains hydrogencarbonate ions and hydrogen ions.

$$CO_2(g) + H_2O(l) \rightleftharpoons HCO_3^-(aq) + H^+(aq)$$

(i) What is the meaning of the symbol $\rightleftharpoons$?

..... [1]

(ii) The solution formed is slightly acidic.

Describe how you would use Universal Indicator paper to determine the pH of this solution.

.....

..... [2]

(iii) Carbon dioxide is a greenhouse gas which causes climate change.

Explain how carbon dioxide contributes to climate change.

..... [1]

(iv) State the name of **one** other greenhouse gas and give **one** source of this gas.

gas .....

source .....
[2]

[Total: 14]

2 A scientist analysed the substances present in a 1 dm^3 sample of river water in an agricultural area. The table shows the mass of each ion dissolved in the 1 dm^3 sample.

name of ion	formula of ion	mass / g
calcium	Ca^{2+}	1.2
chloride	Cl^-	0.1
hydrogencarbonate	HCO_3^-	1.0
magnesium	Mg^{2+}	0.5
nitrate	NO_3^-	1.0
sodium	Na^+	
	SO_4^{2-}	0.5
phosphate	PO_4^{3-}	1.2
	Total	6.0

(a) (i) Which negative ion has the highest concentration, in g / dm^3, in this sample of water?

..... [1]

(ii) Give the name of the ion with the formula SO_4^{2-}.

..... [1]

(iii) Calculate the mass of sodium ions in 1 dm^3 of this river water.

..... [1]

(b) Describe a test for nitrate ions.

test .....

.....

result .....

[3]

(c) The sample of river water also contains insoluble materials such as clay and the remains of dead animals and plants.

(i) What method could be used to separate insoluble materials from river water?

..... [1]

(ii) Some of the remains of dead animals and plants contain food materials.

Which **two** of the following substances are constituents of food?
Tick **two** boxes.

alkane	☐
carbohydrate	☐
graphite	☐
protein	☐

[1]

(iii) Particles of clay suspended in river water show Brownian motion.

Describe the movement of these particles.

..... [1]

(d) Most of the nitrate ions in river water come from fertilisers.

(i) Explain why farmers use fertilisers.

.....

..... [2]

(ii) Ammonium nitrate is a fertiliser.
Ammonium nitrate reacts with calcium hydroxide.

ammonium nitrate + calcium hydroxide $\rightarrow$ calcium nitrate + ammonia + water

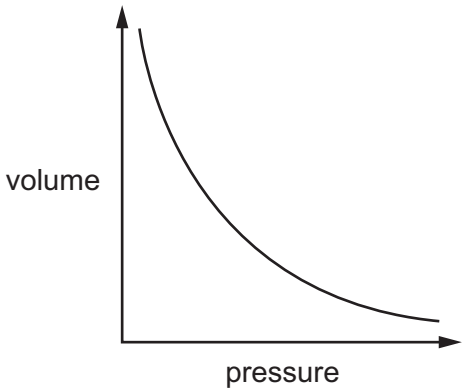
Explain why adding calcium hydroxide to the soil at the same time as nitrate fertilisers results in loss of nitrogen from the soil.

.....

..... [2]

[Total: 13]

8 The graph shows how increasing the pressure at constant temperature changes the volume of a fixed mass of carbon dioxide gas.



(a) Describe how the volume of gas changes with pressure.

.....

.....

..... [2]

(b) What happens to the average distance of the molecules from each other when the pressure is decreased?

..... [1]

(c) Carbon dioxide can be reduced by magnesium.

$$2Mg(s) + CO_2(g) \rightarrow 2MgO(s) + C(s)$$

(i) Use the information in the equation to show that carbon dioxide gets reduced.

..... [1]

(ii) Which one of these processes does **not** produce carbon dioxide?

Tick **one** box.

respiration ☐

reaction of an acid with a metal oxide ☐

reaction of an acid with a carbonate ☐

thermal decomposition of limestone ☐

[1]

(iii) Give **two** problems caused by increasing the amount of carbon dioxide in the atmosphere.

.....

.....

..... [2]

[Total: 7]

Question	Answer	Marks
2 (a) (i)	any 2 from: • more Na^+ ions in sample **B ORA** • more Cl^- ions in sample **B ORA** • more Mg^{2+} ions in sample **B ORA** • more HCO_3^- ions in sample **A ORA** • more Ca^{2+} ions in sample **A ORA** • more K^+ ions in sample **A ORA** • more SiO_3^{2-} ions in sample **A ORA**	**2**
2 (a) (ii)	Mg^{2+}	**1**
2 (a) (iii)	2 mg = [2] $\frac{200}{1000} \times 10 = (10) = [1]$ **OR** 0.2 × (10) = [1]	**2**
2 (b)	*test:* flame test /description of flame test *result:* yellow (flame)	**2**
2 (c)	Brownian (motion)	**1**
2 (d) (i)	indicates a reversible reaction	**1**
2 (d) (ii)	dip (indicator) paper in solution / put (indicator paper) in solution compare the colour with the (colour) chart / different colours represent different pH values	**1** **1**
2 (d) (iii)	absorbs heat / absorbs infra-red radiation / causes global warming	**1**
2 (d) (iv)	*gas:* methane *source:* gases from (digestion in) animals / swamps / decomposition of vegetation / rice paddy fields / fracking / melting of permafrost	**1** **1**
		Total: 14

Continues on next page …

Question	Answer	Marks
2 (a) (i)	phosphate / PO_4^{3-}	**1**
2 (a) (ii)	sulfate	**1**
2 (a) (iii)	0.5 (g)	**1**
2 (b)	*test:* aluminium / magnesium / Devarda's alloy sodium hydroxide / strong alkali (and warm) *result:* gas given off turns (red) litmus blue	 **1** **1** **1**
2 (c) (i)	filtration / filter	**1**
2 (c) (ii)	carbohydrate **AND** protein	**1**
2 (c) (iii)	random / zigzag / go anywhere / irregular	**1**
2 (d) (i)	any 2 from: • improve growth of plants • increase protein (in plants) • fertilisers add nitrogen / nitrates / phosphorus / phosphates / potassium • to put back nitrogen / nitrates / phosphorus / phosphates / potassium <u>into the soil</u>	**2**
2 (d) (ii)	ammonia is produced / formed (ammonia) is a gas	**1** **1**
		Total: 13

Continues on next page …

Question	Answer	Marks
8 (a)	volume decreases as pressure increases; reference to rate of change is more rapid at first / rate of change decreases / correct reference to curve;	**2** 1 1
8 (b)	(distance) increases;	**1**
8 (c) (i)	carbon dioxide loses oxygen;	**1**
8 (c) (ii)	“reaction of an acid with a metal oxide” box ticked;	**1**
8 (c) (iii)	any 2 from: • climate change / more extreme weather; • desertification; • melting ice caps; • rise in sea levels / increased flooding of low-lying areas; • temperature of atmosphere / oceans increases; • habitat loss;	**2**
		Total: 7

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4: Acids, bases and salts – Topic questions

Paper 3

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
4	2016	November	32
5	2016	November	33
6	2016	March	32

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

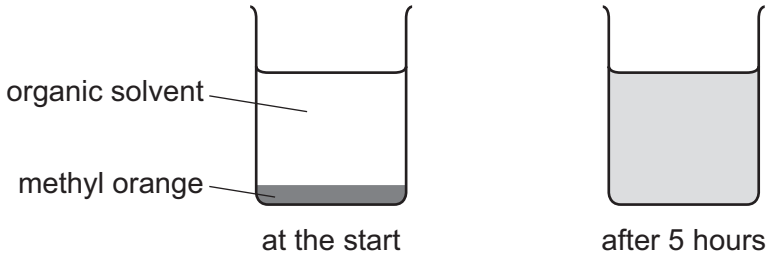
4 Methyl orange and methyl red are both dyes which can be used as indicators.

(a) The actual value for the melting point of methyl red is 180 °C.
A chemist prepares a sample of methyl red and finds that it melts over the range 173 °C to 177 °C.

Suggest why the melting point of this sample was different from the actual value.

..... [1]

(b) A concentrated solution of methyl orange was placed at the bottom of a beaker containing an organic solvent.
After 5 hours, the orange colour had spread throughout the solvent.



Use the kinetic particle model of matter to explain this observation.

.....

.....

.....

..... [3]

(c) Methyl orange is used as an indicator.

What colour is methyl orange when placed in dilute sulfuric acid?

..... [1]

(d) Sulfuric acid can be used to prepare copper(II) sulfate from copper(II) oxide.

(i) Complete the general word equation for this reaction.

metal oxide + acid → ..... + ...

[2]

(ii) Sulfuric acid is added to excess copper(II) oxide. The mixture is heated and the unreacted copper(II) oxide is removed.

Suggest how the unreacted copper(II) oxide is removed.

..... [1]

(iii) Put statements **A** to **E** about the preparation of pure dry crystals of copper(II) sulfate from copper(II) sulfate solution in the correct order.

A The crystals are filtered off.

B The heating is stopped when the point of crystallisation is reached.

C The mixture is left to form crystals.

D The crystals are dried with filter paper.

E The solution is heated gently.

correct order ☐ ☐ ☐ ☐ ☐

[2]

[Total: 10]

5 Lime (calcium oxide) is made by heating limestone (calcium carbonate).

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

(a) (i) Is this reaction exothermic or endothermic?
Explain your answer.

.....

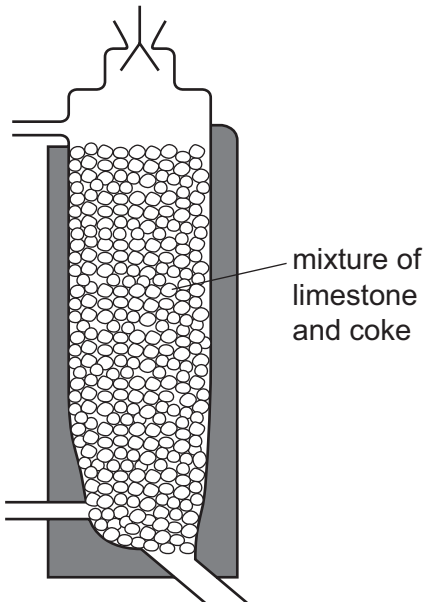
..... [1]

(ii) The reaction is reversible.

What information in the equation shows that this reaction is reversible?

..... [1]

(b) The diagram shows a furnace for making lime.



(i) On the diagram, write

- the letter **C** to show where the waste gases exit the furnace,
- the letter **L** to show where the lime is removed from the furnace.

[2]

(ii) Suggest a reason for adding coke (carbon) to the furnace.

..... [1]

(c) Explain why farmers use lime to treat acidic soils.

.....

..... [2]

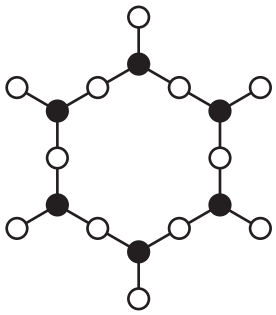
(d) Limestone is used to manufacture cement. The limestone is mixed with clay and heated to 1500 °C. It is then mixed with calcium sulfate and crushed.

(i) Describe the test for sulfate ions.

test .....

result .....
[2]

(ii) Concrete is a mixture of cement, silicates and water. Part of the structure of a silicate is shown.



key

● = silicon atom

○ = oxygen atom

Deduce the formula for this silicate.

..... [1]

(e) Concrete contains small amounts of calcium oxide.
This can react with rainwater to form calcium hydroxide.

(i) Calcium hydroxide is strongly alkaline.

What is the most likely pH of a strongly alkaline solution?
Draw a ring around the correct answer.

pH 2 pH 6 pH 7 pH 12

[1]

(ii) The calcium hydroxide on the surface of a piece of concrete reacts with carbon dioxide in the air.

Complete the chemical equation for this reaction.

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + ...$$

[1]

(iii) Limewater is an aqueous solution of calcium hydroxide. A teacher left an open beaker of limewater in the laboratory.
After a week, the solution in the beaker was pH 7 and a white precipitate was observed.

Use the information in **(e)(i)** and **(e)(ii)** to help you explain these observations.

.....

.....

.....

.....

.....

..... [3]

[Total: 15]

6 Citric acid is found in lemon juice. Citric acid shows typical acidic properties.

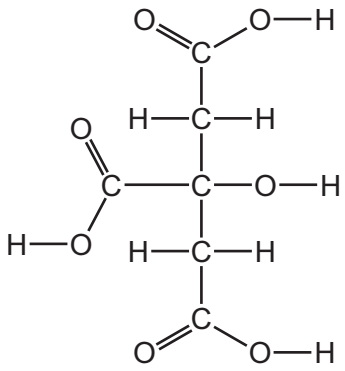
(a) Describe how you could determine the pH of a solution of lemon juice using Universal Indicator.

.....

.....

..... [2]

(b) The structure of citric acid is shown below.



(i) On the diagram, draw a ring around a carboxylic acid functional group. [1]

(ii) State the name of **one** other carboxylic acid.

..... [1]

(c) Calcium citrate can be prepared by neutralising aqueous citric acid with excess calcium carbonate.

(i) Complete the word equation for this reaction.

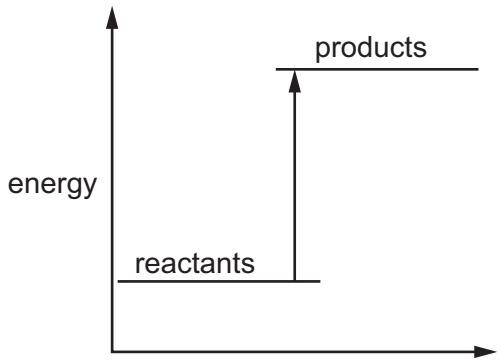
citric acid	+	calcium carbonate	→	calcium citrate	+		+	

[2]

(ii) Suggest how you could separate the excess calcium carbonate from the rest of the solution.

..... [1]

(d) The energy level diagram for the reaction of citric acid with sodium hydrogen carbonate is shown below.



Is this reaction exothermic or endothermic?
Give a reason for your answer.

.....

..... [1]

(e) Both citric acid and ethanol can be manufactured by fermentation.

(i) Complete the chemical equation for the fermentation of glucose to form ethanol.

$$C_6H_{12}O_6 \rightarrow .....C_2H_5OH + ...CO_2$$ [2]

(ii) State **two** conditions needed for fermentation.

.....

..... [2]

(iii) Complete the table below and calculate the relative molecular mass of glucose.

type of atom	number of atoms	relative atomic mass	
carbon	6	12	$6 \times 12 = 72$
hydrogen			
oxygen			

relative molecular mass = ... [2]

[Total: 14]

Question	Answer	Marks
4 (a)	The sample is impure	**1**
4 (b)	any 3 from: • diffusion • particles move / motion of particles • (movement is) random / in any direction / in all directions • particles spread out / particles mix • particles move from high to low concentration	**3**
4 (c)	red	**1**
4 (d) (i)	(metal) salt water	**1** **1**
4 (d) (ii)	filtration / filter	**1**
4 (d) (iii)	**E**, **B**, **C**, **A**, **D**	**2**
		Total: 10

Continues on next page …

Question	Answer	Marks
5 (a) (i)	endothermic because heating is needed	**1**
5 (a) (ii)	Arrow(s) pointing in both directions / ⇌	**1**
5 (b) (i)	**C** in or just outside the tube at the top left **L** in or just outside the tube at the bottom right	**1** **1**
5 (b) (ii)	to produce a high temperature / for heat(ing)	**1**
5 (c)	any 2 from: • plants / crops do not grow well if the soil is too acidic • increases the pH of the soil / makes the soil less acidic • neutralises the acid	**2**
5 (d) (i)	*test:* (aqueous) barium chloride / (aqueous) barium nitrate *result:* white precipitate / white solid	**1** **1**
5 (d) (ii)	SiO_2 / Si_6O_{12}	**1**
5 (e) (i)	pH 12	**1**
5 (e) (ii)	H_2O	**1**
5 (e) (iii)	any 3 from: • (limewater absorbs) carbon dioxide • (carbon dioxide) from the air • carbon dioxide dissolves in limewater • carbon dioxide (solution) is slightly acidic / carbon dioxide is an acidic oxide • idea that carbon dioxide reacts with / neutralises calcium hydroxide / neutralises limewater / neutralises the solution • pH (of limewater / solution) falls / pH goes down • calcium carbonate is formed	**3**
		Total: 15

Continues on next page …

Question	Answer	Marks
6 (a)	add universal indicator to the lemon juice / solution; match colour with colour chart;	**2**
6 (b) (i)	ring around one or more COOH groups;	**1**
6 (b) (ii)	ethanoic (acid) / any other correctly named carboxylic acid;	**1**
6 (c) (i)	carbon dioxide; water;	**2**
6 (c) (ii)	filtration;	**1**
6 (d)	endothermic and energy if products higher than energy of reactants;	**1**
6 (e) (i)	$2(C_2H_5OH)$ $2(CO_2)$	**2**
6 (e) (ii)	any two from: • yeast / zymase • temperature between 5 °C and 40 °C / room temperature • anaerobic / no oxygen / no air • pH ~ 7	**2**
6 (e) (iii)	180; one row correct = [1], e.g. 12 × 1 = 12 or 6 × 16 = 96	**2**
		Total: 14

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5: Reaction rates – Topic questions

Paper 3

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
3	2016	June	31
7	2016	June	31
7	2016	June	32

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

3 **(a)** The reactions between metals and acids are redox reactions.

$$Zn + 2H^+ \rightarrow Zn^{2+} + H_2$$

(i) Which change in the above reaction is oxidation, Zn to Zn^{2+} or $2H^+$ to H_2? Give a reason for your choice.

.....

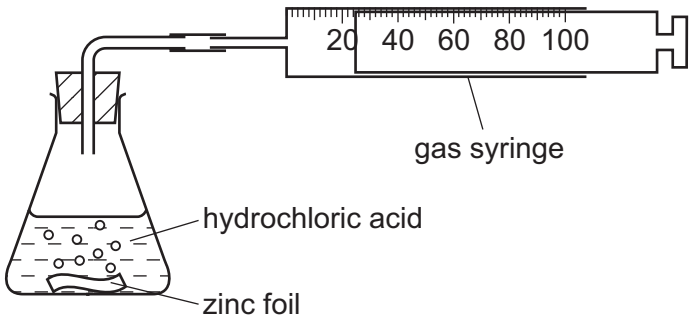
..... [2]

(ii) Which reactant in the above reaction is the oxidising agent? Give a reason for your choice.

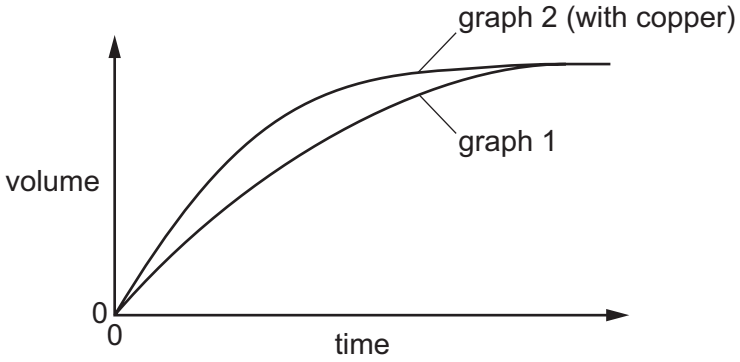
.....

..... [2]

(b) The rate of reaction between a metal and an acid can be investigated using the apparatus shown below.



A piece of zinc foil was added to 50 cm^3 of hydrochloric acid, of concentration 2.0 mol/dm^3. The acid was in excess. The hydrogen evolved was collected in the gas syringe and its volume measured every minute. The results were plotted and labelled as graph 1.



The experiment was repeated to show that the reaction between zinc metal and hydrochloric acid is catalysed by copper. A small volume of aqueous copper(II) chloride was added to the acid before the zinc was added. The results of this experiment were plotted on the same grid and labelled as graph 2.

(i) Explain why the reaction mixture in the second experiment contains copper metal. Include an equation in your explanation.

.....

..... [2]

(ii) Explain how graph 2 shows that copper catalyses the reaction.

.....

.....

..... [3]

(c) If the first experiment was repeated using ethanoic acid, CH_3COOH, instead of hydrochloric acid, how and why would the graph be different from graph 1?

.....

.....

.....

..... [4]

(d) Calculate the maximum mass of zinc which will react with 50 cm^3 of hydrochloric acid, of concentration 2.0 mol/dm^3.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

Show your working.

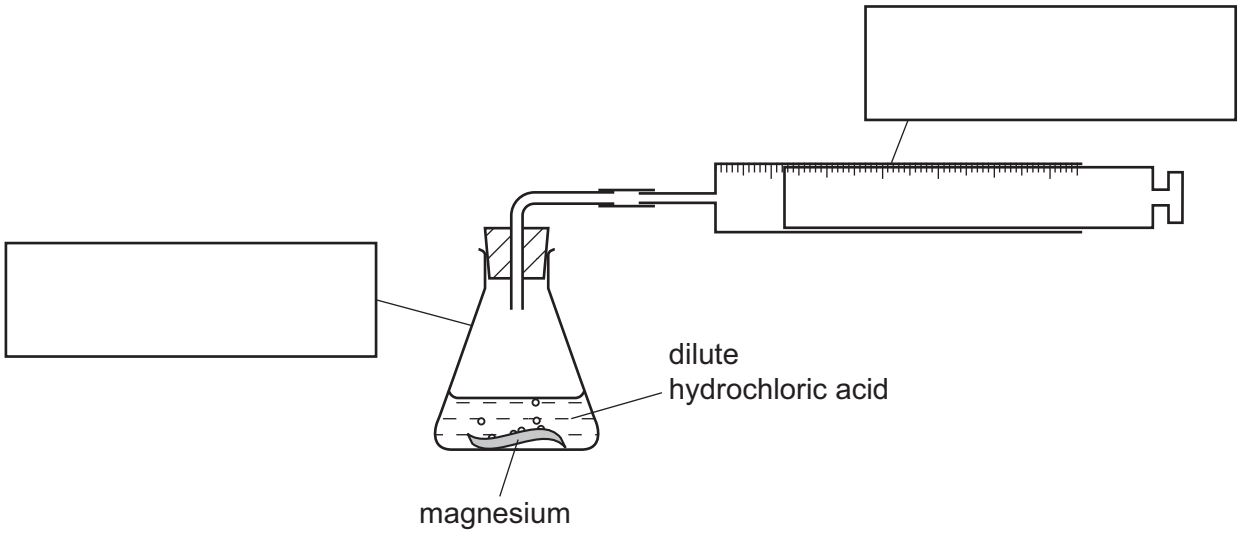
[3]

[Total: 16]

7 When magnesium reacts with hydrochloric acid, the products are aqueous magnesium chloride and hydrogen.

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

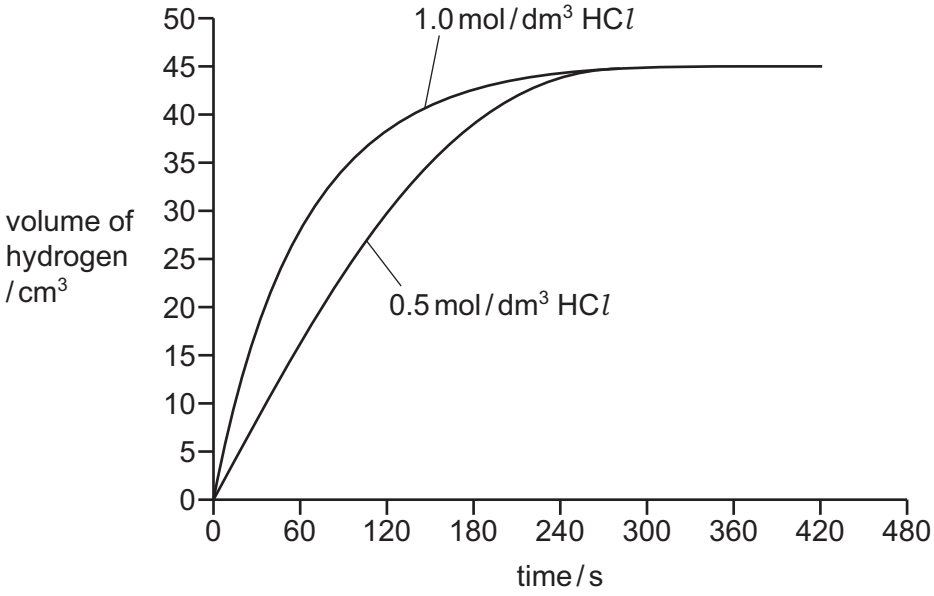
A student used the apparatus shown to follow the progress of this reaction.



(a) Complete the diagram by putting the correct labels in the boxes.

[2]

(b) The student conducted two experiments using the same mass of magnesium in each experiment and two different concentrations of hydrochloric acid. The hydrochloric acid was in excess. All other conditions were kept constant.
The student measured the volume of hydrogen produced over a period of time. The graph shows the results.



(i) Which concentration of hydrochloric acid gave the faster initial rate of reaction?

Use the graph to explain your answer.

.....

..... [1]

(ii) Draw a curve **on the graph on page 16** to show how the volume of hydrogen would change if a third experiment was carried out using 1.5 mol / dm^3 hydrochloric acid and the same mass of magnesium.

[2]

(c) Give **one** use of hydrogen.

..... [1]

(d) Explosions have occasionally been reported where tiny particles of metal dust escape into the air.

Explain why metal dust can form an explosive mixture with air.

.....

..... [1]

[Total: 7]

7 Calcium carbonate reacts with dilute hydrochloric acid.

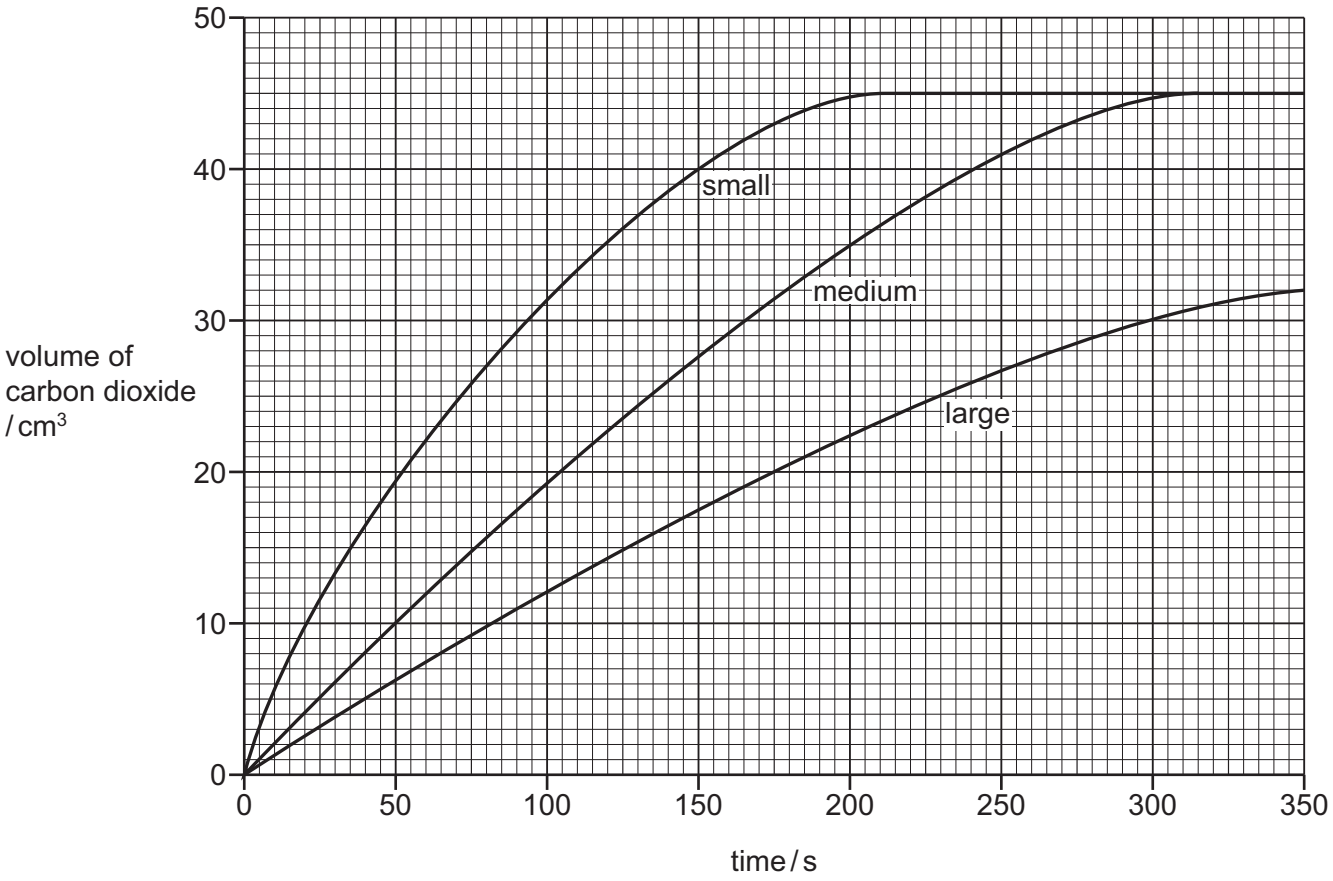
$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

A student investigated this reaction by measuring the volume of carbon dioxide released every minute at constant temperature.

(a) Draw a diagram of the apparatus that the student could use to investigate this reaction.

[2]

(b) The graph shows the results of this reaction using three samples of calcium carbonate of the same mass: large pieces, medium-sized pieces and small pieces.



(i) Which sample, large, medium or small pieces, gave the fastest initial rate of reaction?

Use the graph to explain your answer.

.....

..... [2]

(ii) The experiment was repeated using powdered calcium carbonate of the same mass. Draw a line **on the grid above** to show how the volume of carbon dioxide changes with time for this experiment. [2]

(iii) At what time was the reaction just complete when small pieces of calcium carbonate were used?

..... [1]

(c) When calcium carbonate is heated strongly, calcium oxide is formed.

(i) Give **one** use of calcium oxide.

..... [1]

(ii) What type of oxide is calcium oxide?

Explain your answer.

.....

..... [2]

[Total: 10]

Question	Answer	Marks
3 (a) (i)	Zn to Zn^{2+}; because electron loss;	**2**
3 (a) (ii)	(2)H^+ or 'hydrogen ion(s)'; it accepts electrons or takes electrons (from zinc atoms);	**2**
3 (b) (i)	zinc displaces copper or zinc more reactive than copper; Zn + $CuCl_2$ → $ZnCl_2$ + Cu **OR** Zn + Cu^{2+} → Cu + Zn^{2+};	**2**
3 (b) (ii)	steeper(line) or higher gradient; (means an) increased rate; but the same (final) volume;	**3**
3 (c)	M1 less steep (line) or lower gradient; M2 (because of) decreased rate; M3 ethanoic is a weak(er) acid; M4 only partially ionised or dissociated **OR** lower concentration of hydrogen ions;	**4**
3 (d)	M1 moles of HCl = 0.1 (mol); M2 moles of Zn = 0.05 (mol); mass of zinc = 3.25 g;	**3**
		Total: 16

Continues on next page …

Question	Answer	Marks
7 (a)	flask; (gas) syringe;	**2** 1 1
7 (b) (i)	1.0 (mol/dm^3) because the initial gradient is steeper / initial slope is steeper;	**1**
7 (b) (ii)	steeper gradient than curve for 1.0 mol/dm^3; same final volume	**2** 1 1
7 (c)	any suitable use, e.g. fuel / reducing agent / making margarine / making ammonia / Haber process / fuel cells;	**1**
7 (d)	dust has a (very) high surface area;	**1**
		Total: 7
7 (a)	(gas) syringe leading to flask / beaker / test tube **OR** flask and tube leading to upturned measuring cylinder over trough of water; closed apparatus with no air gaps;	**2** 1 1
7 (b) (i)	small pieces; line / curve / graph steepest;	**2** 1 1
7 (b) (ii)	line to the left of the small pieces starting at (0, 0); finishing at 45 cm^3 and before the other lines;	**2** 1 1
7 (b) (iii)	any value between 205 s and 215 s (inclusive);	**1**
7 (c) (i)	neutralising (acidic) soils / neutralising (acidic) waste / steelmaking / self-heating cans / making concrete / making glass / water treatment / making plaster / making paper / flue-gas desulfurisation / neutralising acids / making limewater;	**1**
7 (c) (ii)	basic oxide; because it is a metal oxide / because it would react with acid / neutralizes acids / calcium is on the left of the Periodic Table'	**2** 1 1
		Total: 10

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6: Metals and the reactivity series – Topic questions

Paper 3

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
3	2016	March	32
5	2016	March	32
8	2016	June	32

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

3 Many metals react with either cold water or steam.

(a) Describe the reaction of sodium with cold water, and iron with steam.
In your answer describe
- the products formed,
- any observations that can be made.

.....

.....

.....

.....

..... [4]

(b) Iron reacts with hydrochloric acid.

$$Fe(s) + 2HCl(aq) \rightarrow FeCl_2(aq) + H_2(g)$$

Describe a practical method to investigate the rate of this reaction.
You may draw a labelled diagram.

.....

.....

..... [3]

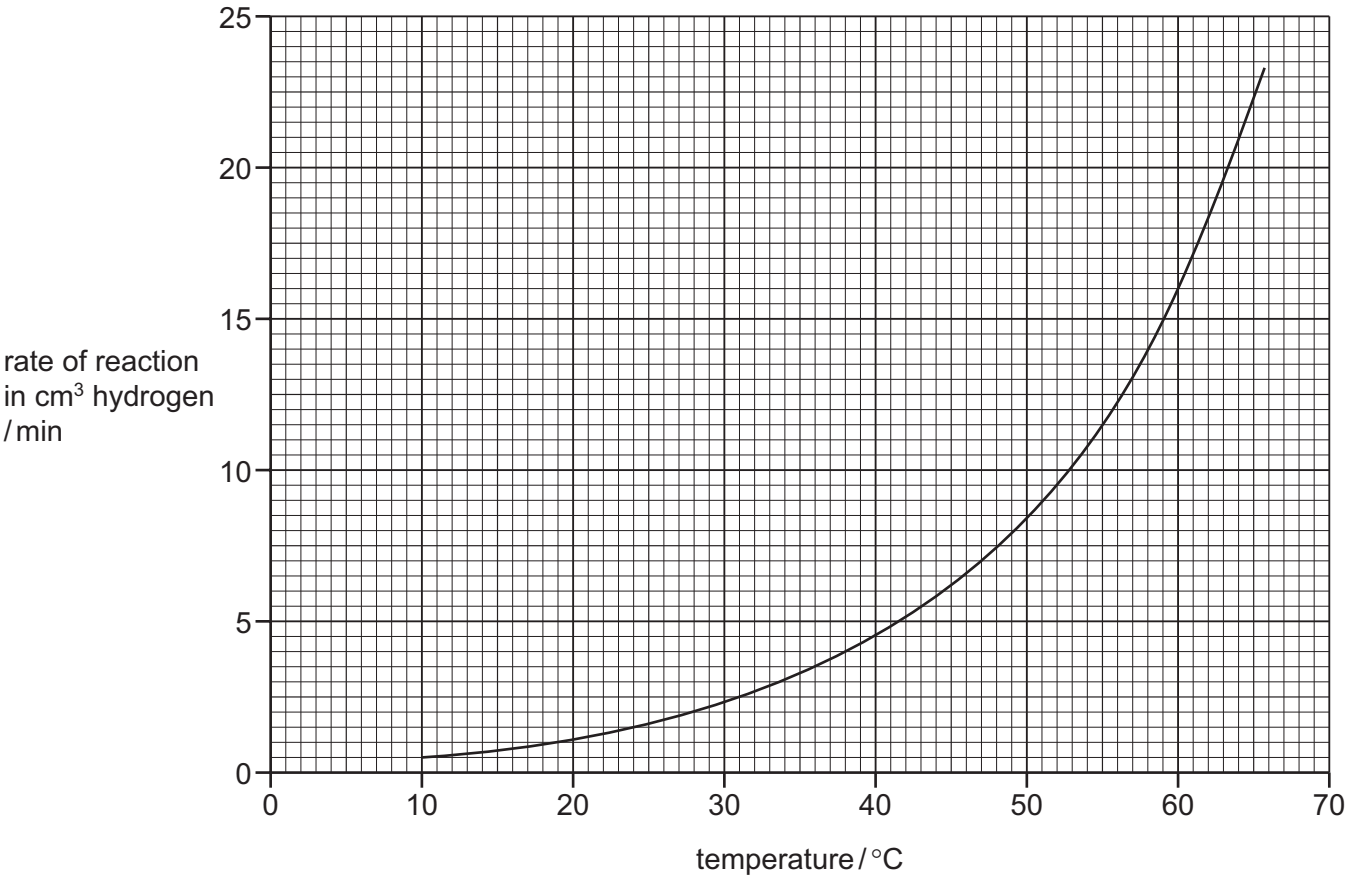
(c) The experiment in **(b)** was repeated using different sized pieces of iron.
All other conditions remained the same.
The sizes of the pieces of iron were
- large pieces,
- small pieces,
- iron powder.

Complete the table below by writing the sizes of the pieces in the first column.

sizes of the pieces of iron	rate of reaction in cm^3 hydrogen / min
	25
	3
	10

[1]

(d) The graph shows the effect of temperature on the rate of the reaction of hydrochloric acid with iron.



(i) Describe the effect of temperature on the rate of this reaction.

.....

..... [2]

(ii) Determine the rate of reaction at 60 °C.

..... cm^3 hydrogen / min [1]

(e) Describe how the concentration of hydrochloric acid affects the rate of its reaction with iron.

.....

..... [1]

[Total: 12]

5 **(a)** The table shows some properties of cobalt, copper, magnesium and tin.

metal	relative heat conduction	density in g / cm^3	melting point / °C	relative strength
cobalt	1.00	8.90	1495	55.0
copper	3.85	8.92	1083	32.0
magnesium	1.50	1.74	649	1.5
tin	0.64	7.28	232	1.0

Answer the questions using the information shown in the table.

(i) Which metal is the best to use for the base of a pan for cooking food?
Use information in the table to give reasons for your answer.

.....

..... [2]

(ii) Which **two** metals in the table are transition elements?
Use information in the table to give reasons for your answer.

.....

..... [2]

(iii) Which metal in the table is most likely to be used in an alloy for aircraft bodies?
Use information in the table to give reasons for your answer.

.....

..... [2]

(b) Some observations about the reactions of the four metals with hydrochloric acid are shown in the table.

metal	observations
cobalt	Bubbles formed very slowly.
copper	No bubbles formed.
magnesium	Many bubbles formed very rapidly.
tin	A steady stream of bubbles formed.

Use the information in the table to put these metals in order of their reactivity with hydrochloric acid.

least reactive ⟶ most reactive

[2]

(c) Crystals of hydrated cobalt(II) sulfate, $CoSO_4.7H_2O$, can be made by reacting dilute sulfuric acid with insoluble cobalt carbonate.

Describe how you could prepare a pure dry sample of cobalt(II) sulfate crystals from dilute sulfuric acid and cobalt(II) carbonate.

.....

.....

.....

.....

..... [4]

(d) When heated, hydrated cobalt(II) sulfate forms an anhydrous salt in a reversible reaction.

(i) Complete the equation for this reaction by inserting the sign for a reversible reaction in the box.

$CoSO_4.7H_2O$ (hydrated cobalt(II) sulfate, pale red) $\square$ $CoSO_4$ (anhydrous cobalt(II) sulfate, dark blue) + $7H_2O$

[1]

(ii) Suggest how you could use this reaction to test for the presence of water.

.....

..... [2]

[Total: 15]

8 Solder is an alloy of lead and tin.

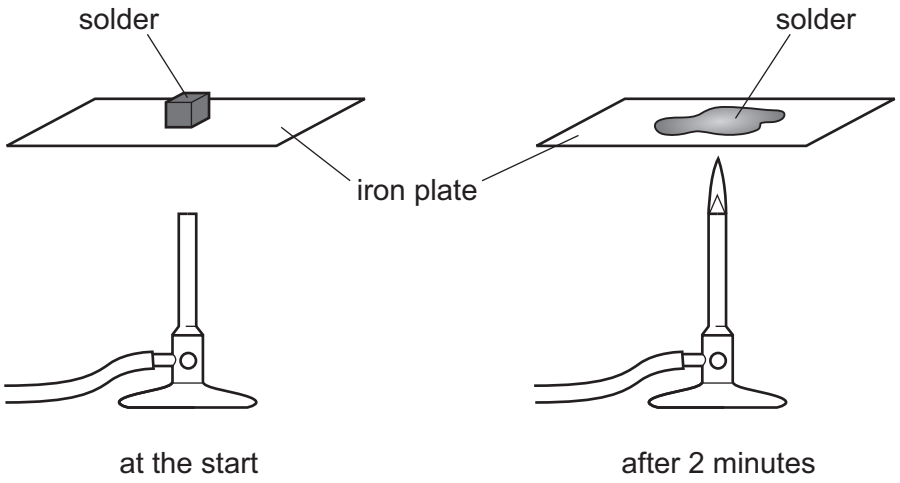
(a) What is the meaning of the term *alloy*?

..... [1]

(b) State the name of another alloy.

..... [1]

(c) A student heated a piece of solder carefully.
The diagram shows what happens to the solder.



Use the kinetic particle theory to describe and explain what happens to the solder as it changes state.

.....

.....

.....

.....

..... [4]

(d) When heated above 1744 °C, lead forms a vapour.

Describe a general property of a vapour (gas) which is not shown by a solid.

..... [1]

[Total: 7]

Question	Answer	Marks
3 (a)	observations with sodium: fizzes or effervesces / sodium goes into a ball / sodium melts / moves over surface of water; products: sodium hydroxide / hydrogen; observations with iron: red or black or brown solid / iron glows; products: iron oxide / hydrogen;	**4**
3 (b)	gas syringe / upturned measuring cylinder filled with water / upturned burette filled with water; workable apparatus, e.g. airtight; use of stopclock / idea of timing;	**3**
3 (c)	powder → 25 large pieces → 3 small pieces → 10;	**1**
3 (d) (i)	rate increases with increasing temperature; idea that graph is not linear / rate does not increase proportionally / upward curve;	**2**
3 (d) (ii)	16 (cm^3 hydrogen/min);	**1**
3 (e)	increasing concentration increases rate;	**1**
		Total: 12

Continues on next page …

Question	Answer	Marks
5 (a) (i)	copper; has high heat conductivity and high melting point;	**2**
5 (a) (ii)	cobalt and copper; high melting point / high strength / high density	**2**
5 (a) (iii)	magnesium; low density	**2**
5 (b)	copper → cobalt → tin → magnesium; one pair reversed = [1]	**2**
5 (c)	any four from: • add excess cobalt carbonate to sulfuric acid • filter (off excess cobalt carbonate) • evaporate filtrate to point of crystallisation / evaporate some of the water and allow to cool • filter (off crystals) • dry crystals with filter paper	**4**
5 (d) (i)	⇌;	**1**
5 (d) (ii)	Add water to anhydrous cobalt sulfate / add water to $CoSO_4$; Colour changes (from blue) to red / pink;	**2**
		Total: 15
8 (a)	mixture of 2 or more metals / mixture of a metal and a non-metal	**1**
8 (b)	any alloy, e.g. brass, bronze etc.;	**1**
8 (c)	any 4 from: • solder has melted; • atoms in solid (only) vibrate; • atoms in solid are regularly arranged / touching / close to each other; • atoms start to vibrate more; • atoms in liquid are irregularly arranged / close together / touching; • atoms in liquids slide over each other / atoms in liquids move slowly; • atoms move more during melting; • atoms become less regularly arranged during melting;	**4**
8 (d)	vapour spreads everywhere / vapour does not stay in one place;	**1**
		Total: 7

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7: Covalent bonding – Topic questions

Paper 3

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

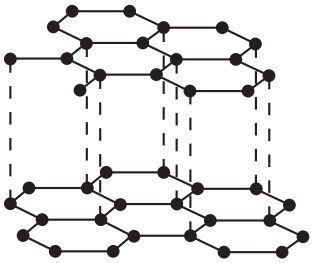
Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
2	2014	November	31
3	2014	November	33
7	2016	November	33

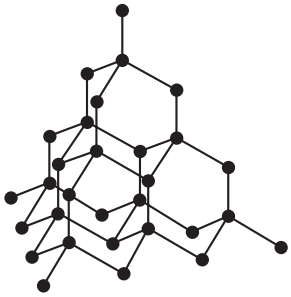
The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

2 Two macromolecular forms of carbon are graphite and diamond. The structures of graphite and diamond are given below.



graphite



diamond

(a) Explain in terms of its structure why graphite is soft and is a good conductor of electricity.

.....

.....

.....

.....

..... [3]

(b) State **two** uses of graphite which depend on the above properties.

It is soft .....

.....

It is a good conductor of electricity .....

.....

[2]

(c) Silicon(IV) oxide also has a macromolecular structure.

(i) Describe the macromolecular structure of silicon(IV) oxide.

.....

..... [1]

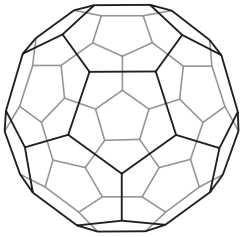
(ii) Predict **two** physical properties which diamond and silicon(IV) oxide have in common.

.....

..... [2]

[Total: 8]

3 In 1985 the fullerenes were discovered. They are solid forms of the element carbon. The structure of the C_{60} fullerene is given below.



(a) (i) In the C_{60} fullerene, how many other carbon atoms is each carbon atom bonded to?

..... [1]

(ii) Another fullerene has a relative molecular mass of 840.
How many carbon atoms are there in one molecule of this fullerene?

..... [1]

(b) Fullerenes are soluble in liquid hydrocarbons such as octane. The other solid forms of carbon are insoluble.
Describe how you could obtain crystals of fullerenes from soot which is a mixture of fullerenes and other solid forms of carbon.

.....

.....

.....

..... [3]

(c) A mixture of a fullerene and potassium is an excellent conductor of electricity.

(i) Which other form of solid carbon is a good conductor of electricity?

..... [1]

(ii) Explain why metals, such as potassium, are good conductors of electricity.

.....

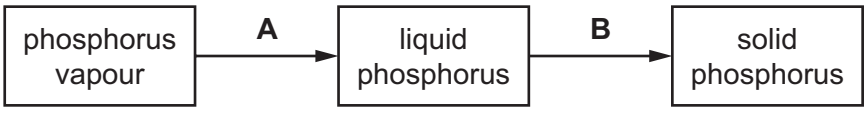
..... [2]

(iii) The mixture of fullerene and potassium has to be stored out of contact with air. There are substances in unpolluted air which will react with potassium.
Name **two** potassium compounds which could be formed when potassium is exposed to air.

..... [2]

[Total: 10]

7 The diagram shows the changes of state when phosphorus is cooled slowly to room temperature.



(a) Give the names of the changes of state labelled **A** and **B**.

A .....

B .....
[2]

(b) Describe the arrangement and motion of the particles in solid phosphorus.

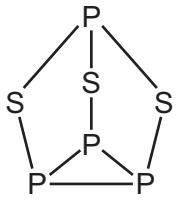
arrangement .....

motion .....
[2]

(c) Is phosphorus(V) oxide an acidic oxide or basic oxide?
Explain your answer.

..... [1]

(d) Phosphorus sulfide is a covalent molecule.



Predict **two** properties of phosphorus sulfide.

.....

..... [2]

(e) Many metal ores contain sulfides.
When zinc sulfide is heated in air the following reaction takes place.

zinc sulfide + oxygen → zinc oxide + sulfur dioxide

Explain why this reaction may be harmful to the environment.

.....

..... [2]

[Total: 9]

Question	Answer	Marks
2 (a)	soft because weak forces between layers / sheets / rows layers can slip / slide good conductor because electrons can move / mobile	**1** **1** **1**
2 (b)	it is soft: pencils **OR** lubricant **OR** polish good conductor: electrodes **OR** brushes (in electric motors)	**1** **1**
2 (c) (i)	Every silicon atom is bonded / attached to 4 oxygen atoms or every oxygen bonded / attached to two silicon atoms	**1**
2 (c) (ii)	any two from: • high melting point / boiling point • hard • colourless crystals / shiny • poor / non-conductor of electricity / insulator • insoluble in water	**2**
		Total: 8
3 (a) (i)	3	**1**
3 (a) (ii)	70	**1**
3 (b)	add octane (or other liquid hydrocarbon) (to soot) **COND**(on addition of **any** solvent) filter (to remove insoluble forms of carbon) (allow to) evaporate **OR** heat **OR** warm **OR** leave in sun (to get crystals of fullerene)	**1** **1** **1**
3 (c) (i)	graphite	**1**
3 (c) (ii)	delocalised electrons / free electrons / sea of electrons **COND** (on electrons) move / mobile / electrons flow	**1** **1**
3 (c) (iii)	any two from: • potassium oxide • potassium hydroxide • potassium carbonate • potassium hydrogencarbonate (bicarbonate)	**2**
		Total: 10

Continues on next page …

Question	Answer	Marks
7 (a)	**A** condensation / condensing / condense **B** freezing / solidification	**1** **1**
7 (b)	*arrangement:* regular *motion:* (only) vibrating / not moving (from place to place)	**1** **1**
7 (c)	acidic because phosphorus is a non-metal / phosphorus is on the right-hand side of the Periodic Table	**1**
7 (d)	any two from: • does not conduct electricity / heat • has a low melting point / boiling point • insoluble in water / soluble in organic solvents	**2**
7 (e)	sulfur dioxide is produced harmful effect of sulfur dioxide, e.g. acid rain / names effect of acid rain, e.g. corrodes metals / death of trees / kills organisms in lakes / irritation to lungs (or eyes / skin / nose / throat)	**1** **1**
		Total: 9

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8: Organic 1 – Topic questions

Paper 3

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
4	2014	June	31
4	2014	June	32
4	2016	June	33

The mark scheme for each question is provided at the end of the document.

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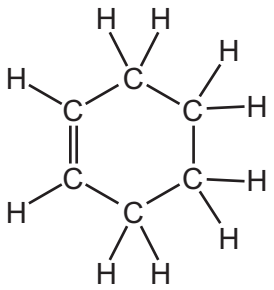
4 The structures of some organic compounds are shown.

P



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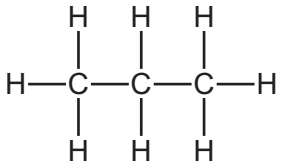

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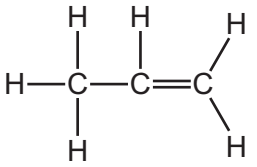

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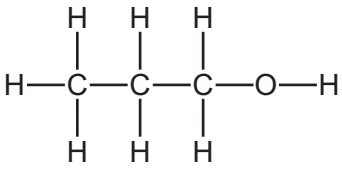

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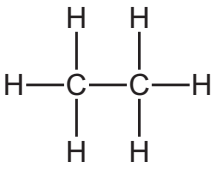

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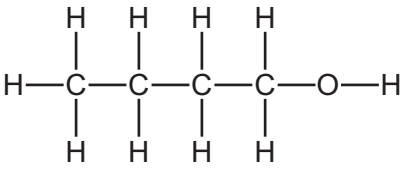


(a) **(i)** Which **two** of these compounds are alcohols?

Explain your answer.

.....

..... [2]

(ii) Which **two** of these compounds are saturated hydrocarbons?

..... [1]

(b) Methanol and ethanol are alcohols in the same homologous series.

Complete the following sentence about a homologous series using words from the list.

alcohols	**chemical**	**compounds**	**elements**
functional	**mixtures**	**physical**	

A homologous series is a family of similar ..... with similar

..... properties due to the same ..... group. [3]

(c) Ethene is an alkene.

(i) Draw the structure of ethene showing all atoms and all bonds.

[1]

(ii) Describe how aqueous bromine is used to show that ethene is an unsaturated compound.

.....

..... [2]

(iii) Ethene is manufactured by cracking.

State the conditions needed for cracking.

..... [1]

(iv) Complete the chemical equation for the cracking of hexadecane, $C_{16}H_{34}$, to form propene and one other hydrocarbon.

$$C_{16}H_{34} \rightarrow C_3H_6 + ...$$

[1]

[Total: 11]

4 Alkanes, alkenes and alcohols are three different homologous series of organic compounds.

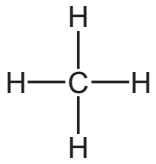
(a) What is meant by the term *homologous series*?

.....

..... [2]

(b) The structures of some alkanes, alkenes and alcohols are shown below.

F



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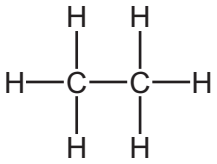

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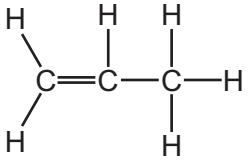

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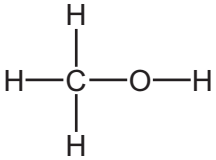

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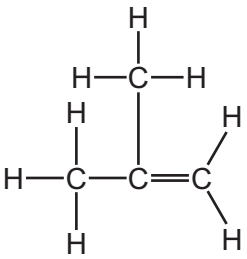
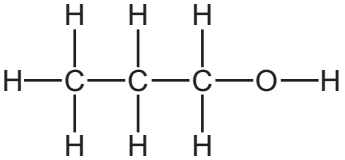


K



(i) Which **two** of these compounds, **F**, **G**, **H**, **I**, **J** and **K**, are saturated hydrocarbons?

Explain your answer.

.....

..... [3]

(ii) Which **one** of these compounds is the main constituent of natural gas?

..... [1]

(iii) Which **two** of these compounds are alkenes?

..... and ..... [2]

(iv) Why are two compounds, **I** and **K**, not hydrocarbons?

..... [1]

(c) The table gives some information about four alcohols.

alcohol	molecular formula	density in g/cm^3	boiling point /°C
methanol	CH_4O	0.793	
	C_2H_6O	0.789	79
propanol	C_3H_8O	0.804	98
butanol	$C_4H_{10}O$	0.810	117

(i) Give the name of the alcohol with the formula C_2H_6O.

..... [1]

(ii) A student predicts that the density of the alcohols increases as the number of carbon atoms increases.
Does the data in the table support this prediction?

Explain your answer.

.....

.....

..... [1]

(iii) Suggest a value for the boiling point of methanol.

..... [1]

(d) The alcohol with the formula C_2H_6O burns in a limited supply of air to form carbon monoxide and water.

(i) Complete the chemical equation for this reaction.

$$C_2H_6O + 2O_2 \rightarrow .....CO + ...H_2O$$

[2]

(ii) State an adverse effect of carbon monoxide on health.

..... [1]

[Total: 15]

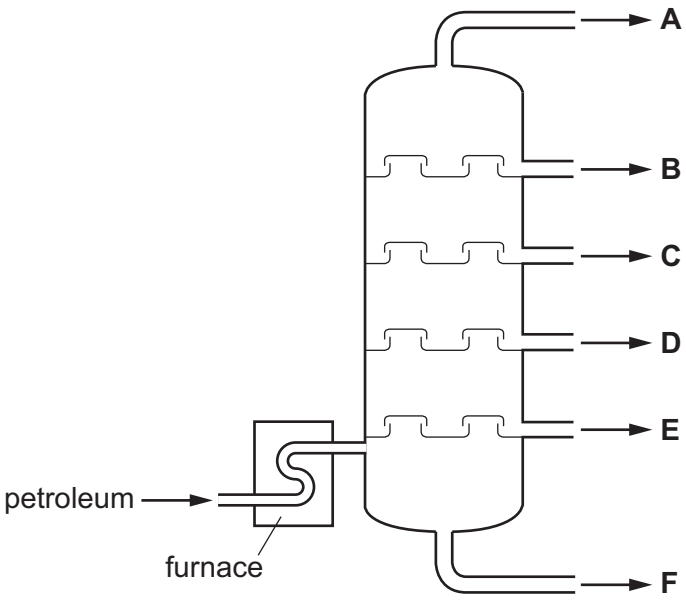
4 Petroleum is a mixture of hydrocarbons.

(a) What is the meaning of the term *hydrocarbon*?

..... [1]

(b) Petroleum can be separated into different fractions by fractional distillation.

The diagram shows a fractionating column. The fractions are shown by letters.



Describe how fractional distillation is used to separate the petroleum into fractions.

In your answer refer to

- changes of state,
- differences in boiling points.

.....

.....

.....

.....

.....

.....

..... [5]

(c) The properties of the fractions are shown in the table.

fraction	number of carbon atoms	percentage by mass of the fraction	boiling range / °C
A	1 – 4	3	less than 40
B	4 – 10	14	40 – 160
C	10 – 16	13	160 – 250
D	16 – 20	9	250 – 300
E	20 – 25	9	300 – 350
F	more than 25		more than 350
		total = 100	

(i) Describe how the number of carbon atoms affects the boiling range.

.....

..... [1]

(ii) Determine the percentage by mass of fraction **F** in this sample of petroleum.

..... [1]

(iii) Which **one** of the fractions is mainly gaseous at 25 °C?

..... [1]

(iv) Fraction **F** is the residue. It contains bitumen.

Give **one** use of bitumen.

..... [1]

(d) Fraction **C** can be cracked to form alkenes.

(i) Describe **one** condition required for cracking.

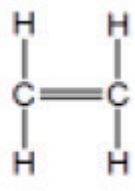
..... [1]

(ii) Complete the chemical equation for the cracking of dodecane, $C_{12}H_{26}$, to form heptane, C_7H_{16}, and one other hydrocarbon.

$$C_{12}H_{26} \rightarrow C_7H_{16} + ...$$

[1]

[Total: 12]

Question	Answer	Marks
4 (a) (i)	S and U; both have OH (group);	2 1 1
4 (a) (ii)	Q and T;	1
4 (b)	compounds; chemical; functional;	3 1 1 1
4 (c) (i)	 ;	1
4 (c) (ii)	aqueous bromine is added to (test tube of) ethene / aqueous bromine is orange; aqueous bromine turns colourless / solution turns colourless;	2 1 1
4 (c) (iii)	High temperature / heat;	1
4 (c) (iv)	$C_{13}H_{28}$;	1
		Total: 11

Continues on next page …

Question	Answer	Marks
4 (a)	any 2 from: • family / group of similar chemicals; • with same functional group; • trend in physical properties; • same general formula; • same / similar chemical reaction; • successive members differ by CH_2;	**2**
4 (b) (i)	F and G; contain only carbon and hydrogen; have only single bonds / no double bonds;	**3** **1** **1** **1**
4 (b) (ii)	F / methane / CH_4;	**1**
4 (b) (iii)	H; J;	**2** **1** **1**
4 (b) (iv)	contain oxygen;	**1**
4 (c) (i)	ethanol;	**1**
4 (c) (ii)	yes and because there is a general increase in the numbers / the numbers go up steadily; **OR** no and because the numbers go down then up again;	**1**
4 (c) (iii)	65 °C	**1**
4 (d) (i)	2 (CO); 3 (H_2O);	**2** **1** **1**
4 (d) (ii)	poisonous / toxic	**1**
		Total: 15

Continues on next page …

Question	Answer	Marks
4 (a)	compound containing carbon and hydrogen only;	**1**
4 (b)	Any 5 of: • petroleum vaporised (in furnace); • column is hot at the bottom and cool at the top; • smaller / lighter molecules move higher up the column ora; • fractions with lower boiling points move further up column ora; • smaller / lighter molecules have lower boiling points ora; • fractions condense when the temperature in the column falls below the (average) boiling point of the fraction;	**5**
4 (c) (i)	the higher the values of the boiling range, the greater the number of (carbon) atoms / boiling range is higher, the greater the number of (carbon) atoms / the more atoms, the more energy it takes to boil;	**1**
4 (c) (ii)	52%	**1**
4 (c) (iii)	A;	**1**
4 (c) (iv)	road surfaces / roofing / cattle sprays / synthetic crude oil / battery sealant / treating fences / waterproofing;	**1**
4 (d) (i)	high temperature / heat;	**1**
4 (d) (ii)	C_5H_{10};	**1**
		Total: 12

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9: Amount of substance – Topic questions

Paper 3

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
4	2015	March	32
5	2016	November	32
6	2015	June	32

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

4 **(a)** A compound **X** contains 82.76% of carbon by mass and 17.24% of hydrogen by mass.

(i) Calculate the empirical formula of compound **X**.

[2]

(ii) Compound **X** has a relative molecular mass of 58.

Deduce the molecular formula of compound **X**.

[2]

(b) Alkenes are unsaturated hydrocarbons.

(i) State the general formula of alkenes.

..... [1]

(ii) State the empirical formula of alkenes.

..... [1]

(c) What is meant by the term *unsaturated hydrocarbon*?

unsaturated .....

.....

hydrocarbon .....

.....

[2]

(d) Describe a test that would distinguish between saturated and unsaturated hydrocarbons.

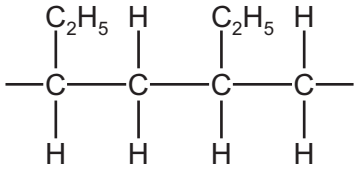
reagent .....

observation (saturated hydrocarbon) .....

observation (unsaturated hydrocarbon) .....

[3]

(e) Addition polymers can be made from alkenes. The diagram shows part of an addition polymer.



(i) Draw a circle on the diagram to show one repeat unit in this polymer. [1]

(ii) Give the structure and the name of the monomer used to make this polymer.

structure

name ..... [2]

(iii) Give the structure of an isomer of the alkene in **(e)(ii)**.

[1]

[Total: 15]

5 Cement is made by heating clay with limestone. Some of the limestone (calcium carbonate) breaks down to form calcium oxide and a gas which turns limewater milky.

(a) (i) Complete the chemical equation for this reaction.

$$CaCO_3 \rightarrow \text{.....} + \text{.....}$$

[2]

(ii) What type of chemical reaction is this?

..... [1]

(iii) Determine the relative formula mass of calcium carbonate. Show all your working.

[2]

(b) Concrete is a mixture of cement, sand, water and small stones.
Calcium carbonate is a compound, but concrete is a mixture.

State **two** differences between a compound and a mixture.

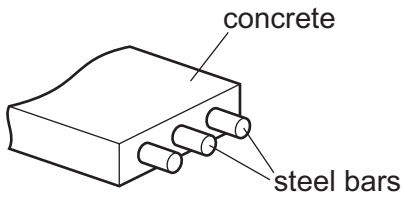
.....

.....

.....

..... [2]

(c) Reinforced concrete contains steel bars within the concrete.



Some properties of concrete and steel are shown in the table.

	relative strength	relative expansion when heated	relative heat conductivity	cost
concrete	60	12	1.5	low
steel	250	12	60.0	high

Use the information in the table to suggest why concrete must be reinforced with steel when it is used to make bridges.

.....

..... [1]

(d) If reinforced concrete becomes cracked, liquids and gases can reach the steel bars. The steel bars rust.

Which **two** substances are needed for steel to rust?

..... and ..... [2]

[Total: 10]

6 The Atacama desert in Chile has deposits of the salt sodium nitrate. Very large amounts of this salt were exported to Europe for use as a fertiliser. After the introduction of the Haber process in 1913, this trade rapidly diminished.

(a) (i) Explain why the introduction of the Haber process reduced the demand for sodium nitrate.

.....

..... [2]

(ii) Suggest why surface deposits of sodium nitrate only occur in areas with very low rainfall such as desert areas.

..... [1]

(iii) The desert has smaller surface deposits of potassium nitrate.

Suggest why potassium nitrate is a better fertiliser than the sodium salt.

..... [1]

(b) All nitrates decompose when heated. The extent to which a nitrate decomposes is determined by the metal in the salt.

(i) Sodium nitrate decomposes to form sodium nitrite, $NaNO_2$.

Write the equation for decomposition of sodium nitrate.

..... [2]

(ii) Sodium nitrite is a reducing agent.

What would be observed if an excess of sodium nitrite solution was added to a solution of acidified potassium manganate(VII)?

..... [2]

(iii) Copper(II) nitrate decomposes to form copper(II) oxide, nitrogen dioxide and oxygen.

What is the relationship between the extent of decomposition and the reactivity of the metal in the nitrate?

.....

..... [1]

(c) The equation for the decomposition of copper(II) nitrate is given below.

$$2Cu(NO_3)_2 \rightarrow 2CuO + 4NO_2 + O_2$$

(i) Predict what you would observe when copper(II) nitrate is heated.

.....

.....

..... [3]

(ii) Copper(II) nitrate forms a series of hydrates with the formula $Cu(NO_3)_2.xH_2O$.
All these hydrates decompose to form copper(II) oxide.
1 mole of $Cu(NO_3)_2.xH_2O$ forms 1 mole of CuO.

What is meant by 1 mole of a substance?

.....

..... [2]

(iii) 7.26 g of a hydrate, $Cu(NO_3)_2.xH_2O$, formed 2.4 g copper(II) oxide.

number of moles of CuO formed = ...

number of moles of $Cu(NO_3)_2.xH_2O$ in 7.26 g = ...

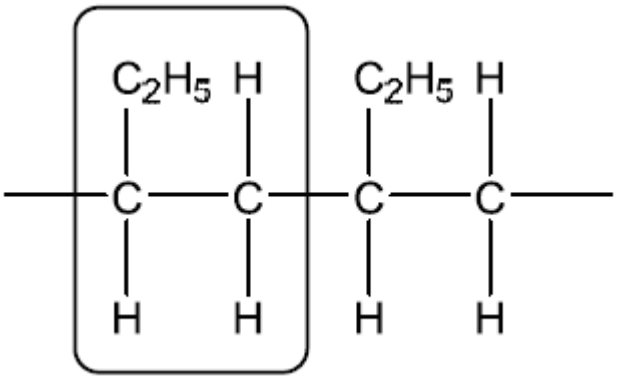
mass of 1 mole of $Cu(NO_3)_2.xH_2O$ = ... g

mass of 1 mole of $Cu(NO_3)_2$ is 188 g

the value of *x* in this hydrate = ...

[4]

[Total: 18]

Question	Answer	Marks
4 (a) (i)	82.76/12 and 17.2(4)(/1) **or** evaluation: 6.89 / 6.9(0) and 17.2(4) C_2H_5 **OR** 82.76 / 100 × 58 = 48 and 17.24 / 100 × 58 = 10 **or** evaluation i.e. 48 and 10 C_2H_5	**1** **1** **1** **1**
4 (a) (ii)	(C_2H_5 =) 29 (58 / 29 = 2) C_4H_{10} **OR:** 82.76 / 100 × 58 = 48 and 17.24 / 100 × 58 = 10 **or** evaluation i.e. 48 and 10 48 / 12 = 4 10 / 1 = 10 (therefore) C_4H_{10}	**1** **1** **1** **1**
4 (b) (i)	C_nH_{2n}	**1**
4 (b) (ii)	CH_2	**1**
4 (c)	(contains) double bond / triple bond / multiple bond(s) / not all bonds are single (contains) carbon and hydrogen **only**	**1** **1**
4 (d)	bromine / bromine water no change / stays brown / orange / yellow / red-brown or only changes in UV (brown / orange / yellow) to colourless / decolourised	**1** **1** **1**
4 (e) (i)	Circle / brackets around any 2 consecutive carbon atoms in the main chain and all attached atoms e.g.  	**1**

Continues on next page …

Question	Answer	Marks
4 (e) (ii)	$CH_3CH_2CH=CH_2$ / $C_2H_5CH=CH_2$ (double bond must be shown) butene / but-1-ene	**1** **1**
4 (e) (iii)	$(CH_3)_2C=CH_2$ / $CH_3CH=CHCH_3$ / $(CH_2)_2CHCH_3$ / $(CH_2)_4$	**1**
		Total: 19

Question	Answer	Marks
5 (a) (i)	CaO CO_2	**1** **1**
5 (a) (ii)	(thermal) decomposition	**1**
5 (a) (iii)	100 = [2] A_r = 40 (Ca), 12 (C), 16 (O) = [1]	**2**
5 (b)	any 2 from: • compound has a fixed composition / mixture has not got a fixed composition • (components of) compound cannot be separated (by physical means) / (components of) mixture can be separated (by physical means) • compound has different properties from the elements it has been made from / substances in a mixture have the same properties as those used to make the mixture	**2**
5 (c)	concrete is weaker / steel is stronger	**1**
5 (d)	oxygen / air water	**1** **1**
		Total: 10

Continues on next page …

Question	Answer	Marks
6 (a) (i)	(Haber process makes) ammonia / NH_3; (ammonia converted into) fertilisers / nitrates / ammonium salts or names or formulae of examples e.g. ammonium nitrate / NH4NO3 / ammonium sulfate / $(NH_4)_2SO_4$ / calcium nitrate / $Ca(NO_3)_2$ / urea / $CO(NH_2)_2$;	**2**
6 (a) (ii)	it (refers to sodium nitrate) / sodium nitrate would dissolve (in rain) / soluble (in water) / wash away / leach / drain off;	**1**
6 (a) (iii)	potassium (is required by plants as well as nitrogen) / NPK;	**1**
6 (b) (i)	$2NaNO_3 \rightarrow 2NaNO_2 + O_2$ species; balancing;	**2**
6 (b) (ii)	(colour changes) from pink / purple; to colourless / decolourised;	**2**
6 (b) (iii)	the more reactive the metal the lower the rate of decomposition / more difficult the decomposition / more stable the nitrate / more energy needed to decompose / decomposes at higher temperature ora;	**1**
6 (c) (i)	(changes from) blue solid / blue crystals; black solid formed; brown gas / brown vapour / (pungent) smell;	**3**
6 (c) (ii)	Avogadro('s) number / constant / 6.02×10^{23}; **COND** particles; **OR** (the number of particles which is equal to the number of atoms in) 12 g of carbon 12; **COND** atoms; **OR** the mass **in grams** which contains Avogadro('s) Number; **COND** particles; **OR** (the amount of substance which has a mass equal to) its relative formula mass / RFM / relative atomic mass / A_r / relative molecular mass / M_r / molar mass; **COND** in grams; **OR** (the amount of substance which has a volume equal to) 24 dm^3; **COND** of a gas **at** RTP;	**2**

Continues on next page …

Question	Answer	Marks
6 (c) (iii)	M1 (number of moles of CuO formed =) **0.03**; M2 (number of moles of $Cu(NO_3)_2 \cdot xH_2O$ in 7.26 g =) **0.03**; M3 (mass of 1 mole of $Cu(NO_3)_2 \cdot xH_2O$ / 0.03 =) **242** (g); (mass of 1 mole of $Cu(NO_3)_2$ is 188 g) M4 The value of x = **3**;	**4**
		Total: 18

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10: Organic 2 – Topic questions

Paper 3

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
3	2016	November	33
6	2016	June	33
7	2015	March	32

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

3 Ethanol can be manufactured by fermentation and from ethene.

(a) Describe the manufacture of ethanol by fermentation **and** from ethene.
In your answer include

- the essential conditions required for each reaction,
- **one** or more relevant word equations.

.....

.....

.....

.....

.....

..... [5]

(b) The table shows some properties of different alcohols.

alcohol	formula	melting point / °C	boiling point / °C	relative viscosity
methanol	CH_4O	–94	65	0.54
ethanol	C_2H_6O	–117	79	1.08
propanol	C_3H_8O	–126	98	1.94
butanol	$C_4H_{10}O$	–89	117	2.54
pentanol	$C_5H_{12}O$	–79		3.47

(i) Deduce the state of methanol at room temperature.
Explain your answer.

.....

..... [2]

(ii) Predict the boiling point of pentanol.

..... [1]

(iii) Describe how the relative viscosity changes with the number of carbon atoms in the alcohol.

..... [1]

(c) **(i)** Draw the structure of ethanol. Show all of the atoms and all of the bonds.

[2]

(ii) Give **one** major use of ethanol.

..... [1]

[Total: 12]

6 Ethanol can be manufactured by reacting ethene with steam.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

(a) What is the meaning of the symbol $\rightleftharpoons$?

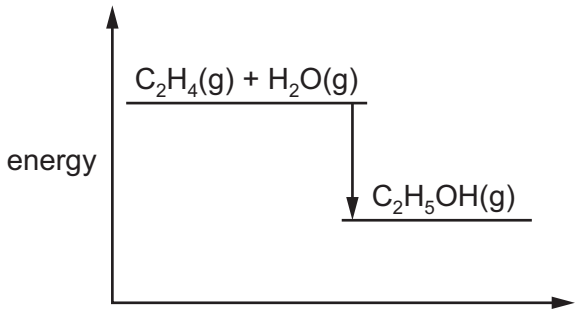
..... [1]

(b) State **two** conditions needed for this reaction.

.....

..... [2]

(c) The energy level diagram for this reaction is shown.



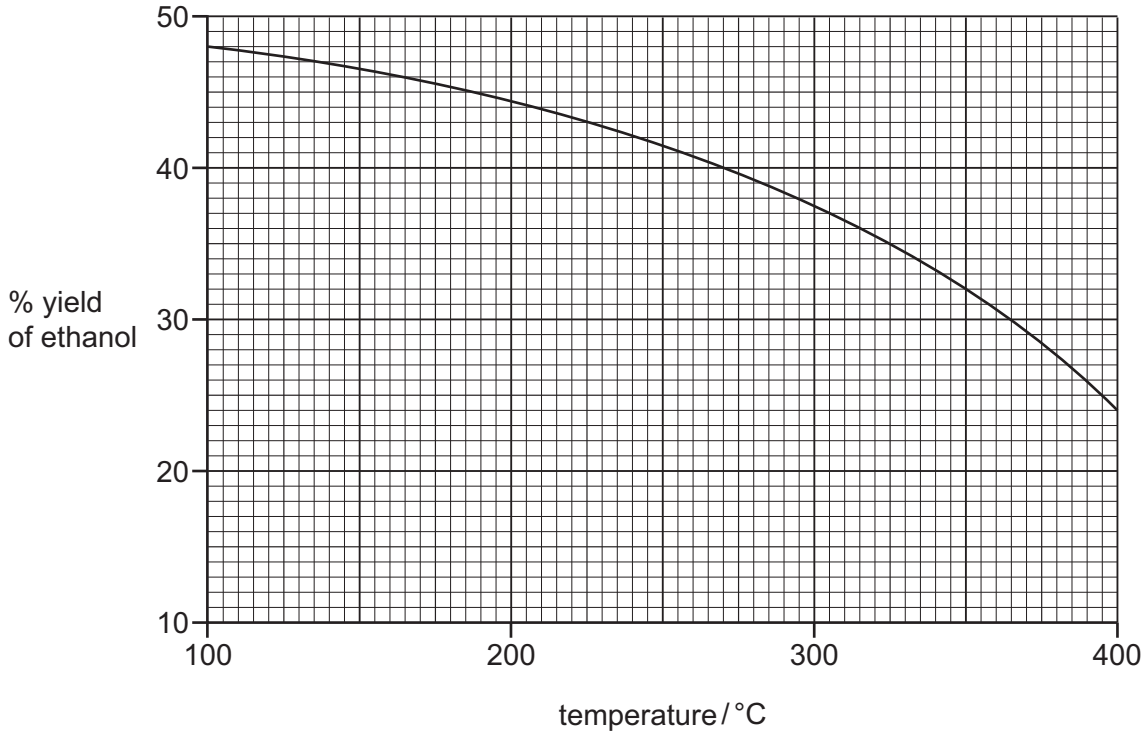
Is this reaction exothermic or endothermic?

Give a reason for your answer.

.....

..... [2]

(d) The graph below shows how the percentage yield of ethanol changes with temperature when the pressure is kept constant.



(i) Describe how the percentage yield changes with temperature.

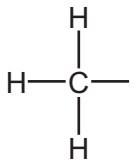
.....

..... [1]

(ii) Determine the percentage yield when the temperature is 350 °C.

..... [1]

(e) **(i)** Complete the structure of ethanol, C_2H_5OH, to show all atoms and all bonds.



[1]

(ii) Give **one** use of ethanol.

..... [1]

(iii) Complete the chemical equation for the complete combustion of ethanol.

$$C_2H_5OH + 3O_2 \rightarrow ....CO_2 + ...H_2O$$

[2]

[Total: 11]

7 Ethanol is manufactured from glucose, $C_6H_{12}O_6$, by fermentation according to the following equation.

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$$

(a) State the conditions required for this reaction.

.....

..... [2]

(b) In an experiment, 30.0 g of glucose was fermented.

(i) Calculate the number of moles of glucose in 30.0 g.

..... mol [2]

(ii) Calculate the maximum mass of ethanol that could be obtained from 30.0 g of glucose.

..... g [2]

(iii) Calculate the volume of carbon dioxide at room temperature and pressure that can be obtained from 30.0 g of glucose.

..... dm^3 [1]

(c) Ethanol can also be manufactured from ethene.

(i) Name the raw material which is the source of ethene.

..... [1]

(ii) Write a balanced equation for the manufacture of ethanol from ethene.

..... [1]

[Total: 9]

Question	Answer	Marks
3 (a)	*conditions required for ethanol manufacture by fermentation* (max = [3]) • uses yeast • uses glucose / sugar(s) • anaerobic / no oxygen present • room temperature / quoted temperature between 10 (°C)–40 (°C) (inclusive) • aqueous conditions / water needed • pH 7 / near pH 7 / neutral *conditions required for ethanol manufacture by hydration of ethene* (max = [3]) • uses high temperature / heat • uses a catalyst • uses high pressure • uses water / steam *equation* (max = [2]) • ethene + water / steam → ethanol • glucose → ethanol + carbon dioxide	**5**
3 (b) (i)	Liquid room temperature is between the melting point and boiling point (of methanol) / room temperature is above the melting point but below the boiling point (of methanol)	**1** **1**
3 (b) (ii)	Values between 125(°C)–145(°C) inclusive	**1**
3 (b) (iii)	Increases with (increasing) number of carbon atoms	**1**
3 (c) (i)	Structure of ethanol showing all of the atoms and all of the bonds OH instead of O—H and rest of structure correct = [1]	**2**
3 (c) (ii)	Any suitable use, e.g. fuel / sterilisation / antiseptic solvent / making a named chemical, e.g. ethanoic acid	**1**
		Total: 12

Question	Answer	Marks
6 (a)	reversible reaction;	**1**
6 (b)	high temperature / heat; catalyst / correctly named catalyst;	**2** **1** **1**
6 (c)	exothermic; products have less energy than reactants;	**2** **1** **1**
6 (d) (i)	(percentage yield) decreases as temperature increases;	**1**
6 (d) (ii)	32%;	**1**
6 (e) (i)	structure of ethanol completed to show all atoms and all bonds;	**1**
6 (e) (ii)	any suitable use, e.g. fuel / solvent	**1**
6 (e) (iii)	2 (CO_2); 3 (H_2O);	**2** **1** **1**
		Total: 11

Question	Answer	Marks
7 (a)	any **two** from: yeast / 20–40 °C / anaerobic or without oxygen or without air / (aqueous) solution or water or aqueous	**2**
7 (b) (i)	M_r = 180 (1) (30/180) = 0.167 (1)	**2**
7 (b) (ii)	2 × 0.167 or 2 × 46 or 0.333 or 92 (2 × 0.167 × 46) = 15.3(33) (g)	**1** **1**
7 (b) (iii)	(2 × 0.167 × 24) = 8 (dm^3)	**1**
7 (c) (i)	crude oil / petroleum	**1**
7 (c) (ii)	$C_2H_4 + H_2O \rightarrow C_2H_5OH$ / CH_3CH_2OH	**1**
		Total: 9

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11: Redox, electrochemistry and Group VII – Topic questions

Paper 3

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

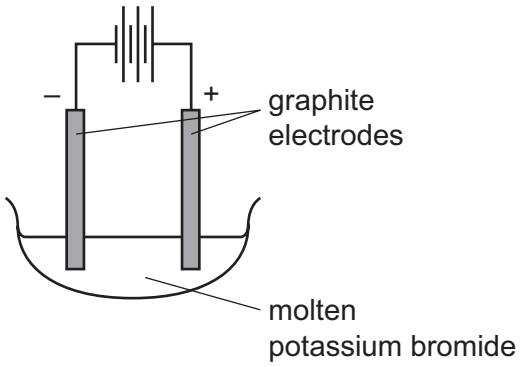
Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
2	2016	March	32
2	2016	June	31
5	2015	June	31

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

2 Molten potassium bromide can be electrolysed using the apparatus shown.



(a) Predict the products of this electrolysis at the

positive electrode (anode), ...

negative electrode (cathode). .....

[2]

(b) **(i)** Explain why graphite electrodes are used in this electrolysis.

..... [1]

(ii) Give **one** other use of graphite.

..... [1]

(c) When chlorine is bubbled through an aqueous solution of potassium bromide, the solution turns red-brown in colour.

Which substance causes the red-brown colour?

..... [1]

(d) Describe what you would observe when an aqueous solution of potassium bromide is added to an acidified aqueous solution of silver nitrate.

..... [1]

(e) Silver nitrate decomposes when heated. One of the products is nitrogen dioxide.

State **one** adverse effect of nitrogen dioxide on health.

..... [1]

[Total: 7]

2 A bicycle maker wants to choose a suitable material to make bicycle frames.
The table shows the properties of some materials that could be used.

material	relative strength	density in g / cm^3	resistance to corrosion	cost per tonne in $ / tonne
aluminium	8	2.7	very good	1500
iron	21	7.9	poor	450
stainless steel	24	7.9	very good	600
titanium	27	4.5	very good	15000
zinc	14	7.1	good	1300

(a) Which material is the most suitable for making the bicycle frame?

Explain your answer using information from the table.

.....

.....

.....

..... [3]

(b) Aluminium is extracted from aluminium oxide by electrolysis.

(i) State the name of the main ore of aluminium.

..... [1]

(ii) Suggest why aluminium is extracted by electrolysis and **not** by reduction with carbon.

..... [1]

(iii) Molten aluminium oxide is electrolysed using graphite electrodes.

Predict the products of this electrolysis at

the positive electrode (anode), ...

the negative electrode (cathode). ..... [2]

(c) The diagram shows the changes of state when zinc vapour is cooled slowly to room temperature.

Explain what happens during these changes in terms of

- the distance between the particles,
- the type of motion shown by the particles.

.....

.....

.....

.....

..... [4]

[Total: 11]

5 The Group VII elements are called the halogens.

(a) Describe the trends in

- the physical properties of the halogens,
- the reactivity of halogens with other halide ions.

Include a relevant word equation in your answer.

.....

.....

.....

.....

.....

.....

..... [5]

(b) Iodine reacts with hot concentrated nitric acid.

$$I_2 + 10HNO_3 \rightarrow 2HIO_3 + 4H_2O + 10NO_2$$

(i) Explain why this reaction could have an adverse effect on health if not carried out in a fume cupboard.

.....

..... [2]

(ii) Nitric acid is strongly acidic.

Which one of the following pH values represents a strongly acidic solution?

Put a ring around the correct answer.

pH 1 pH 7 pH 9 pH 13

[1]

(iii) Nitric acid reacts with zinc oxide.

State the names of the products of this reaction.

..... and .....

[2]

[Total: 10]

Question	Answer	Marks
2 (a)	anode: bromine / Br_2; cathode: potassium / K;	**2**
2 (b) (i)	they are inert / they do not react;	**1**
2 (b) (ii)	any suitable use, e.g. lubricant / pencil leads / brake linings / steelmaking / walls of blast furnace;	**1**
2 (c)	Bromine / Br2;	**1**
2 (d)	cream precipitate / cream solid;	**1**
2 (e)	irritates eyes / irritates nose / irritates lungs;	**1**
		Total: 7

Question	Answer	Marks
2 (a)	stainless steel; any 2 from: (very) strong; (good) resistance to corrosion; cheap; **OR** iron; strong; cheap; **OR** aluminium; low density; (good) resistance to corrosion; **OR** titanium; any 2 from: strong; (good) resistance to corrosion; low density; **OR** zinc; (good) resistance to corrosion;	**3**

Continues on next page …

Question	Answer	Marks
2 (b) (i)	bauxite;	**1**
2 (b) (ii)	aluminium is too reactive / aluminium is high in the electrochemical series / aluminium is very reactive;	**1**
2 (b) (iii)	anode: oxygen / O_2; cathode: aluminium / A*l*;	**2** **1** **1**
2 (c)	any 4 from: • atoms in gas far apart / all over the place; • atoms in gas moving (very) fast / move freely / bouncing around / move randomly; • atoms slow down during condensation / move less than before; • atoms get closer together in condensation; • atoms in liquid are close together / touching; • atoms in liquid slide over each other / atoms in liquids move slowly / restricted movement; • atoms slow down (further) during freezing / atoms in liquid move more than in solid; • atoms in solid only vibrate; • atoms in solid are / touching / close to each other / closely packed / tightly packed;	**4**
		Total: 11

Continues on next page …

Question	Answer	Marks
5 (a)	any 3 physical properties: • melting point increases down the Group; • boiling point increases down the Group; • density increases down the Group; • colour gets darker down the Group / states goes from gas to liquid to solid down the Group; reactivity: • more reactive halogen displaces less reactive halogen (from halide); • correct word equation, e.g. chlorine + potassium bromide → potassium chloride + bromine;	**5** **3** **2**
5 (b) (i)	nitrogen dioxide (formed) / NO2 (formed) / nitrogen oxide (formed) / gas (formed); damages lungs / irritates eyes / sore throat / skin burns / difficulty swallowing / persistent coughing / headache / vomiting;	**2** **1** **1**
5 (b) (ii)	pH 1;	**1**
5 (b) (iii)	zinc nitrate; water;	**2** **1** **1**
		Total: 10

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12: Equilibria – Topic questions

Paper 3

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
3	2016	June	32
6	2016	June	31
7	2016	November	31

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

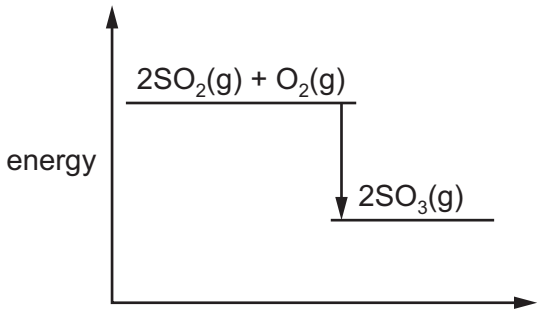
3 Sulfur dioxide reacts with excess oxygen to form sulfur trioxide.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

(a) What is the meaning of the symbol $\rightleftharpoons$?

..... [1]

(b) The energy level diagram for the reaction is shown.



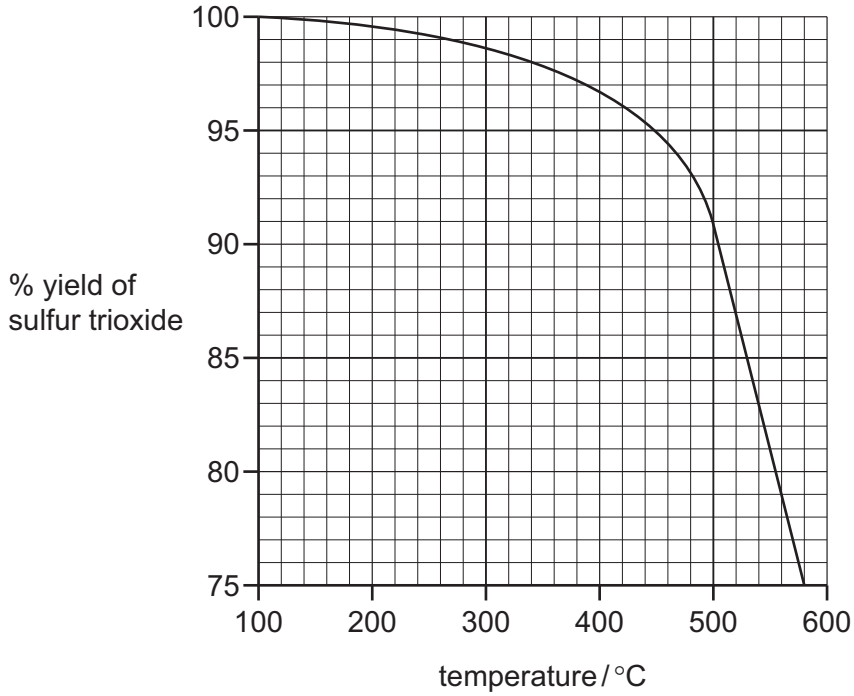
Is this reaction exothermic or endothermic?

Give a reason for your answer.

.....

..... [1]

(c) The graph shows how the percentage yield of sulfur trioxide changes with temperature when the pressure is kept constant.



(i) Describe how the percentage yield of sulfur trioxide changes with temperature.

..... [1]

(ii) Determine the percentage yield of sulfur trioxide when the temperature is 500 °C.

..... [1]

(d) Describe a test for sulfur dioxide.

test .....

result ..... [2]

(e) Give one **use** of sulfur dioxide.

..... [1]

(f) Sulfur dioxide reacts with magnesium.

$$2Mg + SO_2 \rightarrow 2MgO + S$$

Which substance is reduced in this reaction?

Explain your answer.

.....

..... [2]

(g) Sulfur dioxide reacts with water to form sulfurous acid, H_2SO_3. Sulfurous acid reacts with hydrogen sulfide to form water and sulfur.

Complete the chemical equation for this reaction.

$$H_2SO_3 + 2H_2S \rightarrow .....H_2O + 3S$$

[1]

[Total: 10]

6 Ammonia is manufactured by the reaction of nitrogen with hydrogen in the presence of a catalyst.

(a) What is the purpose of a catalyst?

..... [1]

(b) The reaction is reversible.

Complete the equation below by adding the sign for a reversible reaction.

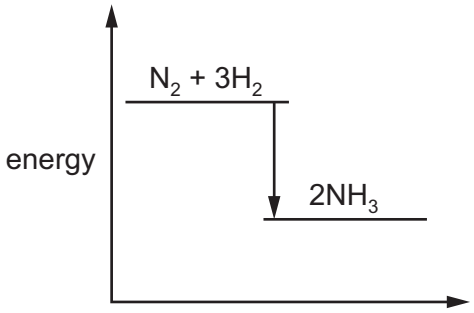
$$N_2 + 3H_2 \quad \_\_ \quad 2NH_3$$

[1]

(c) The energy level diagram for this reaction is shown.

Is this reaction exothermic or endothermic?

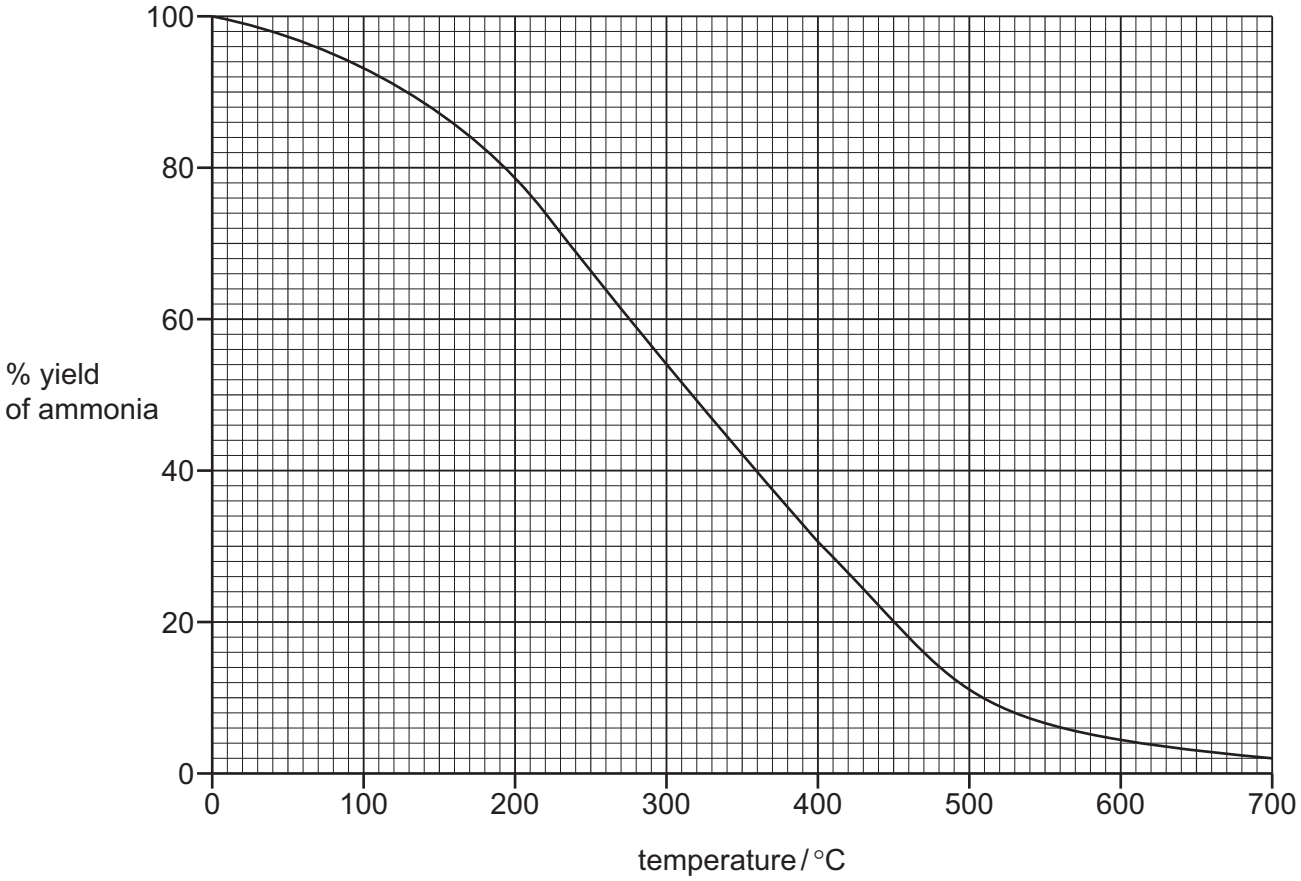
Give a reason for your answer.



.....

..... [1]

(d) The graph shows how the percentage yield of ammonia changes with temperature when the pressure is kept constant.



(i) Describe how the percentage yield of ammonia changes with temperature.

..... [1]

(ii) Determine the percentage yield of ammonia at 350 °C.

..... [1]

(e) Describe a test for ammonia.

test.....

result..... [2]

(f) Ammonia is a weak base.

Describe how you would measure the pH of an aqueous solution of a weak base using Universal Indicator.

.....

..... [2]

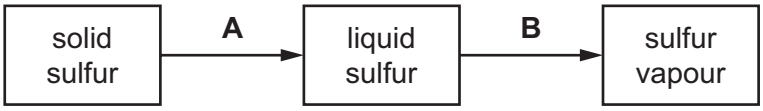
(g) Complete the chemical equation for the reaction of ammonia with chlorine.

$$\text{.....}NH_3 + 3C\mathit{l}_2 \rightarrow N_2 + \text{.....}HC\mathit{l}$$

[2]

[Total: 11]

7 The diagram shows the changes of state when sulfur is heated.



(a) Give the names of the changes of state labelled **A** and **B**.

A .....

B .....
[2]

(b) Describe the arrangement and motion of the particles in sulfur vapour.

arrangement .....

motion .....
[2]

(c) Give **one** use of sulfur.

..... [1]

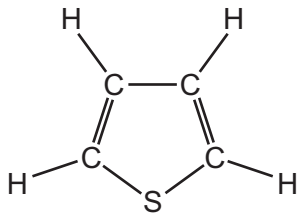
(d) Some compounds of sulfur are found in coal.

Explain why the presence of sulfur in coal has an adverse effect on human health when the coal is burnt.

.....

..... [2]

(e) One of the compounds of sulfur in coal is thiophene.
The structure of thiophene is shown.



(i) Determine the formula of thiophene.

..... [1]

(ii) Thiophene can be made in the laboratory by heating ethyne, C_2H_2, with hydrogen sulfide, H_2S, in the presence of a catalyst.

What is the purpose of the catalyst?

..... [1]

(iii) When 2.6 g of ethyne react with excess hydrogen sulfide, 4.2 g of thiophene are formed.

Calculate the mass of thiophene formed when 15.6 g of ethyne react with excess hydrogen sulfide.

[1]

[Total: 10]

Question	Answer	Marks
3 (a)	reversible reaction / equilibrium;	**1**
3 (b)	exothermic and products have less energy than reactants;	**1**
3 (c) (i)	percentage yield decreases as temperature increases;	**1**
3 (c) (ii)	91%;	**1**
3 (d)	test: acidified potassium manganate(VII) / potassium permanganate; result: (pink solution) turns colourless;	**2** **1** **1**
3 (e)	any suitable use, e.g. food preservation / manufacture of sulfuric acid;	**1**
3 (f)	sulfur dioxide; (sulfur dioxide) loses oxygen;	**2** **1** **1**
3 (g)	3 (H_2O);	**1**
		Total: 10
6 (a)	increase rate of reaction / speeds up reaction;	**1**
6 (b)	⇌;	**1**
6 (c)	exothermic and products have less energy than reactants;	**1**
6 (d) (i)	(yield) decreases with increasing temperature ora / the lower the temperature, the higher the yield ora;	**1**
6 (d) (ii)	42%;	**1**
6 (e)	(damp) red litmus paper turns blue (1 mark for red litmus paper) **OR** concentrated HC*l* (on glass rod) gives white fumes (1 mark for concentrated HC*l* (on glass rod))	**2** **2** **2**
6 (f)	add Universal Indicator to the solution / observe colour; compare with colour chart;	**2** **1** **1**
6 (g)	2 (NH_3); 6 (HC*l*);	**2** **1** **1**
		Total: 11

Continues on next page …

Question	Answer	Marks
7 (a)	**A** = melting / fusion **B** = boiling / vaporisation	**1** **1**
7 (b)	*arrangement:* irregular / random / no fixed position / no (fixed) arrangement *motion:* rapid / fast / random	**2**
7 (c)	any suitable use, e.g. tyre manufacture / making sulfur dioxide / making sulfuric acid / pesticide / insecticide	**1**
7 (d)	sulfur dioxide is formed sulfur dioxide causes irritation to the throat (**OR** nose **OR** lungs **OR** eyes **OR** skin)	**1** **1**
7 (e) (i)	C_4H_4S	**1**
7 (e) (ii)	speeds up the rate of a reaction	**1**
7 (e) (iii)	25.2 (g)	**1**
		Total: 10

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1: Experimental techniques – Topic questions

Paper 4

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
7	2016	November	42

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

7 Proteins are a major constituent of food.

Proteins are polymers.

(a) What is a polymer?

.....

.....

..... [2]

(b) Proteins can be converted into amino acids.

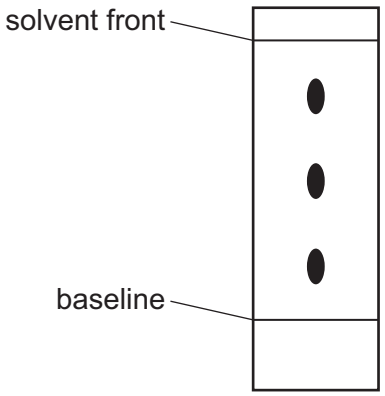
(i) Name the type of chemical reaction which occurs when proteins are converted into amino acids.

..... [1]

(ii) Suggest a condition needed to convert proteins into amino acids.

..... [1]

(c) A colourless mixture of amino acids was separated by chromatography.
Amino acid **X** has an R_f value of 0.8.
The chromatogram of the mixture after treatment with a locating agent is shown.



(i) How is an R_f value calculated?

R_f =

[1]

(ii) On the diagram put a ring around the spot caused by amino acid **X**. [1]

(iii) Describe how you would perform a chromatography experiment to produce the chromatogram shown in **(c)**. Assume you have been given the mixture of amino acids and a suitable locating agent. You are provided with common laboratory apparatus.

.....

.....

.....

.....

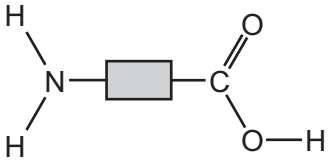
.....

..... [3]

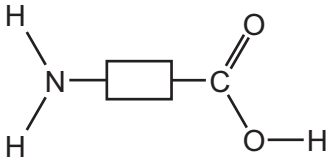
(d) When one molecule of an amino acid **A** combines with one molecule of another amino acid **B**, two different dipeptide molecules could be formed.

Draw the structures of the **two** different dipeptide molecules.
Show all of the atoms and all of the bonds in the linkages.

amino acid **A**



amino acid **B**



[3]

[Total: 12]

Question	Answer	Marks
7 (a)	large / big molecule made from (many) monomers (joined together)	**2**
7 (b) (i)	hydrolysis	**1**
7 (b) (ii)	acid (conditions) / enzyme	**1**
7 (c) (i)	$\frac{\text{distance moved by substance}}{\text{distance moved by solvent (front)}}$	**1**
7 (c) (ii)	circle around top spot	**1**
7 (c) (iii)	mixture of amino acids is placed as a spot onto a (pencil) baseline placed into a (suitable) solvent / water a locating agent is added to the (finished) chromatogram (to reveal spots)	**3**
7 (d)	fully displayed amide link between any two 'blocks' dipeptide 1: amino acid A on left-hand side and amino acid B on right-hand side **AND** dipeptide 2: amino acid B on left-hand side and amino acid A on right-hand side correct terminal amine and carboxylic acid group on both correct dipeptides	**3**
		Total: 12

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2: Particles, atomic structure, ionic bonding and the Periodic Table – Topic questions Paper 4

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
1	2016	March	42
1	2016	June	41
2	2016	November	41

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

1 **(a)** The table below gives information about particles.

Complete the table. The first line has been done for you.

particle	number of protons	number of electrons	electronic configuration	charge on particle
A	12	10	2,8	2+
B		18	2,8,8	1–
C	18		2,8,8	0
D	8	10		

[4]

(b) Gallium is a Group III element.

Define the term *element*.

.....

.....

..... [1]

(c) The following are gallium atoms.

$^{69}_{31}Ga$ $^{71}_{31}Ga$

Complete the following table.

atom	number of protons	number of neutrons	number of electrons
$^{69}_{31}Ga$			
$^{71}_{31}Ga$			

[3]

[Total: 8]

1 Protons, neutrons and electrons are subatomic particles.

(a) Complete the table to show the relative mass and relative charge of a proton, a neutron and an electron.

particle	relative mass	relative charge
proton		
neutron		
electron	$\frac{1}{1840}$	

[3]

(b) Bromine has two isotopes.

(i) Define the term *isotope*.

.....

..... [2]

(ii) Explain why the two isotopes of bromine have the same chemical properties.

.....

..... [2]

(c) The table shows the number of protons, neutrons and electrons in some atoms and ions.

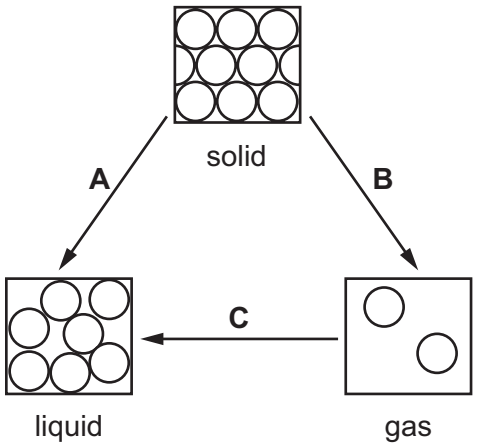
Complete the table.

particle	number of protons	number of neutrons	number of electrons
$^{7}_{3}Li$			
$^{34}_{16}S^{2-}$			
	19	22	18

[5]

[Total: 12]

2 Matter can exist as solid, liquid or gas. The arrows show some changes of state.



(a) Name the changes of state represented on the diagram.

(i) **A** ..... [1]

(ii) **B** ..... [1]

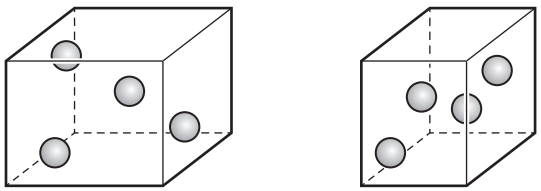
(iii) **C** ..... [1]

(b) Explain why energy has to be supplied to turn a liquid into a gas.

.....

..... [1]

(c) The diagrams represent the same number of particles of a gas in two containers, **D** and **E**, which have different volumes. The two containers are at the same temperature.



In which container will the pressure be higher? Explain your answer.

.....

.....

..... [1]

[Total: 5]

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1 (a)</td><td>B = 17;
C = 18:
D = 2,8; 2^{-}/$^{-}2$;</td><td>4</td></tr>
<tr><td>1 (b)</td><td>substance that cannot be broken down into anything simpler / substance that cannot be broken down (by chemical means) / substance containing atoms with the same atomic number or proton number;</td><td>1</td></tr>
<tr><td>1 (c)</td><td><table><tr><th>number of protons</th><th>number of neutrons</th><th>number of electrons</th></tr><tr><td>31</td><td>38</td><td>31</td></tr><tr><td>31</td><td>40</td><td>31</td></tr></table>M1 column one;
M2 column two;
M3 column three;</td><td>3</td></tr>
<tr><td colspan="3">Total: 8</td></tr>
<tr><td>1 (a)</td><td><table><tr><th>particle</th><th>relative mass</th><th>relative charge</th></tr><tr><td>proton</td><td>1</td><td>+1</td></tr><tr><td>neutron</td><td>1</td><td>nil</td></tr><tr><td>electron</td><td>1/1840</td><td>–1</td></tr></table></td><td>4</td></tr>
<tr><td>1 (b) (i)</td><td>M1 <u>atoms(s)</u> of the same element;
M2 with different number of neutrons;</td><td>2
1
1</td></tr>
<tr><td>1 (b) (ii)</td><td>M1 (both have) the same number of electrons;
M2 in the outer shell;</td><td>2
1
1</td></tr>
<tr><td>1 (c)</td><td><table><tr><th>particle</th><th>number of protons</th><th>number of neutrons</th><th>number of electrons</th></tr><tr><td>$^{7}_{3}Li$</td><td>3</td><td>4</td><td>3</td></tr><tr><td>$^{34}_{16}S^{2-}$</td><td>16</td><td>18</td><td>18</td></tr><tr><td>$^{41}_{19}K^{+}$</td><td>19</td><td>22</td><td>18</td></tr></table></td><td>5</td></tr>
<tr><td colspan="3">Total: 13</td></tr>
</table>

Question	Answer	Marks
2 (a) (i)	melt(ing)	**1**
2 (a) (ii)	sublimation / sublime	**1**
2 (a) (iii)	condensing / condensation	**1**
2 (b)	overcome / break the attractive forces	**1**
2 (c)	**E AND** particles hit the walls (of the container) more often	**1**
		Total: 5

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3: Air and water – Topic questions

Paper 4

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
3	2016	June	43
3	2016	November	42

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

3 Clean dry air contains mainly nitrogen and oxygen.

(a) Name **two** other gases that are in clean dry air.

.....

..... [2]

(b) Air often contains pollutants.

Identify **three** common gaseous pollutants in air and state how each of these pollutants are produced.

pollutant gas 1 .....

how it is produced .....

.....

pollutant gas 2 .....

how it is produced .....

.....

pollutant gas 3 .....

how it is produced .....

.....

[6]

[Total: 8]

3 Clean, dry air contains a small amount of carbon dioxide.

(a) The percentages of the **other** gases present in clean, dry air are shown in the table.

Complete the table by inserting the names of these gases.

name of gas	percentage present
	78
	21
	1

[2]

(b) Oxides of nitrogen are atmospheric pollutants which can cause acid rain.

Describe the formation of oxides of nitrogen and suggest how they can cause acid rain.

.....

.....

.....

..... [3]

(c) Methane contributes to the greenhouse effect.

State **two** sources of methane.

1 .....

2 .....

[2]

(d) Combustion and respiration add carbon dioxide to the atmosphere.

Name **one** natural process which removes carbon dioxide from the atmosphere.

..... [1]

[Total: 8]

Question	Answer	Marks
3 (a)	any 2 from: carbon dioxide; nitrogen; any named noble gas;	**2**
3 (b)	any 6 from: carbon monoxide; from incomplete combustion (of carbon-containing fuel); sulfur dioxide; from burning fossil fuels / roasting ores which contain sulfur / volcanoes; oxides of nitrogen; nitrogen reacting with oxygen in car engines / lightning; methane; from anaerobic decomposition / anaerobic decay;	**6**
		Total: 8
3 (a)	 nitrogen (78%) AND oxygen (21%) noble gases OR argon (1%)	**2**
3 (b)	 nitrogen **AND** oxygen (from the air) react (in the) high temperatures of a car engine NO_x / oxides of nitrogen react with or dissolve in water (to form an acid)	**3**
3 (c)	any 2 from: (named) ruminant animal / cattle / (anaerobic) digestion / flatulence (in animals) / animal waste / (animal) dung decomposing vegetation / animals / organisms / decaying (organic) matter / (fractional distillation / cracking of) petroleum / crude oil / hydrocarbons / natural gas / coal	**2**
3 (d)	photosynthesis	**1**
		Total: 8

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4: Acids, bases and salts – Topic questions

Paper 4

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
4	2016	November	42
3	2016	November	43
5	2016	November	43

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

4 Dilute nitric acid behaves as a typical acid in some reactions but **not** in other reactions.

(a) Dilute nitric acid behaves as a typical acid when reacted with copper(II) oxide and with copper(II) carbonate.

Describe what you would **see** if excess dilute nitric acid is added separately to solid samples of copper(II) carbonate and copper(II) oxide followed by warming the mixtures.

copper(II) carbonate

.....

.....

copper(II) oxide

.....

.....

[4]

(b) When dilute nitric acid is added to pieces of copper and heated, a reaction takes place and copper(II) nitrate is formed.

(i) Part of the chemical equation for the reaction between copper and dilute nitric acid is shown.

Complete the chemical equation by inserting the formula of copper(II) nitrate and balancing the equation.

.....$Cu(s) + 8HNO_3(aq) \rightarrow$ .....$(aq) + 4H_2O(l) + 2NO(g)$

[2]

(ii) How is the reaction of dilute nitric acid with copper different from that of a typical metal with a typical acid?

.....

..... [1]

[Total: 7]

3 When lead(II) nitrate is heated, two gases are given off and solid lead(II) oxide remains. The equation for the reaction is shown.

$$2Pb(NO_3)_2(s) \rightarrow 2PbO(s) + 4NO_2(g) + O_2(g)$$

(a) Calculate the M_r of lead(II) nitrate.

..... [1]

(b) 6.62 g of lead(II) nitrate are heated until there is no further change in mass.

(i) Calculate the mass of lead(II) oxide produced.

..... g [2]

(ii) Calculate the volume of oxygen, O_2, produced at room temperature and pressure (r.t.p.).

..... dm^3 [2]

(c) Describe a test for oxygen.

test .....

result .....
[2]

(d) Lead(II) oxide is insoluble. A student adds solid lead(II) oxide to dilute nitric acid until the lead(II) oxide is in excess. Aqueous lead(II) nitrate and water are produced.

(i) What is meant by the term *excess*?

..... [1]

(ii) How would the student know when the lead(II) oxide is in excess?

..... [1]

(iii) Write a chemical equation for the reaction.

..... [1]

[Total: 10]

5 Sulfuric acid can be manufactured from the raw materials sulfur, air and water. The process can be divided into four stages.

stage 1 converting sulfur into sulfur dioxide

stage 2 converting sulfur dioxide into sulfur trioxide

stage 3 converting sulfur trioxide into oleum, $H_2S_2O_7$

stage 4 converting oleum into sulfuric acid

stage 1

(a) (i) Describe how sulfur is converted into sulfur dioxide.

..... [1]

(ii) Write a chemical equation for the conversion of sulfur into sulfur dioxide.

..... [1]

stage 2

(b) Sulfur dioxide is converted into sulfur trioxide according to the following equation.

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

The reaction is carried out at a temperature of 450 °C and a pressure of 1–2 atmospheres using a catalyst. The energy change, ΔH, for the reaction is –196 kJ / mol.

(i) What is the meaning of the symbol $\rightleftharpoons$?

..... [1]

(ii) Name the catalyst used in this reaction.

..... [1]

(iii) Why is a catalyst used?

..... [1]

(iv) If a temperature higher than 450 °C were used, what would happen to the amount of sulfur trioxide produced? Give a reason for your answer.

.....

..... [2]

(v) Suggest a reason why a temperature lower than 450 °C is **not** used.

.....

..... [1]

(vi) If a pressure higher than 1–2 atmospheres were used, what would happen to the amount of sulfur trioxide produced? Give a reason for your answer.

.....

..... [2]

stage 3

(c) (i) What is added to sulfur trioxide to convert it into oleum?

..... [1]

(ii) Write a chemical equation for the conversion of sulfur trioxide into oleum.

..... [1]

stage 4

(d) (i) What is added to oleum to convert it into sulfuric acid?

..... [1]

(ii) Write a chemical equation for the conversion of oleum into sulfuric acid.

..... [1]

(e) Give **one** use of sulfuric acid.

..... [1]

(f) Sulfuric acid reacts with a hydrocarbon called benzene to produce benzenesulfonic acid, $C_6H_5SO_3H$. Benzenesulfonic acid is a strong acid which ionises to produce hydrogen ions, H^+, and benzenesulfonate ions, $C_6H_5SO_3^-$.

(i) What is meant by the term *strong acid*?

..... [1]

(ii) Describe how to show that a 1 mol / dm^3 solution of benzenesulfonic acid is a strong acid.

.....

..... [2]

(iii) Write a chemical equation for the reaction between benzenesulfonic acid and sodium carbonate, Na_2CO_3.

..... [2]

[Total: 20]

Question	Answer	Marks
4 (a)	*copper(II) carbonate* fizzes / bubbles / effervescence dissolves / disappears *copper(II) oxide* dissolves / disappears blue (solution formed)	**2** **2**
4 (b) (i)	$Cu(NO_3)_2$ $\underline{3}Cu$ **AND** $\underline{3}Cu(NO_3)_2$	**2**
4 (b) (ii)	hydrogen (gas) is not produced (when copper reacts with nitric acid)	**1**
		Total: 7
3 (a)	331	**1**
3 (b) (i)	**M1** mol = 6.62 / 331 **OR** 0.02 **M2** 0.02 × 223 = 4.46 (g)	**1** **1**
3 (b) (ii)	**M1** mol O2 = 0.02 ÷ 2 **OR** 0.01 **M2** vol = 0.01 × 24 = 0.24 (dm^3)	**1** **1**
3 (c)	*test:* glowing splint *result:* relights / rekindles	**1** **1**
3 (d) (i)	more than enough to react (with all the acid) **OR** some lead oxide remains after the reaction **OR** (nitric) acid is limiting	**1**
3 (d) (ii)	solid stops dissolving	**1**
3 (d) (iii)	$PbO + 2HNO_3 \rightarrow Pb(NO_3)_2 + H_2O$ **OR** $PbO + 2H^+ \rightarrow Pb^{2+} + H_2O$	**1**
		Total: 10

Continues on next page …

Question	Answer	Marks
5 (a) (i)	burned / heated in air	**1**
5 (a) (ii)	$S + O_2 \rightarrow SO_2$	**1**
5 (b) (i)	equilibrium / reversible	**1**
5 (b) (ii)	vanadium(V) oxide / vanadium pentoxide	**1**
5 (b) (iii)	increase rate (of reaction) / allow lower temperature to be used / allow lower pressure to be used	**1**
5 (b) (iv)	less SO_3 forward reaction is exothermic / it is exothermic / reverse reaction is endothermic	**1** **1**
5 (b) (v)	rate too low / reaction too slow / slower	**1**
5 (b) (vi)	more SO_3 fewer moles or molecules (of gas) on right-hand side / more moles or molecules (of gas) on left-hand side	**1** **1**
5 (c) (i)	concentrated sulfuric acid / concentrated H_2SO_4	**1**
5 (c) (ii)	$SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$	**1**
5 (d) (i)	water	**1**
5 (d) (ii)	$H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$	**1**
5 (e)	detergents / car batteries / dyes / paints / synthetic resins / printing inks / metal extraction / cleaning metals	**1**
5 (f) (i)	exists completely as ions (in solution) / completely dissociates (in solution) / completely ionises (in solution)	**1**
5 (f) (ii)	Universal Indicator / pH paper / pH indicator / pH meter Universal Indicator or pH paper or pH indicator turns red / pH 0–1	**1** **1**
5 (f) (iii)	$Na_2CO_3 + 2C_6H_5SO_3H \rightarrow 2C_6H_5SO_3Na + CO_2 + H_2O$ formula of $C_6H_5SO_3Na$ all formulae correct and balancing correct	**2**
		Total: 20

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5: Reaction rates – Topic questions

Paper 4

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
4	2016	March	42
4	2016	June	42
8	2016	November	41

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

4 Hydrogen peroxide, H_2O_2, decomposes into water and oxygen in the presence of a catalyst, manganese(IV) oxide.

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

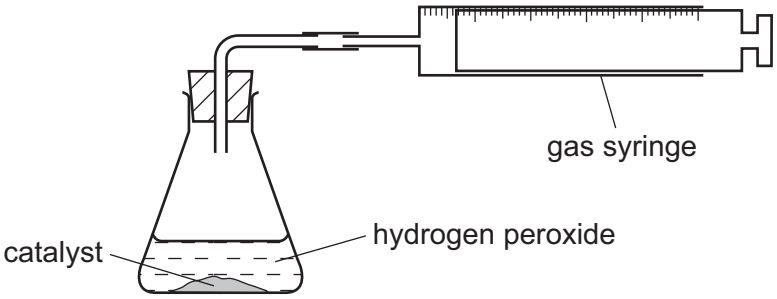
(a) What is meant by the term *catalyst*?

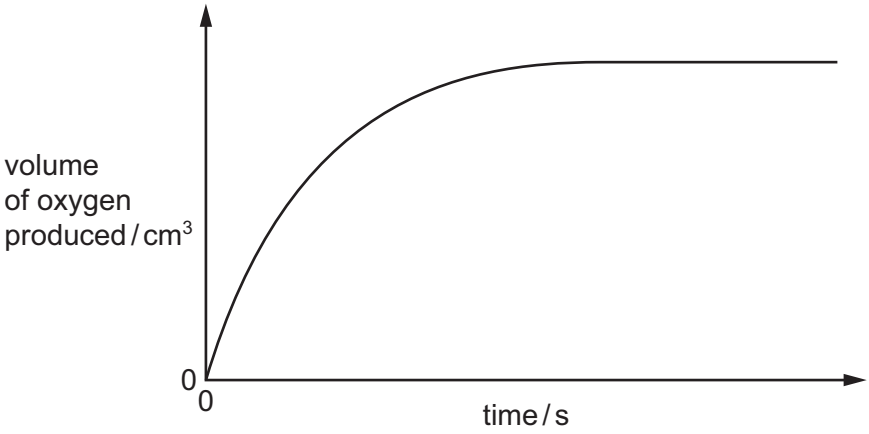
.....

..... [2]

(b) A student studies the rate of decomposition of hydrogen peroxide using the apparatus shown. The student uses 20 cm^3 of 0.1 mol / dm^3 hydrogen peroxide and 1.0 g of manganese(IV) oxide.

The student measures the volume of oxygen given off at regular time intervals until the reaction stops. A graph of the results is shown.





(i) When is the rate of reaction highest?

..... [1]

(ii) Suggest **one** method of increasing the rate of reaction using the same amounts of hydrogen peroxide and manganese(IV) oxide.

..... [1]

(c) (i) Calculate the number of moles of hydrogen peroxide used in this experiment.

..... mol [1]

(ii) Use your answer to **(c)(i)** and the equation to calculate the number of moles of oxygen produced in the reaction.

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

..... mol [1]

(iii) Calculate the volume (at r.t.p.) of oxygen produced.

..... dm^3 [1]

(iv) What would be the effect on the volume of oxygen produced if the mass of catalyst was increased?

..... [1]

(v) Deduce the volume of oxygen that would be produced if 20 cm^3 of 0.2 mol / dm^3 hydrogen peroxide was used instead of 20 cm^3 of 0.1 mol / dm^3 hydrogen peroxide.

..... dm^3 [1]

(d) The student carries out a second experiment to investigate whether another substance, copper(II) oxide, is a better catalyst than manganese(IV) oxide.

Describe how the second experiment is carried out. You should state clearly how you would make sure that the catalyst is the only variable.

.....

.....

.....

.....

.....

..... [3]

[Total: 12]

4 Hydrogen can be manufactured from methane by steam reforming.

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

The reaction is carried out using a nickel catalyst at temperatures between 700 °C and 1100 °C and using a pressure of one atmosphere.

The forward reaction is endothermic.

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

.....

..... [2]

(b) Suggest **two** reasons why a temperature lower than 700 °C is not used.

.....

..... [2]

(c) Suggest **one** advantage of using a pressure greater than one atmosphere.

..... [1]

(d) Suggest **one** disadvantage of using a pressure greater than one atmosphere.

..... [1]

(e) Hydrogen can also be manufactured by electrolysis. The electrolyte is concentrated aqueous sodium chloride. The electrodes are inert.

The products of electrolysis are hydrogen, chlorine and sodium hydroxide.

(i) Define the term *electrolysis*.

.....

..... [2]

(ii) Name a substance that can be used as the inert electrodes.

..... [1]

(iii) Write an ionic half-equation for the reaction in which hydrogen is produced.

..... [1]

(iv) Where is hydrogen produced in the electrolytic cell?

..... [1]

(v) Describe a test for chlorine.

test .....

result .....
[2]

(f) The electrolysis of concentrated aqueous sodium chloride can be represented by the following word equation.

sodium chloride + water → sodium hydroxide + hydrogen + chlorine

Construct a chemical equation to represent this reaction. Do not include state symbols.

..... [2]

(g) State one use of

chlorine, ...

sodium hydroxide, ...

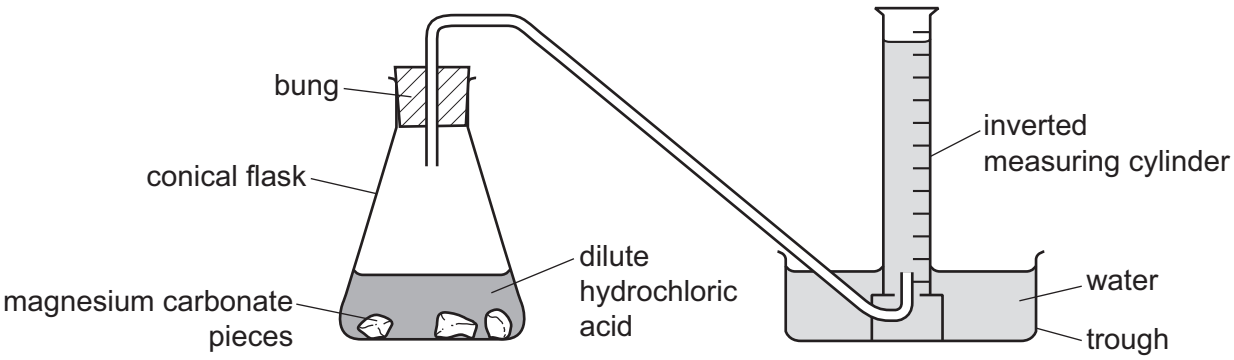
hydrogen. .....
[3]

[Total: 18]

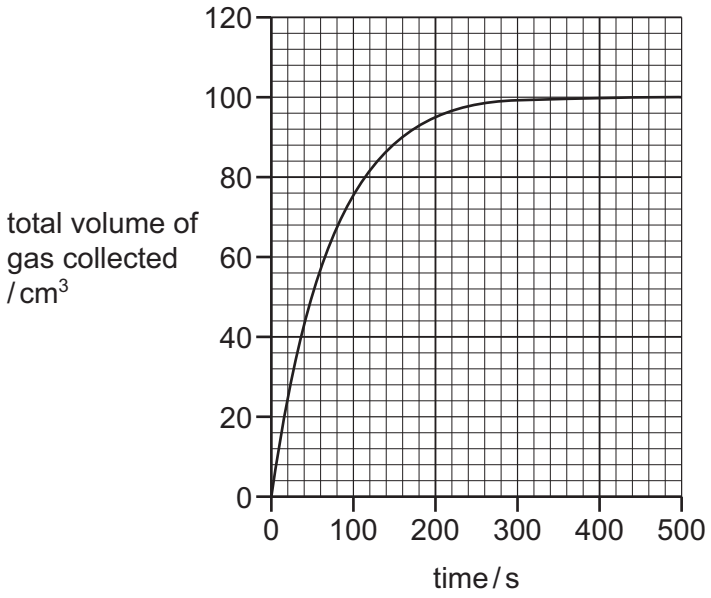
8 Magnesium carbonate reacts with dilute hydrochloric acid.

$$MgCO_3(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l) + CO_2(g)$$

An excess of magnesium carbonate pieces was added to dilute hydrochloric acid. The apparatus in the diagram was used to measure the volume of gas produced. The total volume of gas collected was recorded every 20 seconds.



(a) The results obtained are shown on the graph.



(i) Describe how the rate of this reaction changed during the reaction. Explain why the rate changed in this way.

.....

.....

.....

.....

..... [4]

(ii) The experiment was repeated using the same mass of **powdered** magnesium carbonate with the same volume and concentration of dilute hydrochloric acid.

Explain how the initial rate of reaction and total volume of gas collected would compare to the first experiment.

initial rate of reaction .....

.....

.....

total volume of gas .....

.....

.....

[4]

(b) A piece of magnesium ribbon was cleaned. The experiment was repeated using this clean magnesium ribbon instead of magnesium carbonate.

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

This reaction is exothermic.
The rate of the reaction gradually increased over the first 2 minutes.

Explain why the rate of the reaction increased.

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 13]

Question	Answer	Marks
4 (a)	**M1** (substance that) speeds up a reaction / increases the rate of a reaction; **M2** any one from: unchanged (chemically at the end) / not used up; lowers activation energy;	**2**
4 (b) (i)	at the start / initially / t = 0;	**1**
4 (b) (ii)	Catalyst should be powdered / increase surface area (of catalyst) / decrease particle size (of catalyst); **OR** Increase temperature / heat / warm;	**1**
4 (c) (i)	0.002 (mol);	**1**
4 (c) (ii)	0.001 (mol);	**1**
4 (c) (iii)	0.024 (mol);	**1**
4 (c) (iv)	no change / no effect;	**1**
4 (c) (v)	0.048 (dm^3);	**1**
4 (d)	same mass / amount of / moles / 1.0 g of catalyst; same temperature; same volume and concentration of hydrogen peroxide / 20 cm^3 of 0.1 mol/dm^3 of hydrogen peroxide or reactant;	**3**
		Total: 12

Continues on next page …

Question	Answer	Marks
4 (a)	**M1** substance that speeds up a reaction / increases rate; **M2** unchanged (chemically) at the end / not used up / lowers activation energy / provides alternative pathway	**2** 1 1
4 (b)	**M1** too slow / slower; **M2** lower yield / less product(s) / equilibrium shifts to left / equilibrium shifts in direction of reactants / backward reaction favoured / reverse reaction favoured;	**2** 1 1
4 (c)	faster / increase rate	**1**
4 (d)	lower yield / less product(s) / equilibrium shifts to left / equilibrium shifts in direction of reactants / backward reaction favoured / reverse reaction favoured; **OR** higher cost / expensive; **OR** safety risks;	**1**
4 (e) (i)	**M1** breakdown of an ionic compound when molten or in aqueous solution; **M2** (using) electricity / electric current / electrical energy;	**2** 1 1
4 (e) (ii)	carbon / graphite / platinum;	**1**
4 (e) (iii)	$2H^+ + 2e(^-) \rightarrow H_2$; **OR** $2H_3O^+ + 2e(^-) \rightarrow H_2 + 2H_2O$;	**1**
4 (e) (iv)	cathode / negative electrode;	**1**
4 (e) (v)	**M1** damp blue litmus paper; **M2** bleaches / loses colour / turns white / turns colourless'	**2** 1 1
4 (f)	$2NaCl + 2H_2O \rightarrow 2NaOH + H_2 + Cl_2$ all formulae correct; balancing;	**2**
4 (g)	**M1** *chlorine*: treating (drinking) water / treating water in swimming pools / kill bacteria in water / chlorination of water / (manufacture of) paper products / plastics / PVC / dyes / textiles / medicines / antiseptics / insecticides / herbicides / fungicides / solvents / paints / disinfectant / bleach / hydrochloric acid; **M2** *sodium hydroxide*: drain cleaner / oven cleaner / extraction of aluminium / purification of bauxite / (manufacture of) biodiesel / paper / soap / detergents / washing powder / textiles / dyes; **M3** *hydrogen*: fuel / rocket fuel / fuel cells / in welding / (manufacture of) ammonia / NH_3 / margarine / methanol / hydrochloric acid / refrigerants;	**3** 1 1 1
		Total: 18

Continues on next page …

Question	Answer	Marks
8 (a) (i)	any 4 from: slowed down acid became less concentrated **OR** fewer particles per unit volume fewer collisions per second **OR** lower collision rate (then the reaction) stopped all the hydrochloric acid reacted	**4**
8 (a) (ii)	any 4 from: faster (reaction) (powder has) larger surface area more collisions per second **OR** higher collision rate same volume of gas amount / moles hydrochloric acid is not changed	**4**
8 (b)	any 5 from: temperature increased particles have more energy (particles) move faster more collisions per second **OR** higher collision rate more particles have sufficient energy to react / activation energy more of the collisions are successful	**5**
		Total: 13

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6: Metals and the reactivity series – Topic questions

Paper 4

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
2	2016	March	42
3	2016	June	42
6	2016	March	42

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

2 Rubidium, Rb, is a Group I element. It has similar physical and chemical properties to the other elements in Group I.

(a) Predict how many electrons there are in the outer shell of a rubidium atom.

..... [1]

(b) Predict **one** physical property of rubidium which is the same as that of a transition element such as iron.

..... [1]

(c) Predict **two** physical properties of rubidium which are different to those of a transition element such as iron.

.....

..... [2]

(d) When rubidium is added to cold water a reaction occurs.

(i) Suggest **two** observations that would be made when rubidium is added to cold water.

.....

..... [2]

(ii) What would be the colour of the solution if methyl orange was added to it after the reaction?

..... [1]

(iii) Write a chemical equation for the reaction between rubidium and water.

..... [2]

(iv) Put the Group I elements, caesium, lithium, potassium, rubidium and sodium in their order of reactivity with water. Put the most reactive element first.

most reactive ⟶ least reactive

[1]

(v) Suggest **one** safety measure that should be used when rubidium is added to cold water.

..... [1]

(e) The phosphate ion has the formula PO_4^{3-}.

Deduce the formula of rubidium phosphate.

..... [1]

[Total: 12]

3 Gallium is a metallic element in Group III. It has similar properties to aluminium.

(a) **(i)** Describe the structure and bonding in a metallic element.
You should include a labelled diagram in your answer.

.....

..... [3]

(ii) Explain why metallic elements such as gallium are good conductors of electricity.

..... [1]

(b) Give the formula of

gallium(III) chloride, ...

gallium(III) sulfate. .....
[2]

(c) Gallium(III) oxide, Ga_2O_3, is amphoteric.

(i) Write the chemical equation for the reaction between gallium(III) oxide and dilute nitric acid to form a salt and water only.

..... [2]

(ii) The reaction between gallium(III) oxide and sodium hydroxide solution forms only water and a salt containing the negative ion $Ga_2O_4^{2-}$.

Write the chemical equation for this reaction.

..... [2]

(d) Alloys of gallium and other elements are often more useful than the metallic element itself.

Suggest **two** reasons why alloys of gallium are more useful than the metallic element.

.....

..... [2]

[Total: 12]

6 Iron pyrite, FeS_2, is known as Fool's Gold because it is a shiny yellow solid which is similar in appearance to gold. Iron pyrite is an ionic compound. Gold is a metallic element.

(a) Iron pyrite, FeS_2, contains positive and negative ions. The positive ion is Fe^{2+}.

Deduce the formula of the negative ion.

..... [1]

(b) A student is provided with a sample of iron pyrite and a sample of gold.

Suggest how the student could distinguish between the two substances.

.....

..... [2]

(c) Sulfur dioxide is produced on a large scale by heating iron pyrite strongly in air. The iron pyrite reacts with oxygen in the air producing iron(III) oxide, Fe_2O_3, and sulfur dioxide.

(i) Construct a chemical equation for the reaction between iron pyrite and oxygen.

..... [2]

(ii) Give **one** use of sulfur dioxide.

..... [1]

[Total: 6]

Question	Answer	Marks
2 (a)	1;	**1**
2 (b)	conducts electricity or heat / malleable / ductile / sonorous / shiny;	**1**
2 (c)	any two from: (low) melting point / (low) boiling point; hardness / softness / rubidium can be cut easily; strength; (low) density;	**2**
2 (d) (i)	any two from: bubbles / effervescence / fizzing; flame / sparks / ignites; movement; dissolves / forms a solution / disappears / gets smaller; floats; rubidium melts / rubidium forms a ball; explosion;	**2**
2 (d) (ii)	yellow;	**1**
2 (d) (iii)	$2Rb + 2H_2O \rightarrow 2RbOH + H_2$ formula of RbOH; whole correct equation completely correct;	**2**
2 (d) (iv)	caesium → rubidium → potassium → sodium → lithium / Cs → Rb → K → Na → Li;	**1**
2 (d) (v)	goggles / glasses / gloves / safety screen / stand at safe distance / tongs / open space;	**1**
2 (e)	Rb_3PO_4;	**1**
		Total: 12

Continues on next page …

Question	Answer	Marks
3 (a) (i)	**M1** positive ions / cations (labelled or named in text); **M2** electrons (labelled or named in text); **M3** attraction between positive and negative;	**3** 1 1 1
3 (a) (ii)	(conduction due to) movement of electrons / mobile electrons;	**1**
3 (b)	$GaCl_3$; $Ga_2(SO_4)_3$;	**2** 1 1
3 (c) (i)	$Ga_2O_3 + 6HNO_3 \rightarrow 2Ga(NO_3)_3 + 3H_2O$; formula of $Ga(NO_3)_3$; all formulae and balancing correct;	**2**
3 (c) (ii)	$Ga_2O_3 + 2NaOH \rightarrow Na_2Ga_2O_4 + H_2O$; formula of $Na_2Ga_2O_4$; all formulae and balancing correct;	**2**
3 (d)	any 2 from: (do not) corrode; strong; hard; (improved) appearance;	**2**
		Total: 12

Continues on next page …

Question	Answer	Marks
6 (a)	S_2^{2-}; **OR** S^-;	**1**
6 (b)	test conductivity; gold conducts / ora; **OR** malleability / hit with a hammer; gold malleable / only gold produces ringing sound / ora; **OR** density; gold denser / ora; **OR** add acid / any named / formula of acid; gold does not react (ignore products with pyrites) / ora; **OR** heat (both strongly) in air / oxygen; iron pyrite reacts (ignore products); **OR** melting point; gold lower / ora; **OR** heat with a more reactive metal than iron; gold does not react / ora;	**2**
6 (c) (i)	$4FeS_2 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2$ all formulae; balancing;	**2**
6 (c) (ii)	bleaching (in the manufacture of) wood pulp (for paper or straw or wool or cotton) / (food) preservative or killing bacteria in food or wine / fumigant / refrigerant / tanning (leather);	**1**
		Total: 7

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7: Covalent bonding – Topic questions

Paper 4

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
1	2016	November	43
3	2016	March	42
4	2016	November	43

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

1 **(a)** Complete the table.

particle	charge	relative mass
proton	+1	
neutron		1
electron		

[2]

(b) The following are isotopes of carbon.

$^{12}_{6}C$ $^{13}_{6}C$ $^{14}_{6}C$

(i) In terms of numbers of protons, neutrons and electrons, how are these **three** isotopes the same and how are they different?

They are the same because .....

.....

They are different because .....

.....

[3]

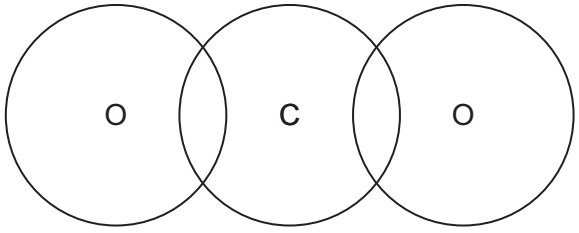
(ii) Why do all isotopes of carbon have the same chemical properties?

..... [1]

(c) Name **two** forms of the element carbon which have giant covalent structures.

..... and ..... [1]

(d) Complete the diagram to show the electron arrangement in a carbon dioxide molecule. Show the outer shell electrons only.



[2]

[Total: 9]

3 Carbon dioxide and silicon(IV) oxide are oxides of Group IV elements.

(a) Complete the following table.

	carbon dioxide	silicon(IV) oxide
formula		SiO_2
melting point / °C	–56	1610
physical state at 25 °C	gas	
conduction of electricity	non-conductor	
structure		macromolecular

[4]

(b) (i) Name the type of bonds that exist between the atoms in silicon(IV) oxide.

..... [1]

(ii) Explain why silicon(IV) oxide has a very high melting point.

.....

..... [1]

(iii) Explain, in terms of attractive forces between particles, why carbon dioxide has a very low melting point.

.....

..... [1]

(iv) Explain, in terms of particles, why carbon dioxide is a non-conductor of electricity.

.....

..... [1]

(c) Suggest a chemical equation for the reaction between sodium hydroxide solution and carbon dioxide.

..... [2]

(d) (i) Name the type of chemical reaction in which carbon dioxide is produced from fossil fuels.

..... [1]

(ii) Name the chemical process in which green plants convert carbon dioxide into carbohydrates.

..... [1]

(iii) Name the chemical process in which living things produce carbon dioxide.

..... [1]

[Total: 13]

4 Silicon(IV) oxide and sodium chloride have different types of bonding and structure.

(a) Name the type of bonding present in

silicon(IV) oxide, ...

sodium chloride. .....
[2]

(b) Name the type of structure present in silicon(IV) oxide.

..... [1]

(c) **(i)** Silicon(IV) oxide has a high melting point. Explain why.

.....

..... [2]

(ii) Silicon(IV) oxide is a poor conductor of electricity. Explain why.

..... [1]

(d) Solid sodium chloride does not conduct electricity. However, it conducts electricity when molten.

Explain why solid sodium chloride does **not** conduct electricity, whereas molten sodium chloride does conduct electricity.

.....

.....

.....

..... [3]

(e) A **concentrated** aqueous solution of sodium chloride is electrolysed using carbon electrodes.

(i) Name the products formed at the electrodes.

product at the positive electrode (anode) .....

product at the negative electrode (cathode) .....
[2]

(ii) Write an ionic half-equation for the reaction occurring at the negative electrode.

..... [1]

(f) A **dilute** aqueous solution of sodium chloride is electrolysed using carbon electrodes.

Name the main product formed at the positive electrode.

..... [1]

(g) Molten sodium chloride is electrolysed using carbon electrodes.

(i) Name the product formed at the negative electrode.

..... [1]

(ii) Write an ionic half-equation for the reaction occurring at the negative electrode.

..... [1]

(iii) Chlorine is produced at the positive electrode.

Give the test for chlorine.

test .....

result .....
[2]

[Total: 17]

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1 (a)</td><td><table>
<tr><td>proton</td><td>+1</td><td>1</td></tr>
<tr><td>neutron</td><td>0</td><td>1</td></tr>
<tr><td>electron</td><td>–1</td><td>$^{1}/_{1840}$</td></tr>
</table></td><td>2</td></tr>
<tr><td>1 (b) (i)</td><td>(same) number of protons and electrons / 6 protons and six electrons
(different) neutron (number) / 6, 7 and 8 neutrons</td><td>2
1</td></tr>
<tr><td>1 (b) (ii)</td><td>same <u>number</u> of electrons / electron configuration</td><td>1</td></tr>
<tr><td>1 (c)</td><td>diamond and graphite</td><td>1</td></tr>
<tr><td>1 (d)</td><td>two double bonds with no extra electrons on the carbon atoms
both oxygen atoms with four non-bonding electrons</td><td>1
1</td></tr>
<tr><td colspan="3">Total: 9</td></tr>
</table>

Continues on next page …

Question	Answer	Marks
3 (a)	<table><tr><td>CO_2;</td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td>solid;</td></tr><tr><td></td><td>poor conductor / non-conductor;</td></tr><tr><td>simple molecular / simple (covalent);</td><td></td></tr></table>	**4**
3 (b) (i)	covalent;	**1**
3 (b) (ii)	all bonds are (very) strong or bonds; **OR** bonds need a lot of energy or heat to break; **OR** (there are) no weak bonds / no (weak) intermolecular forces;	**1**
3 (b) (iii)	weak forces between molecules; **OR** weak intermolecular forces or weak van der Waals' forces; **OR** low amount of energy needed to break intermolecular / van der Waals' forces;	**1**
3 (b) (iv)	no (moving) ions / no mobile or moving electrons / all electrons used in bonding / made of uncharged molecules;	**1**
3 (c)	$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$ **OR** $NaOH + CO_2 \rightarrow NaHCO_3$ formula of Na_2CO_3 / $NaHCO_3$; whole equation correct;	**2**
3 (d) (i)	(complete) combustion / burning;	**1**
3 (d) (ii)	photosynthesis;	**1**
3 (d) (iii)	respiration;	**1**
		Total: 13

Continues on next page …

Question	Answer	Marks
4 (a)	*silicon(IV) oxide*: covalent *sodium chloride*: ionic / electrovalent	**1** **1**
4 (b)	giant molecular / macromolecular / giant covalent / giant atomic	**1**
4 (c) (i)	**M1** (covalent) bonds are strong **M2** a lot of heat or energy is needed to break / weaken / overcome bonds **OR** there are no weak bonds **OR** there are no intermolecular forces **OR** covalent bonds are the only bonds **OR** strong bonds are the only bonds	**2**
4 (c) (ii)	(it has) no moving ions / no moving electrons / all electrons are used in bonding / no moving charged particles	**1**
4 (d)	(sodium chloride contains) ions / is ionic in the solid ions are not moving / they are in fixed positions ions can move when molten	**1** **1** **1**
4 (e) (i)	*product at the positive electrode*: chlorine *product at the negative electrode*: hydrogen	**1** **1**
4 (e) (ii)	$2H^+ + 2e(^-) \rightarrow H_2$ **OR** $2H_3O^+ + 2e(^-) \rightarrow H_2 + 2H_2O$	**1**
4 (f)	oxygen	**1**
4 (g) (i)	sodium	**1**
4 (g) (ii)	$Na^+ + e(^-) \rightarrow Na$	**1**
4 (g) (iii)	*test*: (damp blue) litmus *result*: bleached / removes colour / (turns) white	**1** **1**
		Total: 17

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8: Organic 1 – Topic questions

Paper 4

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
5	2016	June	42
6	2016	June	41
7	2016	March	42

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

5 **(a)** Hydrocarbons are compounds which contain hydrogen and carbon only.

- 10 cm^3 of a gaseous hydrocarbon, C_xH_y, are burned in 100 cm^3 of oxygen, which is an excess of oxygen.
- After cooling to room temperature and pressure, there is 25 cm^3 of unreacted oxygen, 50 cm^3 of carbon dioxide and some liquid water.

All volumes are measured under the same conditions of temperature and pressure.

(i) What is meant by an *excess* of oxygen?

..... [1]

(ii) What was the volume of oxygen that reacted with the hydrocarbon?

..... [1]

(iii) Complete the table below to express the smallest whole number ratio of

volume of hydrocarbon reacted : volume of oxygen reacted : volume of carbon dioxide produced

	volume of hydrocarbon reacted	volume of oxygen reacted	volume of carbon dioxide produced
smallest whole number ratio of volumes			

[1]

(iv) Use your answer to **(a)(iii)** to find the mole ratio in the equation below. Complete the equation and deduce the formula of the hydrocarbon.

.....$C_xH_y(g)$ + ...$O_2(g)$ → .....$CO_2(g)$ + ...$H_2O(l)$

formula of hydrocarbon = ...

[2]

(b) Cracking is used to convert long chain alkanes into shorter chain alkanes and alkenes. Alkenes are unsaturated compounds.

Decane, $C_{10}H_{22}$, can be cracked to give propene and one other product.

(i) Complete the chemical equation.

$$C_{10}H_{22} \rightarrow C_3H_6 + \text{.....}$$

[1]

(ii) What is meant by the term *unsaturated*?

..... [1]

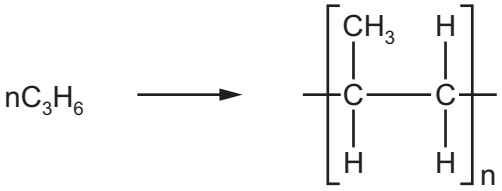
(iii) Describe a test to show that propene is an unsaturated compound.

test .....

result .....

[2]

(c) Propene can be polymerised. The only product is polypropene. The equation for the polymerisation is:



(i) Name the type of polymerisation that occurs.

..... [1]

(ii) Deduce the maximum mass of polypropene that could be produced from 1 kg of propene.

..... kg [1]

(iii) Give the empirical formula of

propene, ...

polypropene. .....

[2]

[Total: 13]

6 Petroleum is a source of many important chemicals.

(a) Name **two** industrial processes which must take place to produce alkenes from petroleum.

.....

..... [2]

(b) Ethene, $CH_2=CH_2$, and propene, $CH_2=CHCH_3$, can both be converted into polymers.

(i) What type of polymerisation takes place when ethene forms a polymer?

..... [1]

(ii) What is the empirical formula of the polymer formed from ethene?

..... [1]

(iii) Propene has the structural formula $CH_2=CHCH_3$.

Draw **two** repeat units of the polymer made from propene.

[2]

(c) Ethene will react with steam to form ethanol.

Propene will react with steam to form two isomers, both of which are alcohols.

Suggest the structures of these alcohols.

[2]

(d) Esters are organic chemicals noted for their characteristic smells. Ethanoic acid and methanol will react to form an ester.

(i) Name the catalyst needed to form an ester from ethanoic acid and methanol.

..... [1]

(ii) Name the ester formed when ethanoic acid reacts with methanol.

..... [1]

(iii) Draw the structure of the ester formed when ethanoic acid reacts with methanol. Show all bonds.

[2]

(iv) Give the name of a polyester.

..... [1]

[Total: 13]

7 **(a)** Alkanes and alkenes are examples of hydrocarbons.

(i) What is meant by the term *hydrocarbon*?

.....

..... [1]

(ii) Give the general formula of straight-chain

alkanes, ...

alkenes. .....
[2]

(b) A compound X contains carbon, hydrogen and oxygen only.

X contains 54.54% of carbon by mass, 9.09% of hydrogen by mass and 36.37% of oxygen by mass.

(i) Calculate the empirical formula of compound X.

[2]

(ii) Compound X has a relative molecular mass of 88.

Deduce the molecular formula of compound X.

[2]

(c) An ester has the molecular formula $C_3H_6O_2$.

Name and give the structural formulae of **two** esters with the molecular formula $C_3H_6O_2$.

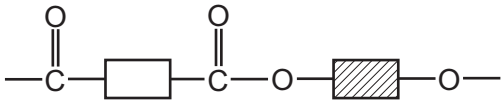
name of ester		
structural formula		

[4]

(d) Name the ester produced from the reaction of propanoic acid and methanol.

..... [1]

(e) A polyester is represented by the structure shown.



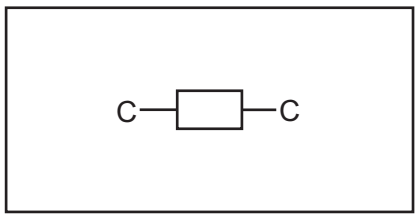
(i) What type of polymerisation is used for the production of polyesters?

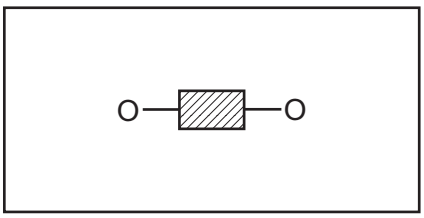
..... [1]

(ii) Which simple molecule is removed when the polyester is formed?

..... [1]

(iii) Complete the diagrams below to show the structures of the monomers used to produce the polyester. Show all atoms and bonds.



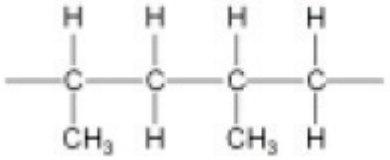
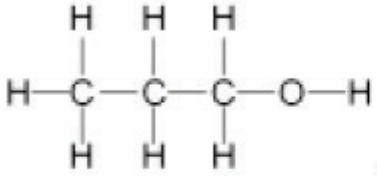
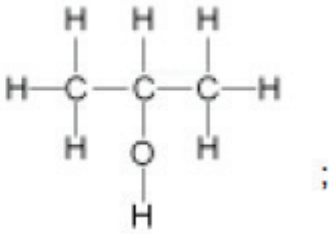
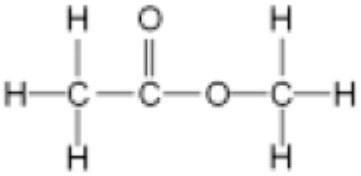


[2]

[Total: 16]

Question	Answer	Marks
5 (a) (i)	more than enough to react (with all the hydrocarbon); **OR** (some) oxygen remaining;	**1**
5 (a) (ii)	75 cm^3;	**1**
5 (a) (iii)	2 : 15 : 10;	**1**
5 (a) (iv)	2 : 15 : 10 : 10; C_5H_{10};	**2** 1 1
5 (b) (i)	C_7H_{16};	**1**
5 (b) (ii)	contains a double bond / triple bond / multiple bond; **OR** not all bonds are single bonds;	**1**
5 (b) (iii)	test: aqueous bromine / bromine (water) / Br_2; result: (orange / yellow / brown) to colourless / decolourised / colour disappears;	**2** 1 1
5 (c) (i)	addition;	**1**
5 (c) (ii)	1 (kg);	**1**
5 (c) (iii)	propene: CH_2; polypropene; CH_2;	**2** 1 1
		Total: 13

Continues on next page …

Question	Answer	Marks
6 (a)	fractional distillation; cracking;	**2** 1 1
6 (b) (i)	addition;	**1**
6 (b) (ii)	CH_2;	**1**
6 (b) (iii)	 **M1** chain of 4 carbon atoms with single bonds and continuation bonds; **M2** correctly positioned CH_3 side chains;	**2**
6 (c)	 ;  ;	**2**
6 (d) (i)	(concentrated) sulfuric acid;	**1**
6 (d) (ii)	methyl ethanoate	**1**
6 (d) (iii)	 **M1** ester link; **M2** rest of molecule;	**2**
6 (d) (iv)	terylene;	**1**
		Total: 13

Continues on next page …

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>7 (a) (i)</td><td>compound containing carbon and hydrogen only;</td><td>1</td></tr>
<tr><td>7 (a) (ii)</td><td>C_nH_{2n+2};
C_nH_{2n};</td><td>2</td></tr>
<tr><td>7 (b) (i)</td><td>mol C = 54.54 / 12 or 4.5(45) and mol H = 9.09 / 1 or 9.09 and mol O = 36.37 / 16 or 2.27;
C_2H_4O</td><td>2</td></tr>
<tr><td>7 (b) (ii)</td><td>M_r of C_2H_4O = 44;
88 / 44 = 2 therefore $C_4H_8O_2$;</td><td>2</td></tr>
<tr><td>7 (c)</td><td><table><tr><td>methyl ethanoate</td><td>ethyl methanoate</td></tr><tr><td>CH_3COOCH_3;</td><td>$HCOOC_2H_5$;</td></tr></table></td><td>4</td></tr>
<tr><td>7 (d)</td><td>methyl propanoate;</td><td>1</td></tr>
<tr><td>7 (e) (i)</td><td>condensation;</td><td>1</td></tr>
<tr><td>7 (e) (ii)</td><td>water / H_2O</td><td>1</td></tr>
<tr><td>7 (e) (iii)</td><td>dicarboxylic acid or diacyl chloride;
diol;</td><td>2</td></tr>
<tr><td colspan="3">Total: 16</td></tr>
</table>

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9: Amount of substance – Topic questions

Paper 4

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
2	2016	June	41
5	2016	June	43
7	2016	November	41

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

2 Period 3 contains the elements sodium to argon. This question asks about the chemistry of each of the Period 3 elements or their compounds.

(a) Sodium nitrate is a white crystalline solid. When heated it melts and the following reaction occurs.

$$2NaNO_3(l) \rightarrow 2NaNO_2(l) + O_2(g)$$

A 3.40 g sample of sodium nitrate is heated.

Calculate the

- number of moles of $NaNO_3$ used,

..... mol

- number of moles of O_2 formed,

..... mol

- volume of O_2 formed, in dm^3 (measured at r.t.p.).

..... dm^3
[3]

(b) Magnesium reacts slowly with warm water to form a base, magnesium hydroxide.

(i) Explain what is meant by the term *base*.

..... [1]

(ii) Write a chemical equation for the reaction between magnesium and warm water.

..... [2]

(c) Aluminium oxide is amphoteric. It is insoluble in water.

Describe experiments to show that aluminium oxide is amphoteric.

.....

.....

.....

..... [3]

(d) Silicon(IV) oxide has a giant structure.

(i) Name the type of bonding in silicon(IV) oxide.

..... [1]

(ii) Give two **physical** properties of silicon(IV) oxide.

.....

..... [2]

(e) Calcium phosphate is used in fertilisers. The bonding in calcium phosphate is ionic. Calcium phosphate contains the phosphate ion, PO_4^{3-}.

(i) What is ionic bonding?

.....

..... [2]

(ii) Deduce the formula of calcium phosphate.

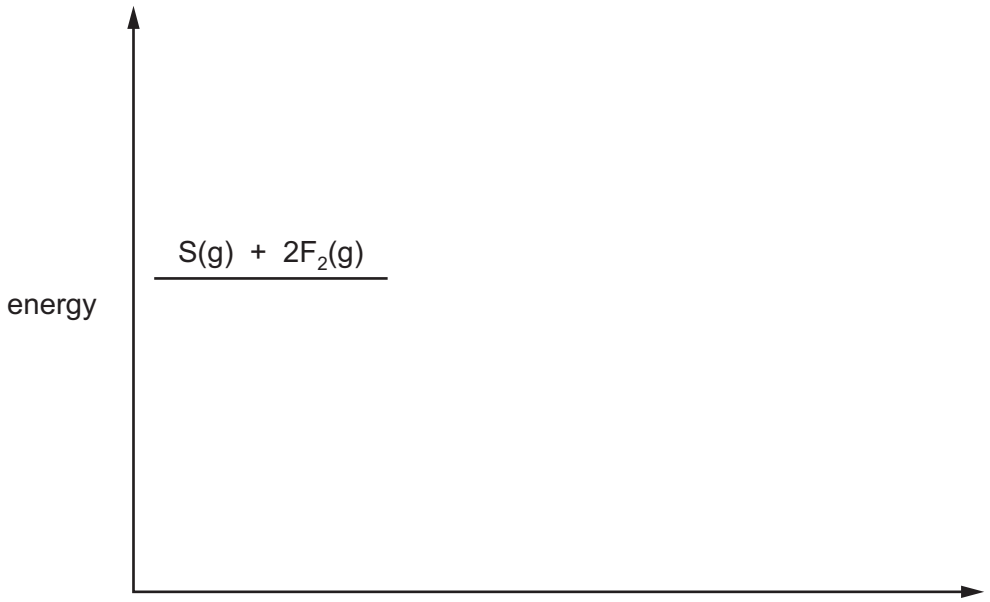
..... [1]

(f) Sulfur tetrafluoride, SF_4, can be made by combining gaseous sulfur with fluorine.

$$S(g) + 2F_2(g) \rightarrow SF_4(g)$$

The reaction is exothermic.

(i) Complete the energy level diagram for this reaction. Include an arrow which clearly shows the energy change during the reaction.

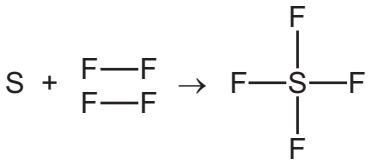


[3]

(ii) During the reaction the amount of energy given out is 780 kJ / mol.

The F–F bond energy is 160 kJ / mol.

Use this information to determine the bond energy, in kJ / mol, of one S–F bond in SF_4.



..... kJ / mol [3]

(g) Chlorine and compounds of chlorine are important in water treatment and in laboratory testing for water.

(i) Chlorine is added to water to make the water safe to drink.

Explain why adding chlorine makes water safe to drink.

..... [1]

(ii) A compound of chlorine is used in the laboratory to test for the presence of water.

Name the compound of chlorine used in this test and describe the colour change seen in a positive result of this test.

name of compound .....

colour change from ..... to .....
[3]

(h) Argon is an unreactive noble gas.

(i) Explain why argon is unreactive.

..... [1]

(ii) Give **one** use of argon.

..... [1]

[Total: 27]

5 Dilute hydrochloric acid reacts with sodium carbonate solution.

$$2HCl(aq) + Na_2CO_3(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$$

(a) Explain why effervescence is seen during the reaction.

.....

..... [1]

(b) Dilute hydrochloric acid was titrated with sodium carbonate solution.

- 10.0 cm^3 of 0.100 mol / dm^3 hydrochloric acid were placed in a conical flask.
- A few drops of methyl orange indicator were added to the dilute hydrochloric acid.
- The mixture was titrated with sodium carbonate solution.
- 16.2 cm^3 of sodium carbonate solution were required to react completely with the acid.

(i) What colour would the methyl orange indicator be in the hydrochloric acid?

..... [1]

(ii) Calculate how many moles of hydrochloric acid were used.

..... mol [1]

(iii) Use your answer to **(b)(ii)** and the equation for the reaction to calculate the number of moles of sodium carbonate that reacted.

..... mol [1]

(iv) Use your answer to **(b)(iii)** to calculate the concentration of the sodium carbonate solution in mol / dm^3.

..... mol / dm^3 [2]

(c) In another experiment, 0.020 mol of sodium carbonate were reacted with excess hydrochloric acid.

Calculate the maximum volume (at r.t.p.) of carbon dioxide gas that could be made in this reaction.

..... dm^3 [3]

[Total: 9]

7 Calcium chloride can be made by reacting calcium carbonate with hydrochloric acid.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

An excess of calcium carbonate was added to 50.0 cm^3 of 0.500 mol / dm^3 hydrochloric acid. The solution was filtered to remove the excess calcium carbonate.

(a) How many moles of HCl were used in this reaction?

..... mol [2]

(b) Deduce the number of moles of carbon dioxide gas made in this reaction.

..... mol [1]

(c) Calculate the mass of carbon dioxide made in this reaction.

..... g [2]

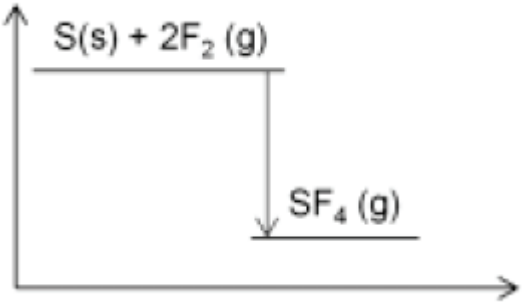
(d) Calculate the volume, in dm^3, of carbon dioxide made in this reaction at room temperature and pressure (r.t.p.).

..... dm^3 [1]

[Total: 6]

Question	Answer	Marks
2 (a)	number of moles of $NaNO_3$ used: 3.40/85 = 0.04(00) (mol) **OR** 4.(00) × 10^{-2} (mol); number of moles of O_2 formed: 0.04/2 = 0.02(00) (mol) **OR** 2.(00) × 10^{-2} (mol); volume of O_2 formed: 0.02 × 24 = 0.48 (dm^3);	**3**
2 (b) (i)	(a substance which is) a proton / H^+ / hydrogen ion acceptor;	**1**
2 (b) (ii)	$Mg(s) + 2H_2O(l) \rightarrow Mg(OH)_2(aq) + H_2(g)$ $Mg(OH)_2$; rest of equation;	**2**
2 (c)	**M1** add a *named* acid, e.g. HC*l* and a *named* alkali, e.g. NaOH; **M2** Al_2O_3 will react with / neutralises both reagents; **M3** and so it will dissolve into the reagent / form a solution;	**3** 1 1 1
2 (d) (i)	covalent;	**1**
2 (d) (ii)	any 2 from: high melting point / high boiling point; poor conductor (of electricity); hard; insoluble;	**2**
2 (e) (i)	**M1** (electrostatic) attraction; **M2** between oppositely charged ions;	**2** 1 1
2 (e) (ii)	$Ca_3(PO_4)_2$;	**1**

Continues on next page …

Question	Answer	Marks
2 (f) (i)	 **M1** *exothermic mark*: horizontal product energy line at lower energy than that of reactant energy line; **M2** *label of product mark*: SF_4; **M3** *correct direction of vertical heat of reaction arrow*: arrow must start level with reactant energy and finish level with product energy **and** must have only **one** (correct) arrow-head;	**3** 1 1 1
2 (f) (ii)	**M1** *bond energy of* $2F_2$: 2 × F–F = 2 × 160 = 320 (kJ/mol); **M2** *bond energy of all bonds in* SF_4: 780 + 320 = 1100 (kJ/mol); **M3** *calculated bond energy of* SF_4 *divided by 4*: 1100/4 = 275 (kJ/mol);	**3** 1 1 1
2 (g) (i)	kills bacteria;	**1**
2 (g) (ii)	name of compound: cobalt(II) chloride; from: blue; to: pink;	**3** 1 1 1
2 (h) (i)	it has a complete outer shell / a full outer shell / 8 electrons in the outer shell'	**1**
2 (h) (ii)	(in) lamps;	**1**
		Total: 27

Continues on next page …

Question	Answer	Marks
5 (a)	carbon dioxide / a gas is made;	**1**
5 (b) (i)	red;	**1**
5 (b) (ii)	0.001;	**1**
5 (b) (iii)	0.0005	**1**
5 (b) (iv)	0.031 (2 marks) **M1 (iii)** / 0.0162;	**2**
5 (c)	0.48 (dm^3) **M1** moles carbon dioxide = 0.02; **M2** volume of carbon dioxide = 0.02 × 24; **M3** = 0.48 (dm^3);	**3** 1 1 1
		Total: 9
7 (a)	0.025 **M1** 50/1000 (=0.05) **M2** (0.05 x 0.5) = 0.025	 **1** **1**
7 (b)	0.0125	**1**
7 (c)	0.55 **M1** 44 **M2** 0.55	 **1** **1**
7 (d)	0.3	**1**
		Total: 6

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10: Organic 2 – Topic questions

Paper 4

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
6	2016	November	41
6	2016	November	43

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

6 Nylon, *Terylene* and proteins are all polymers.

(a) What is a polymer?

.....

.....

..... [2]

(b) Proteins are natural polymers. Proteins are biodegradable.

(i) Name the type of linkage in proteins.

..... [1]

(ii) What is meant by the term *biodegradable*?

.....

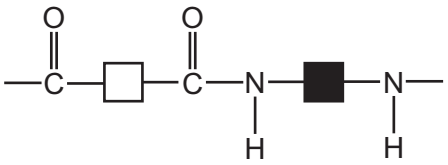
.....

..... [2]

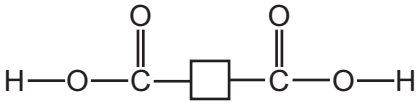
(iii) Name another natural polymer.

..... [1]

(c) Nylon and *Terylene* are synthetic polymers.
The repeat unit of nylon can be shown as



Terylene can be made from the monomers shown.



Draw a diagram to show the repeat unit of *Terylene*.

[3]

[Total: 9]

6 Synthetic polyamides are made by condensation polymerisation.

(a) (i) What is meant by the term *condensation polymerisation*?

.....

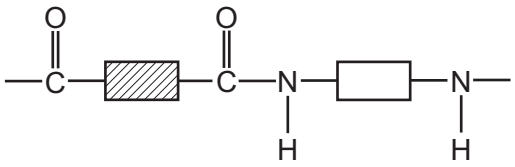
.....

..... [3]

(ii) Name another type of polymerisation.

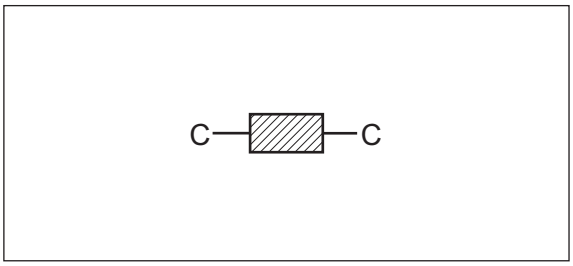
..... [1]

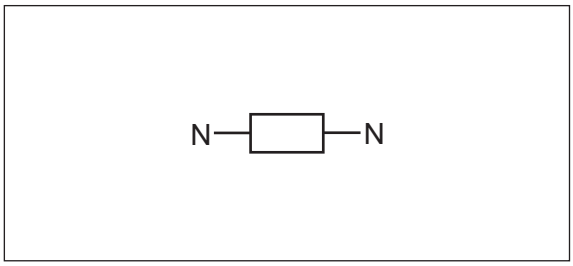
(b) One repeat unit of a synthetic polyamide is represented by the following structure.



(i) Draw a ring around the amide link. [1]

(ii) Complete the diagrams to show the structures of the monomers used to produce the synthetic polyamide. Show all the missing atoms and bonds.





[2]

(iii) Name an example of a synthetic polyamide.

..... [1]

(c) Proteins and synthetic polyamides have similarities and differences.

(i) Name the type of compounds that are the monomers used to make up proteins.

..... [1]

(ii) Starting with a sample of protein, describe how to produce, separate, detect and identify the monomers which make it up.

Your answer should include

- the name of the process used to break down the protein into its monomers,
- the name of the process used to separate the monomers,
- the method used to detect the monomers after they have been separated,
- the method used to identify the monomers after they have been separated.

.....

.....

.....

.....

..... [4]

[Total: 13]

Question	Answer	Marks
6 (a)	large / big molecule made from (many) monomers (joined together)	**1** **1**
6 (b) (i)	amide / peptide	**1**
6 (b) (ii)	(can be) broken down by microbes / bacteria	**1** **1**
6 (b) (iii)	starch / cellulose / DNA / RNA / polysaccharides	**1**
6 (c)	**M1** at least one correct ester linkage between boxes **M2** at least two boxes shown and sufficient correct C and O atoms to make **two correct** ester linkages **M3** continuation bond(s) **AND** if more than one repeat unit is shown, the repeat unit must be correctly identified	**1** **1** **1**
		Total: 9
6 (a) (i)	*condensation*: **M1** (two) molecules / monomers joining **M2** with the removal of a (small) molecule *polymerisation*: **M3** (to form) a large molecule / a long chain	**3**
6 (a) (ii)	addition	**1**
6 (b) (i)	circled amide link	**1**
6 (b) (ii)	all missing atoms and bonds shown on the diacid all missing atoms and bonds shown on the diamine	**1** **1**
6 (b) (iii)	nylon / Kevlar / Nomex	**1**
6 (c) (i)	amino acids	**1**
6 (c) (ii)	hydrolysis chromatography (spray with) locating agent / UV determine R_f values / compare with standards	**1** **1** **1** **1**
		Total: 13

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11: Redox, electrochemistry and Group VII – Topic questions

Paper 4

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
4	2016	June	41
5	2016	November	41
5	2016	November	42

The mark scheme for each question is provided at the end of the document.

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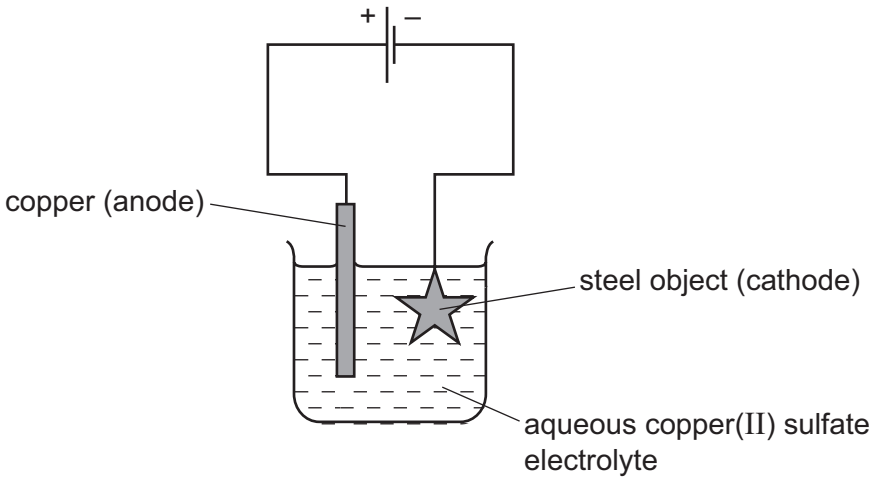
4 Electroplating steel objects with silver involves a three-step process.

step 1 A coating of copper is applied to the object.

step 2 A coating of nickel is applied to the object.

step 3 The coating of silver is applied to the object.

(a) A diagram of the apparatus used for **step 1** is shown.



(i) The chemical process taking place on the surface of the object is

$$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$$

Explain whether this process is oxidation or reduction.

.....

..... [1]

(ii) Explain why the concentration of copper ions in the electrolyte remains constant throughout **step 1**.

.....

.....

..... [2]

(b) Give **two** changes which would be needed in order to coat nickel onto the object in **step 2**.

.....

.....

.....

..... [2]

(c) Copper, nickel and silver are transition elements.
Typical physical properties of transition elements are a high density and a high melting point.

Give **three** different properties of transition metals which are not typical of other metals.

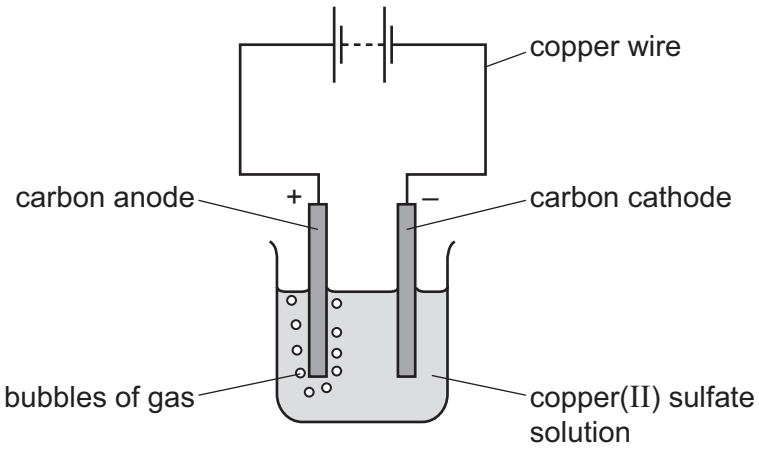
.....

.....

..... [3]

[Total: 8]

5 Copper(II) sulfate solution was electrolysed using the apparatus shown.



(a) A gas was formed at the anode.

Identify this gas and give the test for this gas.

gas .....

test .....

result of test .....

[3]

(b) During electrolysis, electricity passes through the copper(II) sulfate solution.

Solid copper(II) sulfate does not conduct electricity.

Explain **both** of these statements.

.....

.....

.....

.....

..... [3]

(c) The electrolysis was repeated using copper electrodes in place of carbon electrodes. The ionic half-equations for the reactions at the two electrodes are shown.

anode $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$

cathode $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

(i) Which species is reduced during the electrolysis? Explain your answer.

.....

.....

..... [2]

(ii) The masses of the copper electrodes changed during the electrolysis.

State how **and** explain why the masses of the **two** copper electrodes changed.
Use the ionic half-equations to help you.

.....

.....

.....

.....

.....

.....

..... [3]

(iii) Explain why, during the electrolysis, the colour of the copper(II) sulfate solution does **not** change.

.....

.....

..... [1]

[Total: 12]

5 Chlorine, bromine and iodine are halogens.

(a) Chlorine can be made in the laboratory by heating manganese(IV) oxide with concentrated hydrochloric acid.

$$MnO_2(s) + 4HCl(aq) \rightarrow MnCl_2(aq) + 2H_2O(l) + Cl_2(g)$$

Calculate the volume of 8.00 mol / dm^3 HCl(aq) needed to react with 3.48 g of MnO_2.

- moles of MnO_2 used

..... mol

- moles of HCl needed

..... mol

- volume of HCl needed

..... cm^3

[4]

(b) A student bubbled chlorine gas into a test-tube containing aqueous potassium bromide.

(i) Describe the colour change seen in the test-tube.

from ..... to .....

[2]

(ii) Complete the **ionic** equation for this reaction.

Include state symbols.

$$Cl_2(g) + ...Br^-(aq) \rightarrow ..... + ...$$

[3]

(c) When one mole of bromine, Br_2, reacts with one mole of propene, one organic product is formed.

(i) Which part of the propene molecule reacts with bromine?

..... [1]

(ii) What is the name of the type of reaction which takes place between bromine and propene?

..... [1]

(d) When one mole of chlorine, Cl_2, reacts with one mole of propane, a mixture of two structural isomers is formed.

(i) What is the name of the type of reaction which takes place between chlorine and propane?

..... [1]

(ii) Explain what is meant by the term *structural isomers*.

.....

..... [2]

(iii) Draw the structure of **two** structural isomers formed when **one** mole of chlorine reacts with **one** mole of propane.

[2]

(e) Iodine forms an oxide which has the composition by mass: I, 76.0%; O, 24.0%.

(i) Use this information to determine the empirical formula of this oxide of iodine.

empirical formula ..... [3]

(ii) The oxide of iodine in **(e)(i)** dissolves in water.

Predict and explain the effect of adding Universal Indicator to an aqueous solution of this oxide of iodine.

effect on Universal Indicator .....

explanation .....
[2]

[Total: 21]

Question	Answer	Marks
4 (a) (i)	reduction and (the Cu^{2+} ion / copper ions) is gaining electrons / is decreasing in oxidation number	**1**
4 (a) (ii)	formation of Cu^{2+} / copper ions at the anode happens at the same rate as; removal of Cu^{2+} / copper ions at the cathode ora;	**2** 1 1
4 (b)	replace (anode of) copper with nickel; replace electrolyte with nickel(II) sulfate / $NiSO_4$;	**2** 1 1
4 (c)	(good) catalysts; variable oxidation numbers; form coloured compounds / coloured ions	**3** 1 1 1
		Total: 8
5 (a)	(gas) oxygen (test) glowing splint (result of test) relights	**1** **1** **1**
5 (b)	reference to ions / ionic ions cannot move in solid **OR** are in fixed positions in solid ions can move when in solution	**1** **1** **1**
5 (c) (i)	copper ions / Cu^{2+} gain of electrons / oxidation number decreases	**1** **1**
5 (c) (ii)	any 3 from: anode decreases (in mass) copper removed (from anode) / solid (copper from anode) becomes aqueous cathode increases (in mass) copper deposited / added / Cu^{2+} deposited as Cu (on cathode)	**3**
5 (c) (iii)	copper is both added and removed (at same rate) **OR** the concentration (of copper ions) does not change	**1**
		Total: 12

Continues on next page …

Question	Answer	Marks
5 (a)	20 cm^3 **M1** M_r of MnO_2: 87 **M2** moles of MnO_2 used: 3.48/87 = 0.04 **M3** moles of HCl needed: 0.04 × 4 = 0.16 **M4** volume of HCl needed: (0.16/8.0) × 1000 **AND** 20 cm^3	**4**
5 (b) (i)	from colourless to yellow / orange / brown	**2**
5 (b) (ii)	$Cl_2(g) + 2Br^-(aq) \rightarrow Br_2(aq) + 2Cl^-(aq)$ **M1** (aq) as state symbols for the two products given **M2** correct products **M3** balancing	**3**
5 (c) (i)	the (C=C) double bond	**1**
5 (c) (ii)	addition **OR** bromination	**1**
5 (d) (i)	substitution	**1**
5 (d) (ii)	(compounds with the) same molecular formula different structural formulae or structures	**2**
5 (d) (iii)	structure of 1-chloropropane structure of 2-chloropropane	**2**
5 (e) (i)	I_2O_5 **M1** 76.0/127 **AND** 24.0/16.0 **M2** 0.59 **AND** 1.5 **OR** 1 **AND** 2.5 **M3** I_2O_5	**3**
5 (e) (ii)	(turns) red / pink / orange / yellow iodine is a non-metal	**2**
		Total: 21

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12: Equilibria – Topic questions

Paper 4

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
4	2016	June	41
5	2016	November	41
5	2016	November	42

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

4 **(a)** Ammonia, NH_3, is made by reacting nitrogen with hydrogen in the Haber process.

(i) Write a chemical equation for the formation of ammonia in the Haber process.

..... [2]

(ii) Name the raw materials from which nitrogen and hydrogen are obtained.

nitrogen .....

hydrogen .....
[2]

(iii) State the temperature and pressure used in the Haber process. Include the units.

temperature .....

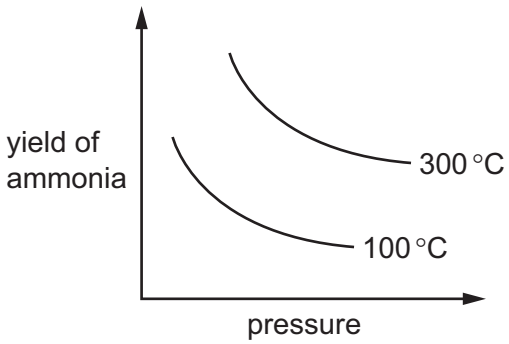
pressure .....
[2]

(b) Ammonia is also made when ammonium carbonate decomposes.

$$(NH_4)_2CO_3(s) \rightleftharpoons 2NH_3(g) + H_2O(g) + CO_2(g)$$

The reaction is reversible and can reach a position of equilibrium.

The graph shows how the yield of ammonia at equilibrium changes with temperature and pressure.



(i) What is meant by the term *equilibrium* for a reversible reaction?

.....

.....

..... [2]

(ii) Using information from the graph, explain whether the reaction is endothermic or exothermic.

.....

..... [1]

(iii) State and explain the effect of increasing the pressure on the yield of ammonia in this reaction.

.....

.....

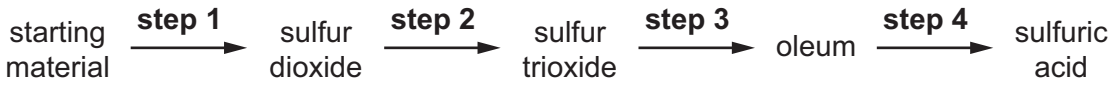
.....

.....

..... [3]

[Total: 12]

5 Sulfuric acid is produced by the Contact process. The steps of the Contact process are shown.



(a) Sulfur is a common starting material for the Contact process.

Name a source of sulfur.

..... [1]

(b) Describe **step 2**, giving reaction conditions and a chemical equation. Reference to reaction rate and yield is not required.

.....

.....

.....

.....

.....

.....

..... [5]

(c) **Step 3** involves adding sulfur trioxide to concentrated sulfuric acid to form oleum.

Complete the chemical equation for this reaction.

$$H_2SO_4 + SO_3 \rightarrow .....$$

[1]

(d) Dilute sulfuric acid is a typical acid.

A student adds excess dilute sulfuric acid to a sample of solid copper(II) carbonate in a test-tube.

(i) Give **three** observations the student would make.

.....

.....

..... [2]

(ii) Give the **names** of all products formed.

.....

..... [1]

(e) Concentrated sulfuric acid has different properties to dilute sulfuric acid.

When concentrated sulfuric acid is added to glucose, $C_6H_{12}O_6$, steam is given off and a black solid is formed.

(i) Name the black solid.

..... [1]

(ii) What type of reaction has occurred?

..... [1]

[Total: 12]

5 This question is about compounds of nitrogen.

(a) (i) Describe the Haber Process giving reaction conditions and a chemical equation. Reference to rate and yield is not required.

.....

.....

.....

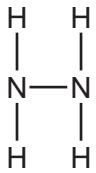
.....

..... [5]

(ii) Give **one** use of ammonia.

..... [1]

(b) The diagram shows the structure of a hydrazine molecule.



Draw the electron arrangement of a hydrazine molecule. Show the outer shell electrons only.

[2]

(c) Hydrazine is a base.

(i) Define the term *base*.

..... [1]

(ii) Complete the chemical equation to show that hydrazine acts as a base when added to water.

$N_2H_4 + H_2O \rightarrow$ ..... + ... [1]

(d) Nitrogen dioxide is an atmospheric pollutant.

(i) State **one** environmental problem caused by nitrogen dioxide.

..... [1]

(ii) Explain how oxides of nitrogen, such as nitrogen dioxide, are formed in car engines.

.....

..... [2]

[Total: 13]

Question	Answer	Marks
4 (a) (i)	$N_2 + 3H_2 \rightleftharpoons 2NH_3$ **M1** formulae **M2** balancing	**2**
4 (a) (ii)	(nitrogen) air / atmosphere (hydrogen) steam / water / hydrocarbons / natural gas	**1** **1**
4 (a) (iii)	(temperature) answer in range 370–470°C (pressure) answer in range 150–300 atm	**1** **1**
4 (b) (i)	**M1** forward and reverse reactions (occur) **M2** amounts / moles / concentrations (of reagents and products) constant **OR** **M2** rate of forward and reverse reactions equal	**1** **1**
4 (b) (ii)	endothermic **AND** yield increases as temperature increases	**1**
4 (b) (iii)	**M1** yield decreases (as pressure increases) **M2** because more moles / molecules (of gas) on the right **M3** so position of equilibrium moves left	**1** **1** **1**
		Total: 12
5 (a)	(sulfur-containing) fossil fuels;	**1**
5 (b)	**M1** vanadium pentoxide / vanadium(V) oxide / V_2O_5 (catalyst); **M2** 1–5 atmospheres (units required); **M3** 450°C (units required); **M4** $2SO_2 + O_2 \rightarrow 2SO_3$; **M5** equilibrium / reversible reaction;	**5** 1 1 1 1 1
5 (c)	$H_2S_2O_7$;	**1**
5 (d) (i)	3 correct (2 marks) 2 correct (1 mark) bubbles / effervescence / fizzing; dissolves / disappears / forms a solution; blue (solution);	**2**
5 (d) (ii)	carbon dioxide and water and copper(II) sulfate;	**1**
5 (e) (i)	carbon;	**1**
5 (e) (ii)	dehydration;	**1**
		Total: 12

Question	Answer	Marks
5 (a) (i)	pressure in range 150–300 atmospheres / atm; temperature in range 370–470°C; iron (catalyst); balanced equation: $N_2 + 3H_2 \rightarrow 2NH_3$; equilibrium / reversible;	**5**
5 (a) (ii)	manufacture of fertilisers / nylon / nitric acid / cleaning agent (allow oven cleaner) / hair dye / urea / refrigeration / explosives;	**1**
5 (b)	**M1** all shared electrons correct (5 bonds) **M2** exactly two non-bonding electrons on each N and no additional non-bonding electrons	**2**
5 (c) (i)	proton / H+ acceptor;	**1**
5 (c) (ii)	$(N_2H_4 + H_2O) \rightarrow N_2H_5^+ + OH^-$; **OR** $(N_2H_4) + 2H_2O \rightarrow N_2H_6^{2+} + 2OH^-$;	**1**
5 (d) (i)	acid rain / effect of acid rain / (photochemical) smog / (producing) low level ozone;	**1**
5 (d) (ii)	**M1** nitrogen and oxygen (from the air) react / combine or word equation; **M2** at high temperature / spark / very hot;	**2**
		Total: 13

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1: Experimental techniques – Topic questions Paper 6

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

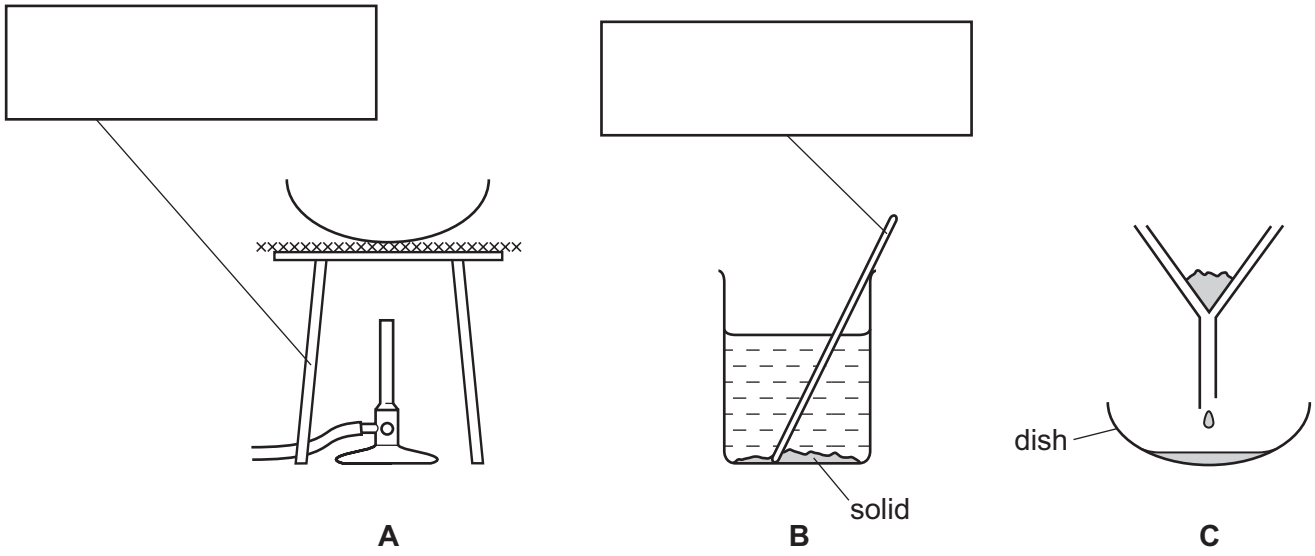
Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
1	2016	March	62
3	2016	March	62
4	2016	March	62

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

1 The diagrams show the apparatus used to obtain crystals of calcium chloride from a mixture of solid calcium chloride and solid calcium carbonate.
Calcium chloride is soluble in water and calcium carbonate is insoluble in water.



(a) Complete the boxes to name the apparatus. [2]

(b) (i) Write down the order in which the apparatus should be used in this experiment.

..... [1]

(ii) Name the separation process in **C**.

..... [1]

(c) (i) What has been added to the mixture in **B**?

..... [1]

(ii) What is the general name given to the liquid in the dish in **C**?

..... [1]

(d) How would you know when to stop heating the dish in **A**?

.....

..... [1]

[Total: 7]

2 A teacher investigated the rate of a reaction between two solutions, **J** and **K**, and sulfuric acid at different temperatures.

Four experiments were carried out.

(a) *Experiment 1*

A large measuring cylinder was used to pour 50 cm^3 of distilled water and 40 cm^3 of sulfuric acid into a 250 cm^3 conical flask.
A small measuring cylinder was used to add 2 cm^3 of methyl orange and 5 cm^3 of solution **J** to the mixture in the conical flask. The temperature of the mixture was measured.
The reaction was started by adding 5 cm^3 of solution **K** to the conical flask, immediately starting the timer and swirling the mixture.
The time taken for the mixture to turn pale yellow was measured. The final temperature of the mixture was measured.

Experiment 2

Experiment 1 was repeated but the mixture in the conical flask was heated to about 30 °C **before** adding the solution **K**. The temperature of the mixture was measured.
5 cm^3 of solution **K** was added to the conical flask. The timer was started and the mixture swirled.
The time taken for the mixture to turn pale yellow was measured. The final temperature of the mixture was measured.

Experiment 3

Experiment 1 was repeated but the mixture in the conical flask was heated to about 40 °C before adding the solution **K** to the flask. The same measurements were taken.

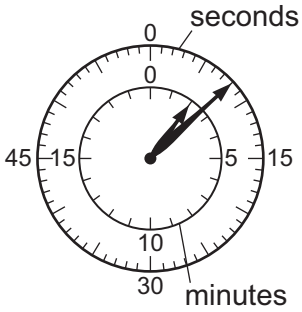
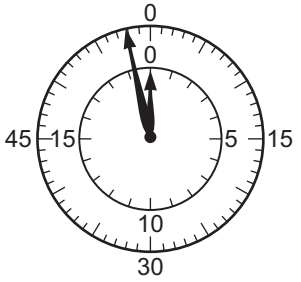
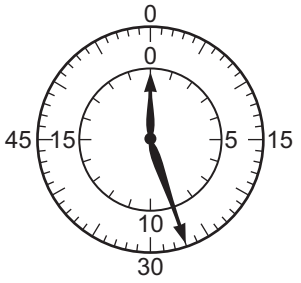
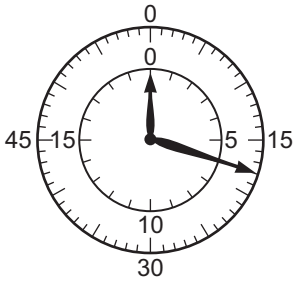
Experiment 4

Experiment 1 was repeated but the mixture in the conical flask was heated to about 50 °C before adding the solution **K** to the flask. The same measurements were taken.

Stop-clock diagrams for these experiments are on page 4.

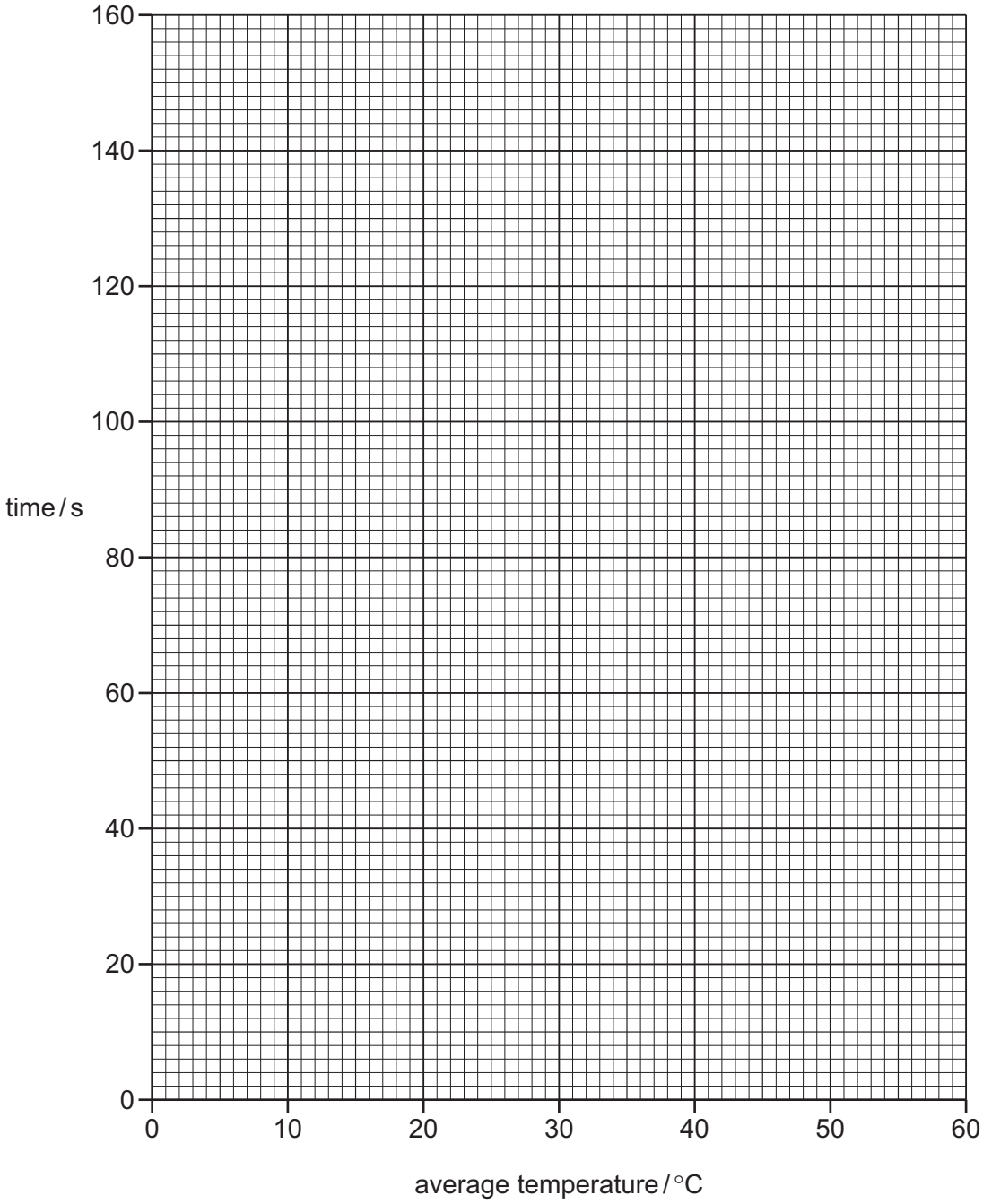
Use the stop-clock diagrams to record the times in the table.

Work out the average temperatures to complete the table.

experiment	stop-clock diagram	time taken for mixture to turn pale yellow / s	initial temperature / °C	final temperature / °C	average temperature / °C
1			17	15	
2			28	26	
3			42	40	
4			51	49	

[4]

(b) Plot the results on the grid and draw a smooth line graph.



[4]

(c) **From your graph** deduce the time taken for the mixture to turn pale yellow if Experiment 1 was repeated at an average temperature of 60 °C.
Show clearly **on the grid** how you worked out your answer.

..... [2]

(d) (i) In which experiment was the rate of reaction greatest?

..... [1]

(ii) Explain why the rate of reaction was greatest in this experiment.

.....

.....

..... [2]

(e) (i) Suggest and explain the effect **on the results** of using a burette to measure the volume of solution **J**.

.....

..... [2]

(ii) Suggest and explain one **other** improvement to these experiments.

.....

..... [2]

[Total: 17]

4 The label on a bottle of orange drink stated 'contains no artificial colours'. A scientist thought that the orange colour in the drink was a mixture of two artificial colours:

- Sunset Yellow E110
- Allura Red E129

Plan an investigation to show that the orange colour in the drink did **not** contain these two artificial colours.
You are provided with samples of E110, E129 and the orange colouring from the drink. You are also provided with common laboratory apparatus.
You may draw a diagram to help answer the question.

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 6]

Question	Answer	Mark
1 (a) (i)	tripod stirring rod/stirrer	2
1 (b) (ii)	B, C, A	1
1 (b) (ii)	filtration	1
1 (c) (i)	water	1
1 (c) (ii)	filtrate	1
1 (d)	solid/crystal appearing on edge/glass rod test	1
		Total: 7
3 (a)	blue/green (solid/crystals)	1
3 (b) (i)	(pale) blue precipitate royal/deep blue dissolves/solution	4
3 (b) (ii)	(pale) blue precipitate	1
3 (b) (iii)	white precipitate	1
3 (b) (iv)	no reaction/change/precipitate	1
3 (c)	ammonium; iodide	2
		Total: 10
4	any 6 from: chromatography (pencil) baseline/origin apply orange colour to paper add samples of both E110 and E129 solvent/names solvent check heights of spots of E colours against orange drink conclusion/allow comparison to known R_f values	6
		Total: 6

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3: Air and water – Topic questions

Paper 6

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

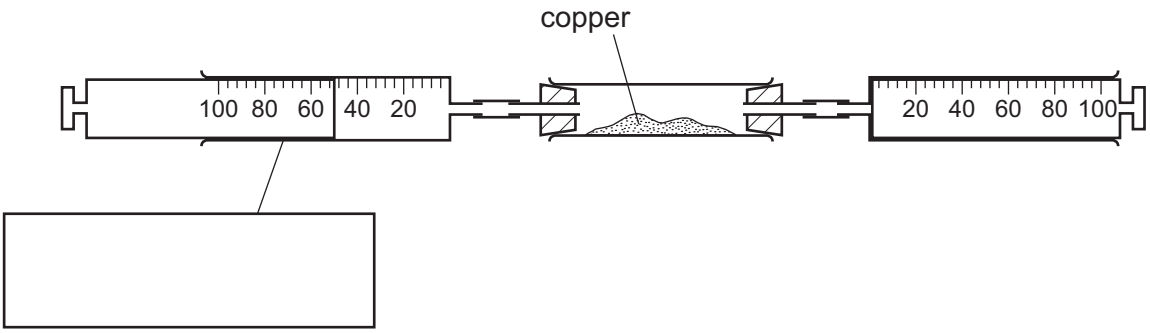
Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
1	2016	June	63

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

1 Air is a mixture of gases. The diagram shows the apparatus used to find the percentage of oxygen in air.
50 cm^3 of air were passed backwards and forwards over excess heated copper until there was no further change. The apparatus was left to cool and the volume of gas remaining was 40 cm^3.



(a) Complete the box to name the apparatus. [1]

(b) Use an arrow to indicate where heat is applied. [1]

(c) The colour of the copper changed from ..... to ..... . [2]

(d) From the results, work out the percentage of oxygen in the air.

..... % [2]

[Total: 6]

Question	Answer	Mark
1 (a)	(gas) syringe	1
1 (b)	arrow under copper	1
1 (c)	orange/red/brown/pink to black	1 1
1 (d)	volume of oxygen = 10 cm^3 % of oxygen = 10/50 × 100 = 20%	1 1
		Total: 6

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4: Acid, bases and salts – Topic questions

Paper 6

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
2	2016	June	61
3	2016	June	61
3	2016	March	62

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

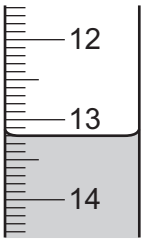
2 A student investigated the reaction between aqueous sodium carbonate and two different solutions of dilute hydrochloric acid, **A** and **B**.
The reaction is:

$$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$$

Three experiments were carried out.

(a) *Experiment 1*

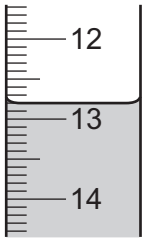
Using a measuring cylinder, 25 cm^3 of aqueous sodium carbonate were poured into a conical flask.
Thymolphthalein indicator was added to the conical flask.
A burette was filled up to the 0.0 cm^3 mark with solution **A** of dilute hydrochloric acid. **A** was added to the flask, until the solution just changed colour.
Use the burette diagram to record the reading in the table.



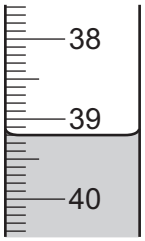
final reading

Experiment 2

Experiment 1 was repeated using methyl orange indicator instead of thymolphthalein.
Methyl orange is red-orange in acidic solutions and yellow in alkaline solutions.
Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

	experiment 1	experiment 2
final burette reading / cm^3		
initial burette reading / cm^3		
difference / cm^3		

[4]

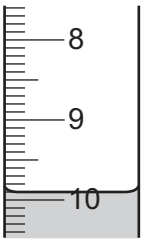
(b) What colour change was observed in the lask in experiment 2?

from ..... to ..... [1]

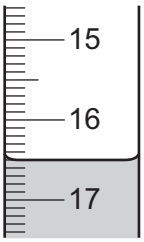
(c) *Experiment 3*

Experiment 1 was repeated using solution **B** of acid instead of solution **A**.

Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

	experiment 3
final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[2]

(d) Suggest **one** observation, other than colour change, that is made when hydrochloric acid is added to sodium carbonate.

..... [1]

(e) Complete the sentence below.

Experiment ..... needed the largest volume of hydrochloric acid to change the colour of the indicator. [1]

(f) What would be a more accurate method of measuring the volume of the aqueous sodium carbonate?

..... [1]

(g) What would be the effect on the results, if any, if the solutions of sodium carbonate were warmed before adding the hydrochloric acid? Give a reason for your answer.

effect on results .....

reason .....
[2]

(h) **(i)** Determine the ratio of volumes of dilute hydrochloric acid used in experiments 1 and 3.

..... [1]

(ii) Use your answer to **(h)(i)** to deduce how the concentration of solution **A** differs from that of solution **B**.

..... [1]

(i) Suggest a **different** method, using standard laboratory chemicals, to determine which of the solutions of dilute hydrochloric acid, **A** or **B**, is more concentrated.

.....

.....

.....

.....

..... [3]

[Total: 17]

3 Two substances, **C** and **D**, were analysed. Solid **C** was a salt and solution **D** was an aqueous solution of chromium(III) chloride.
The tests on solid **C**, and some of the observations, are in the following table.

tests	observations
<u>tests on solid **C**</u> Solid **C** was added to distilled water in a test-tube and shaken to dissolve. The solution was divided into two portions in test-tubes, and the following tests carried out. Appearance of the solution. The pH of the first portion of the solution was tested.	colourless liquid pH = 7
Dilute nitric acid was added to the second portion of the solution followed by aqueous silver nitrate.	cream precipitate
A flame test was carried out on solid **C**.	yellow flame colour

(a) Identify solid **C**.

..... [2]

(b) Describe the appearance of solution **D**.

..... [1]

(c) Tests were carried out on solution **D**.

Complete the observations for tests 1, 2 and 3.

(i) test 1

Drops of aqueous sodium hydroxide were added to solution **D**.

Excess aqueous sodium hydroxide was then added to the mixture.

observations .....

..... [3]

(ii) test 2

Excess aqueous ammonia was added to solution **D**.

observations ..... [2]

(iii) test 3

Dilute nitric acid was added to solution **D** followed by aqueous silver nitrate.

observations ..... [1]

(d) Chromium(III) can be converted to chromium(VI). Chromium(VI) is hazardous.

Suggest **one** safety precaution when using chromium(VI).

..... [1]

[Total: 10]

3 Two solids, **L** and **M**, were analysed. Solid **L** was copper(II) chloride and solid **M** was a different salt.
The tests on the solids, and some of the observations, are shown.

tests on solid L

(a) Describe the appearance of solid **L**.

observation ..... [1]

(b) Distilled water was added to solid **L** and shaken to dissolve.

The solution was divided into four equal portions in four test-tubes and the following tests carried out.

(i) Drops of aqueous ammonia were added to the first portion of the solution.

Excess ammonia solution was then added to the mixture and shaken.

observation .....

.....

.....

..... [4]

(ii) Excess aqueous sodium hydroxide was added to the second portion of the solution.

observation .....

..... [1]

(iii) Dilute nitric acid was added to the third portion of the solution followed by aqueous silver nitrate.

observation ..... [1]

(iv) Dilute nitric acid was added to the fourth portion of the solution followed by aqueous barium nitrate.

observation ..... [1]

tests on solid M

Tests are carried out and the following observations made.

tests on solid **M**	observations
Appearance of the solid.	white crystals
The solid was heated and the gas given off was tested with damp red litmus paper.	a sublimate formed on the sides of the test-tube litmus paper turned blue
Solid **M** was dissolved in water to form a solution. Aqueous sodium hydroxide was added to the solution and the mixture heated. The gas given off was tested.	pungent gas evolved pH paper showed pH 10
Dilute nitric acid was added to the solution followed by aqueous silver nitrate.	yellow precipitate

(c) Identify solid **M**.

.....

..... [2]

[Total: 10]

Question	Answer	Mark
2 (a)	final readings completed correctly: 13.2, 39.2; initial readings completed correctly: 0.0, 12.8; differences completed correctly: 13.2, 26.4; all readings and differences to 1 decimal place;	1 1 1 1
2 (b)	yellow to orange/red/pink	1
2 (c)	initial and final readings complete correctly: 9.9, 16.5 difference completed correctly: 6.6	1 1
2 (d)	bubbles/fizzing/effervescence	1
2 (e)	Experiment 2	1
2 (f)	use a pipette/burette	1
2 (g)	effect on results: none owtte reason: no change in concentration owtte	1 1
2 (h) (i)	2:1	1
2 (h) (ii)	acid **B** is double the concentration of acid **A** ora acid **B** is more concentrated ora	1
2 (i)	any suitable correct and different method M1 method M2 reagents M3 result	 1 1 1
		Total: 17
3 (a)	sodium bromide	1 1
3 (b)	green	1
3 (c) (i)	green precipitate with excess, green solution/clear/dissolves	1 1 1
3 (c) (ii)	grey-green precipitate	1 1
3 (c) (iii)	white precipitate	1
3 (d)	fume cupboard/protective clothing, e.g. gloves or goggles	1
		Total: 10

Question	Answer	Mark
3 (a)	white (solid/crystals/powder)	1
3 (b) (i)	no change	1
3 (b) (ii)	turns from purple/pink to colourless/white	1 1
3 (c)	yellow/orange (flame)	1
3 (d)	ammonia/NH_3	1
3 (e)	ammonium/NH_4^+	1
		Total: 7

Cambridge Assessment International Education

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5: Reaction rates – Topic questions

Paper 6

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
2	2016	June	62
2	2016	November	62
2	2016	March	62

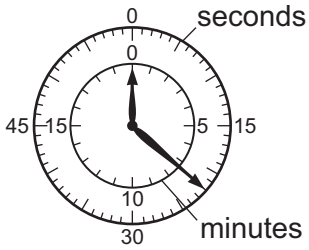
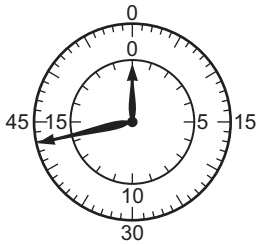
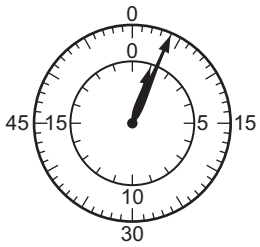
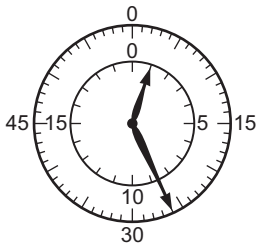
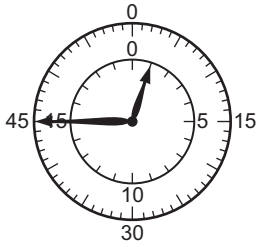
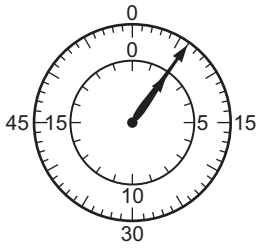
The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

2 A student investigated the rate of reaction between hydrogen peroxide and aqueous potassium iodide. When these chemicals react they form iodine. Sodium thiosulfate solution reacts with iodine and can be used to show how fast the reaction proceeds.

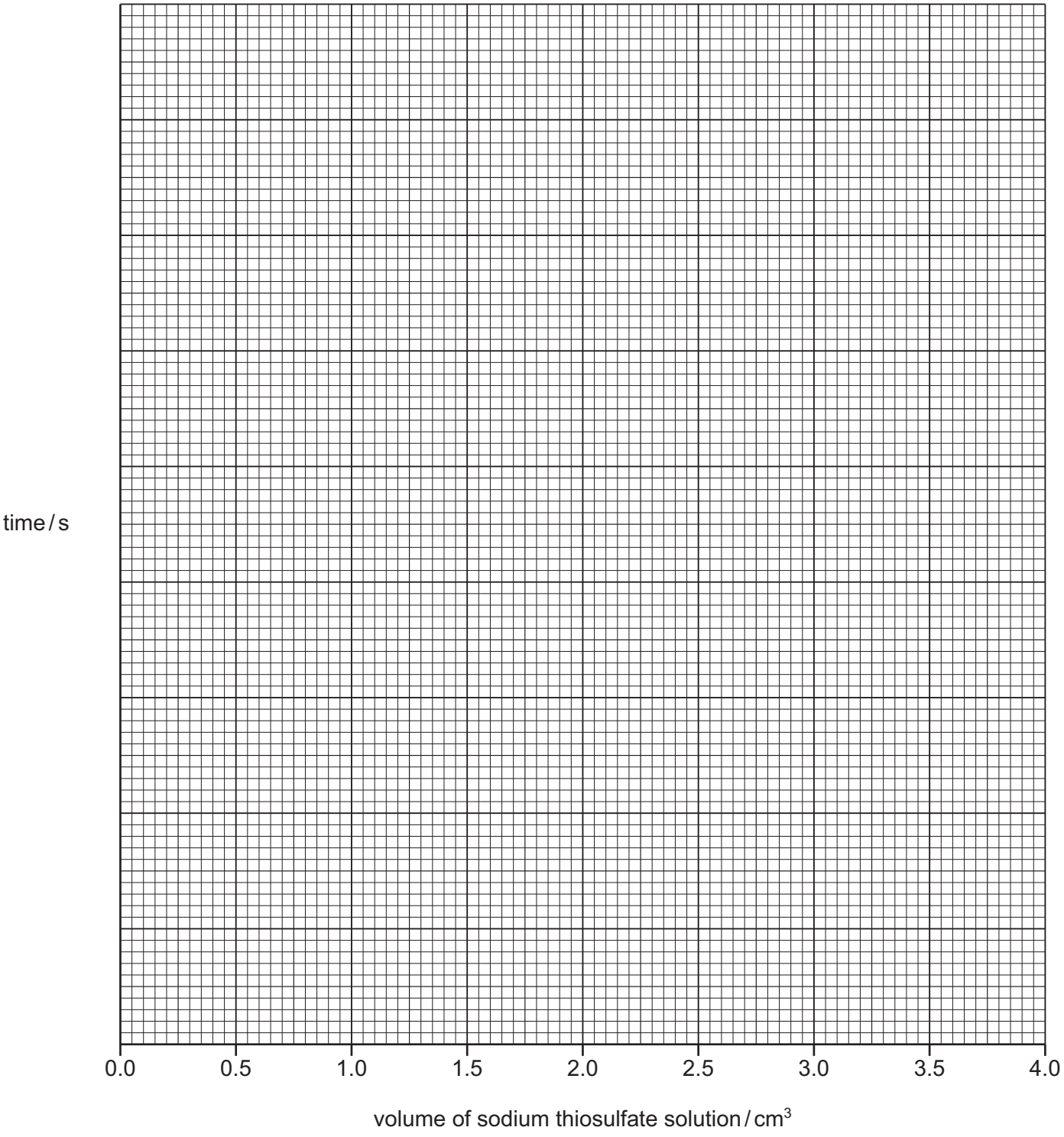
(a) A burette was filled up to the 0.0 cm^3 mark with sodium thiosulfate solution.
Using a large measuring cylinder, 100 cm^3 of distilled water were poured into a conical flask.
Using a small measuring cylinder, 6 cm^3 of sulfuric acid, 1 cm^3 of starch solution and 4 cm^3 of aqueous potassium iodide were added to the flask.
0.5 cm^3 of sodium thiosulfate solution was added from the burette to the mixture in the flask and swirled to mix.
The reaction was then started by adding 3 cm^3 of hydrogen peroxide solution to the mixture, and the timer started.
The time taken for a blue colour to appear was noted.
A further 0.5 cm^3 of sodium thiosulfate solution was added to the mixture in the conical flask, swirled and the blue colour disappeared. The time when the blue colour reappeared was noted.
The experiment continued by adding further 0.5 cm^3 portions of sodium thiosulfate solution until a total of 3.0 cm^3 of sodium thiosulfate solution had been added, noting the times at which the blue colour reappeared.

Use the timer diagrams on page 4 to record the times in seconds in the table.

total volume of sodium thiosulfate solution added / cm^3	timer diagram	time at which blue colour appeared / s
0.5		
1.0		
1.5		
2.0		
2.5		
3.0		

[3]

(b) Plot the results you have obtained on the grid and draw a best-fit straight-line graph.



[5]

(c) (i) **From your graph** deduce the time at which the blue colour would appear if a total of 4.0 cm^3 of sodium thiosulfate solution were added to the mixture in the conical flask.
Show clearly **on the grid** how you worked out your answer.

..... [3]

(ii) Sketch **on the grid** the graph you would expect if the experiment was repeated at a higher temperature. [1]

(d) Suggest the purpose of the starch solution.

..... [1]

(e) **(i)** Suggest **one** advantage of using a pipette to measure the volume of the hydrogen peroxide.

..... [1]

(ii) Suggest and explain **one** disadvantage of using a pipette to measure the volume of the hydrogen peroxide.

.....

..... [2]

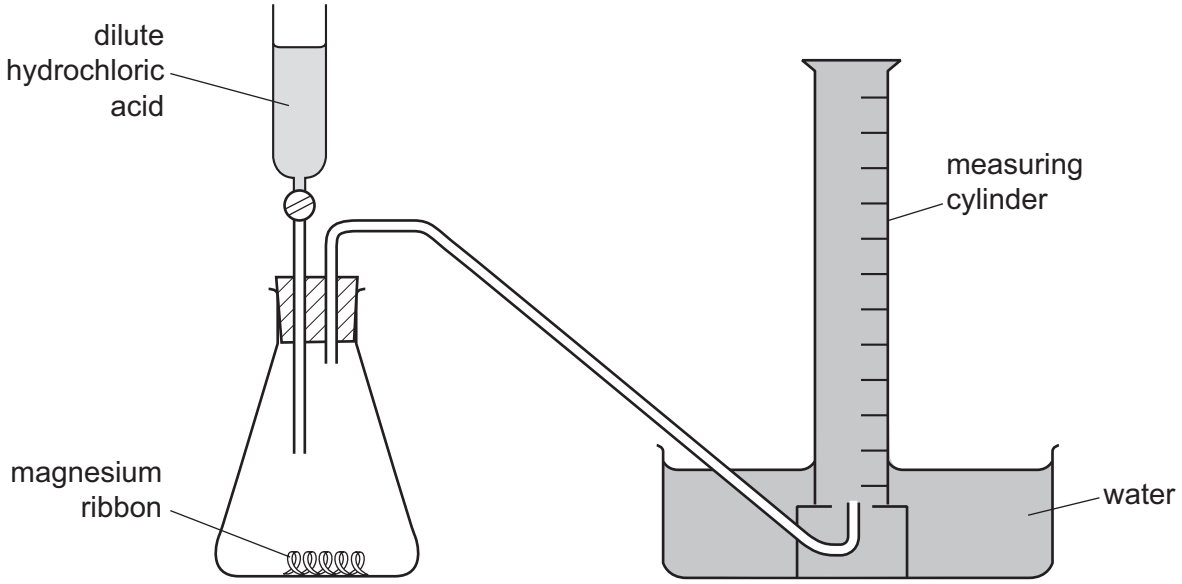
(f) Explain **one** disadvantage of using a beaker instead of a conical flask.

.....

..... [1]

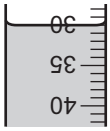
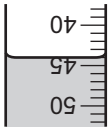
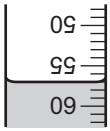
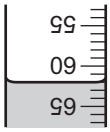
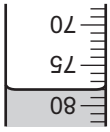
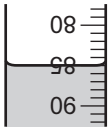
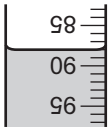
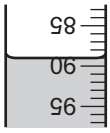
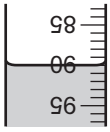
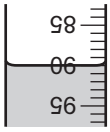
[Total: 17]

2 A student investigated the rate of reaction between dilute hydrochloric acid and excess magnesium at room temperature.
The apparatus was set up as shown in the diagram.



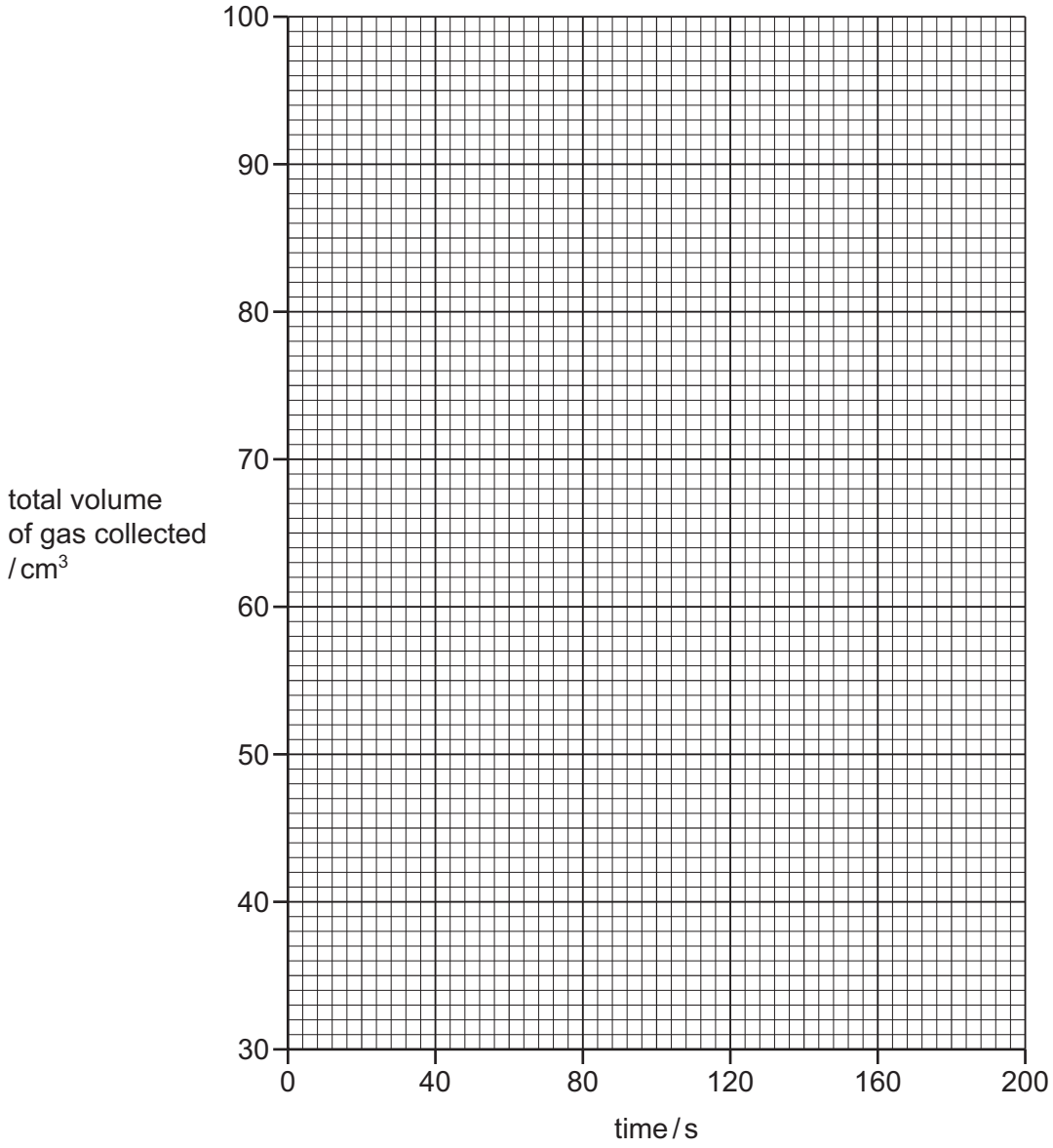
30 cm^3 of dilute hydrochloric acid were added to the conical flask containing magnesium ribbon. The timer was then started and the volume of gas collected in the measuring cylinder was measured every 20 seconds for 180 seconds (3 minutes).

(a) Use the measuring cylinder diagrams to record the total volume of gas collected in the table.

time / s	measuring cylinder diagram	total volume of gas collected / cm^3
0		30
20		
40		
60		
80		
100		
120		
140		
160		
180		

[2]

(b) Plot the results on the grid and draw a smooth line graph.



[3]

(c) (i) Which result is anomalous?

..... [1]

(ii) Suggest a possible reason for this anomalous result.

..... [1]

(iii) **Use your graph** to deduce the total volume of gas that you would have expected to collect instead of this anomalous volume.
Show clearly **on the grid** how you worked out your answer.

..... cm^3 [2]

(d) Explain why the total volume of gas collected does **not** increase after 160 seconds.

.....

..... [2]

(e) The average rate of the reaction can be calculated using the equation shown.

$$\text{average rate of reaction} = \frac{\text{volume of gas collected / cm}^3}{\text{time / s}}$$

(i) Calculate the volume of gas collected between 20 seconds and 40 seconds.

..... [1]

(ii) Calculate the average rate of reaction between 20 seconds and 40 seconds.
Include the unit.

average rate of reaction = ... [2]

(f) Room temperature was 20 °C.

Sketch **on the grid** the graph you would expect if the experiment were repeated at 30 °C. [2]

(g) Suggest why the reading on the measuring cylinder was 30 cm^3 after the acid had been added and before the timer had been started.

.....

..... [1]

(h) Suggest and explain **one** improvement to this experiment.

.....

.....

..... [2]

[Total: 19]

2 A teacher investigated the rate of a reaction between two solutions, **J** and **K**, and sulfuric acid at different temperatures.

Four experiments were carried out.

(a) *Experiment 1*

A large measuring cylinder was used to pour 50 cm^3 of distilled water and 40 cm^3 of sulfuric acid into a 250 cm^3 conical flask.
A small measuring cylinder was used to add 2 cm^3 of methyl orange and 5 cm^3 of solution **J** to the mixture in the conical flask. The temperature of the mixture was measured.
The reaction was started by adding 5 cm^3 of solution **K** to the conical flask, immediately starting the timer and swirling the mixture.
The time taken for the mixture to turn pale yellow was measured. The final temperature of the mixture was measured.

Experiment 2

Experiment 1 was repeated but the mixture in the conical flask was heated to about 30 °C **before** adding the solution **K**. The temperature of the mixture was measured.
5 cm^3 of solution **K** was added to the conical flask. The timer was started and the mixture swirled.
The time taken for the mixture to turn pale yellow was measured. The final temperature of the mixture was measured.

Experiment 3

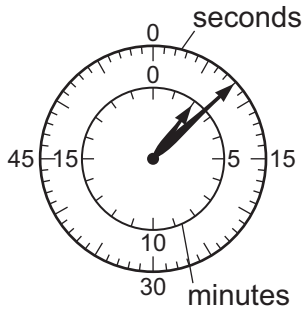
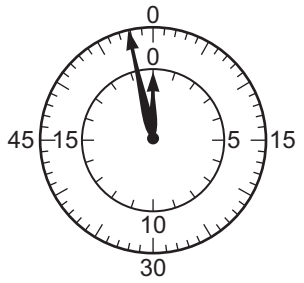
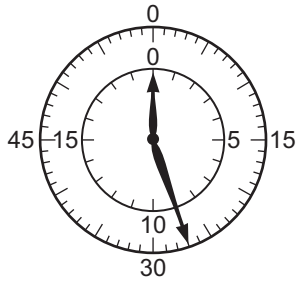
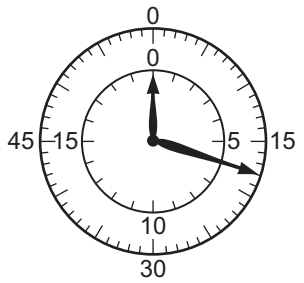
Experiment 1 was repeated but the mixture in the conical flask was heated to about 40 °C before adding the solution **K** to the flask. The same measurements were taken.

Experiment 4

Experiment 1 was repeated but the mixture in the conical flask was heated to about 50 °C before adding the solution **K** to the flask. The same measurements were taken.

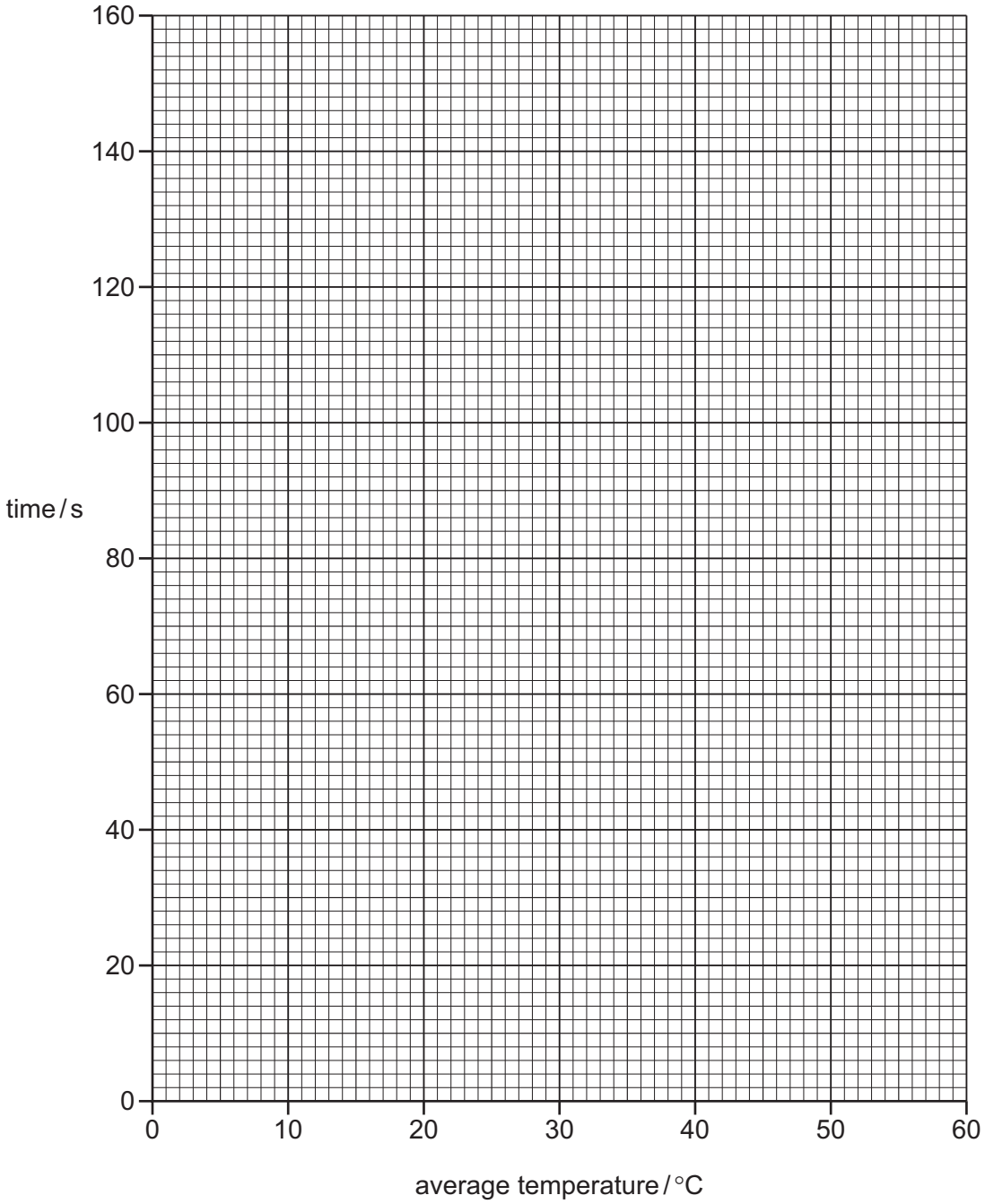
Use the stop-clock diagrams to record the times in the table.

Work out the average temperatures to complete the table.

experiment	stop-clock diagram	time taken for mixture to turn pale yellow / s	initial temperature / °C	final temperature / °C	average temperature / °C
1			17	15	
2			28	26	
3			42	40	
4			51	49	

[4]

(b) Plot the results on the grid and draw a smooth line graph.



[4]

(c) **From your graph** deduce the time taken for the mixture to turn pale yellow if Experiment 1 was repeated at an average temperature of 60 °C.
Show clearly **on the grid** how you worked out your answer.

..... [2]

(d) (i) In which experiment was the rate of reaction greatest?

..... [1]

(ii) Explain why the rate of reaction was greatest in this experiment.

.....

.....

..... [2]

(e) (i) Suggest and explain the effect **on the results** of using a burette to measure the volume of solution **J**.

.....

..... [2]

(ii) Suggest and explain one **other** improvement to these experiments.

.....

..... [2]

[Total: 17]

Question	Answer	Mark
2 (a)	all 6 times completed correctly (2 marks) (22, 43, 64, 86, 105, 126) 5 times completed correctly (1 mark); in seconds;	2 1
2 (b)	appropriate scale for y-axis / increasing at 20 s per large square; y-axis is a linear scale; all 6 points plotted correctly ± half a small square (2 marks); 5 points plotted correctly ± half a small square (1 marks); best-fit straight-line graph;	1 1 2 1
2 (c) (i)	value from graph ± half a small square (typically 167–170); units / s; extrapolation;	1 1 1
2 (c) (ii)	sketch line below original line and diverging	1
2 (d)	as an indicator	1
2 (e) (i)	(more) accurate	1
2 (e) (ii)	solution slow to run out of pipette difficult to know when to start time/reaction does not start at once/inaccurate time measurement owtte	1 1
		Total: 16
2 (a)	table of results volume boxes completed correctly (30), 44, 57, 62, 78, 85, 88, 89, 90, 90	2
2 (b)	all points correctly plotted smooth line graph	2 1
2 (c) (i)	point at 60 s / 62 cm^3 / fourth point / measurement 4	1
2 (c) (ii)	misread measuring cylinder/read too early	1
2 (c) (iii)	value from graph (68–70) shown clearly	1 1
2 (d)	the Reaction has finished all the acid has reacted/HC*l* is the limiting factor	1 1
2 (e) (i)	value from graph or table (57–44 = 13$cm^{3)}$	1
2 (e) (ii)	13/20 = 0.65 cm^3 / s	1 1
		Total: 14

Question	Answer	Mark
2 (a)	In each column 4 correct = [2] 3 correct = [1] average temperature boxes completed correctly: 16, 27, 41, 50 times completed in seconds correctly: 128, 58, 27, 18	4
2 (b)	all points plotted correctly = [3] smooth line graph	4
2 (c)	value from graph: 12–13s extrapolation	2
2 (d) (i)	Experiment 4	1
2 (d) (ii)	any **2** from: highest temperature more energy more (chance of) collisions	2
2 (e) (i)	more accurate than a measuring cylinder	2
2 (e) (ii)	insulation/use a lid; to reduce heat losses OR repeats; averages results OR measure water or sulfuric acid or methyl orange using a burette/use a 2 d.p. stopwatch/digital thermometer, reference to accuracy	2
		Total: 17

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6: Metals and the reactivity series – Topic questions

Paper 6

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
2	2016	June	63

The mark scheme for each question is provided at the end of the document.

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2 A student investigated what happens when dilute hydrochloric acid and copper(II) sulfate solution react with different metals.

Five experiments were carried out.

(a) *Experiment 1*

A measuring cylinder was used to pour 10 cm^3 of dilute hydrochloric acid into a boiling tube.
The temperature of the hydrochloric acid was measured.
1 g of zinc was added to the boiling tube and the mixture stirred with a thermometer.
The maximum temperature reached by the mixture was measured.

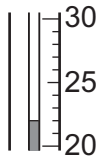
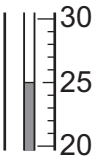
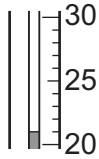
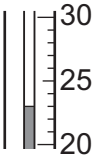
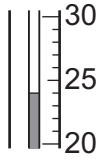
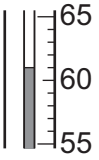
Experiment 2

Experiment 1 was repeated using 1 g of iron instead of zinc.

Experiment 3

Experiment 1 was repeated using 1 g of magnesium instead of zinc.

Use the thermometer diagrams to record the results in the table. Complete the final column in the table.

experiment	thermometer diagram	initial temperature of acid / °C	thermometer diagram	maximum temperature reached / °C	temperature rise / °C
1					
2					
3					

[3]

(b) The gas produced in experiment 3 was tested with a lighted splint and the result recorded below.

test ...lighted splint.....

result ...popped.....

Name the gas given off in experiment 3.

..... [1]

(c) *Experiment 4*

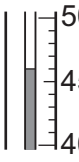
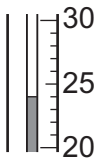
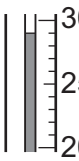
A measuring cylinder was used to pour 10 cm^3 of copper(II) sulfate solution into a boiling tube.
The temperature of the solution was measured.
1 g of magnesium was added to the boiling tube and the mixture stirred with a thermometer.
The maximum temperature reached by the mixture was measured.

Experiment 5

Experiment 4 was repeated using 1 g of iron instead of magnesium.
The observation was recorded below.

.....The solution turned colourless and a brown deposit formed.....

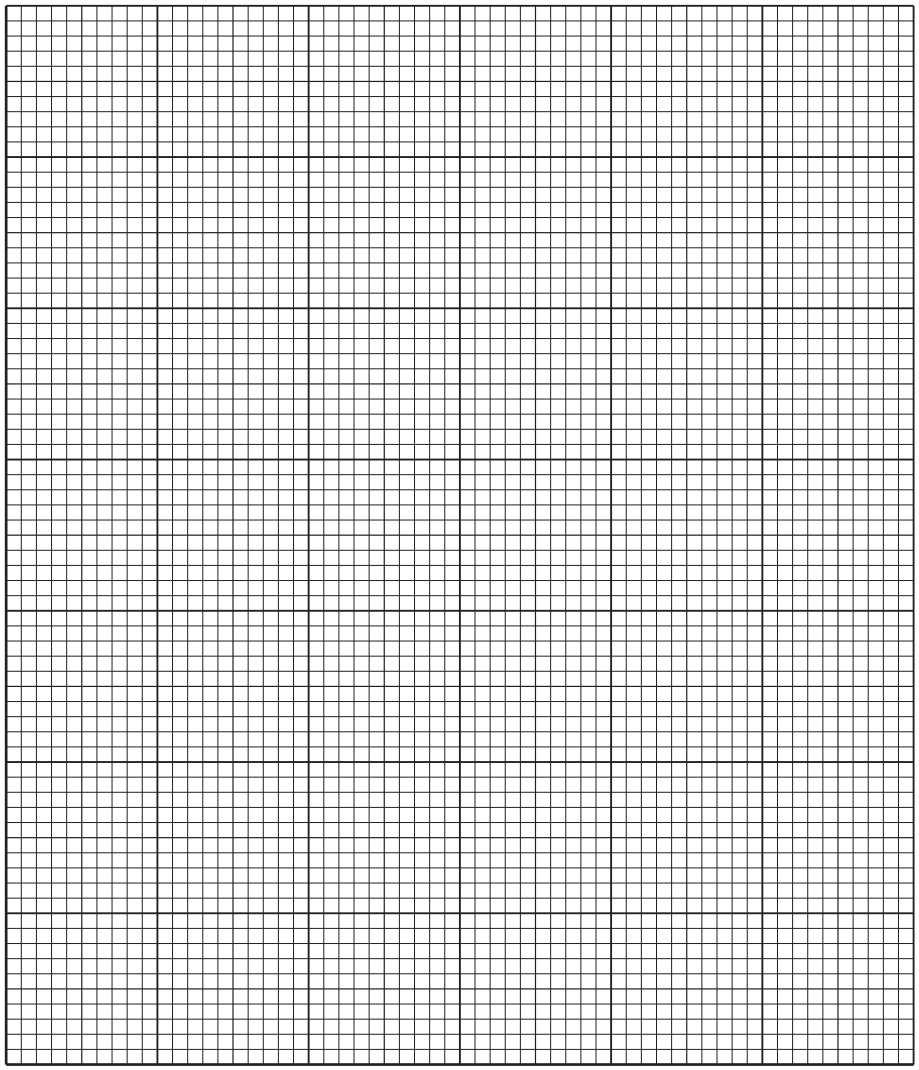
Use the thermometer diagrams to record the results in the table. Complete the final column in the table.

experiment	thermometer diagram	initial temperature of acid / °C	thermometer diagram	maximum temperature reached / °C	temperature rise / °C
4					
5					

[2]

(d) Draw a labelled bar chart for the results of experiments 1, 2, 3, 4 and 5 on the grid below.

temperature rise / °C



[3]

(e) Use the results for experiments 1, 2 and 3 to answer the following questions.

(i) Which experiment, 1, 2 or 3, produced the largest temperature rise?

..... [1]

(ii) Suggest why this experiment produced the largest temperature rise.

.....

..... [1]

(f) Explain the observations in experiment 5.

.....

.....

..... [2]

(g) Suggest why potassium was **not** used as one of the metals in these experiments.

..... [1]

(h) Give **one** advantage of using a measuring cylinder to add the hydrochloric acid to the boiling tube.

..... [1]

(i) Suggest and explain **one** improvement to increase the accuracy of these experiments.

.....

.....

..... [2]

[Total: 17]

Question	Answer	Mark
2 (a)	initial temperature boxes completed correctly: 22, 21, 24; maximum temperature boxes completed correctly: 25, 23, 61; temperature differences completed correctly: 3, 2, 37;	1 1 1
2 (b)	hydrogen	1
2 (c)	all temperature boxes completed correctly: 21, 46 and 24, 29; differences completed correctly: 25, 5;	1 1
2 (d)	y-axis scale linear and highest temperature change over half way up y-axis all 5 bars at the correct height; bars clearly labelled;	1 1 1
2 (e) (i)	experiment 3	1
2 (e) (ii)	magnesium is the most reactive metal	1
2 (f)	copper formed iron is more reactive/displacement reaction	1 1
2 (g)	potassium is too reactive/dangerous	1
2 (h)	quick/easy to use	1
2 (i)	insulate / lag tube / use a lid; to reduce heat losses; OR use a pipette / burette; instead of measuring cylinder / more accurate;	1 1 1 1
		Total: 19

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8: Organic 1 – Topic questions

Paper 6

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

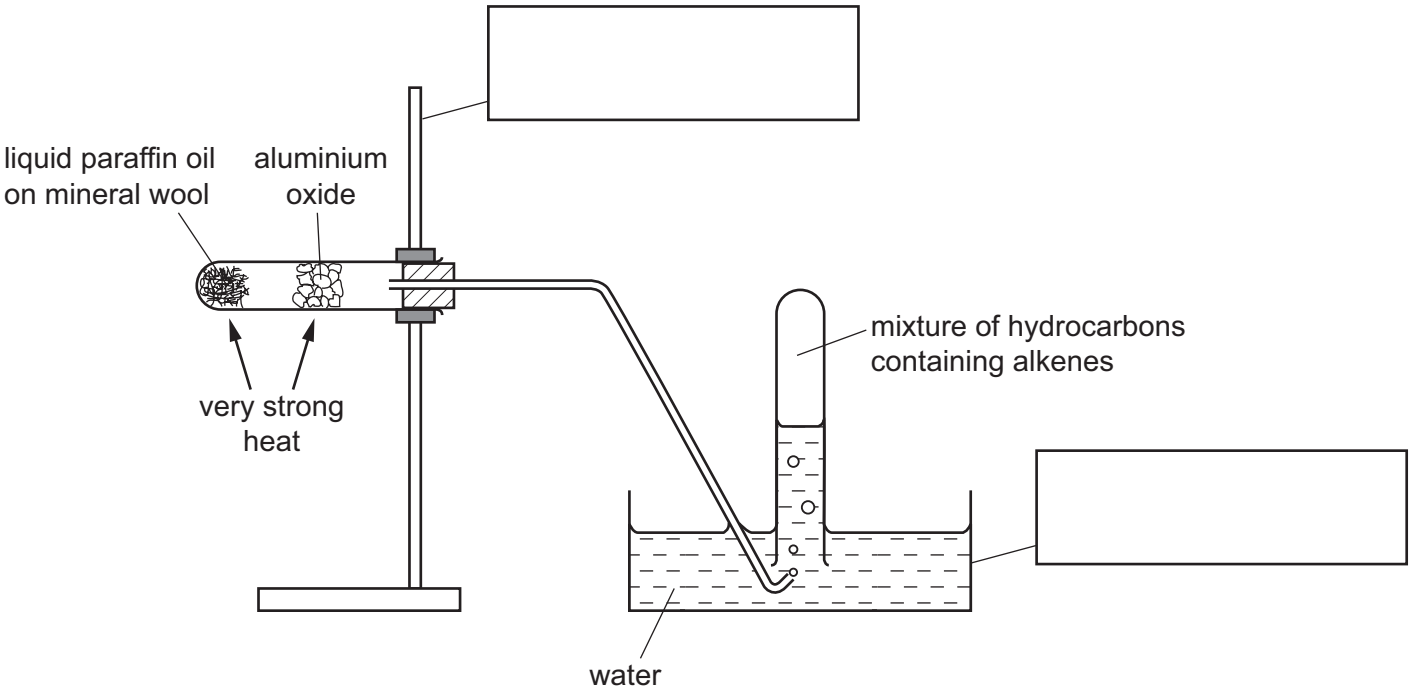
Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
1	2016	November	63

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

1 The diagram shows the apparatus used to crack paraffin oil. Paraffin oil vapour is passed over heated aluminium oxide to produce a mixture of hydrocarbons containing alkenes.



(a) Complete the boxes to name the apparatus. [2]

(b) What is the purpose of the mineral wool?

.....

..... [1]

(c) Give a test to show the presence of alkenes.

test .....

result .....

[2]

(d) Why must the delivery tube be removed from the water when the heating is stopped?

..... [1]

[Total: 6]

Question	Answer	Mark
1 (a)	(clamp/retort) stand trough	1 1
1 (b)	to absorb/hold/keep/soak up/contain paraffin oil	1
1 (c)	M1 bromine (aqueous cyclohexane) M2 turns colourless/decolourised	1 1
1 (d)	to prevent suck back (of water)	1
		Total: 6

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11: Redox, electrochemistry and Group VII – Topic questions

Paper 6

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

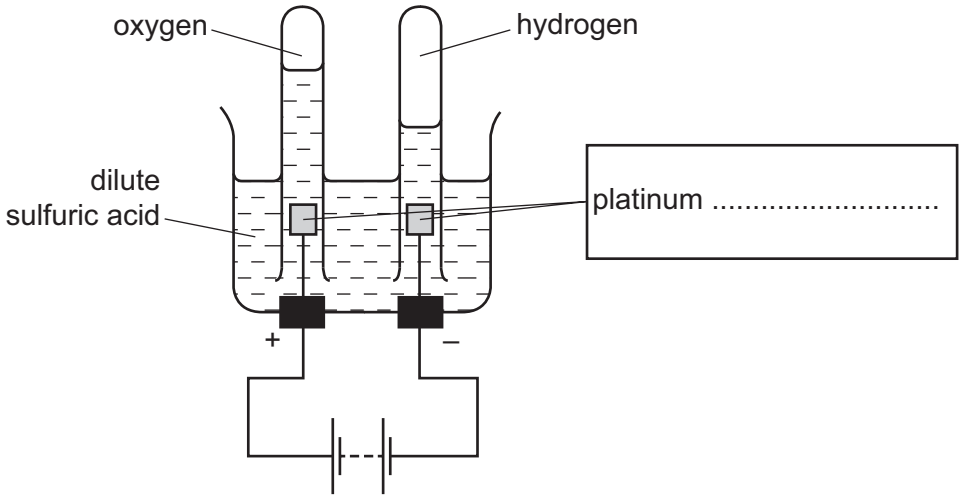
Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
1	2016	November	61
4	2016	November	62

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

1 The diagram shows the apparatus used to electrolyse dilute sulfuric acid.



(a) Complete the box to show the role of the platinum. [1]

(b) Give **one** observation made during this electrolysis.

..... [1]

(c) **(i)** Compare the volumes of oxygen and hydrogen produced.

.....

..... [2]

(ii) Which substance breaks down to form these gases?

..... [1]

(d) Give **one** test to distinguish between oxygen and hydrogen.

test

result with oxygen .....

result with hydrogen .....
[2]

[Total: 7]

4 Metal rings can be coated with a layer of copper using electricity.
Plan an experiment to electroplate a small metal ring with copper.
You are provided with common laboratory apparatus, a copper rod, copper(II) sulfate crystals, water and a small metal ring.
Include a labelled diagram in your answer.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 6]

Question	Answer	Mark
1 (a)	electrodes	1
1 (b)	bubbles/fizz/effervescence	1
1 (c) (i)	more hydrogen twice as much hydrogen/half as much oxygen	1 1
1 (c) (ii)	water	1
1 (d)	*lighted splint* no effect/brighter for oxygen 'pops' for hydrogen **OR** *glowing splint* relights for oxygen no effect for hydrogen	 1 1 1 1
		Total: 7
4	clean/sandpaper the metal ring dissolve copper(II) sulfate in water/copper(II) sulfate solution set up circuit/switch on electricity/complete circuit copper rod anode (+ve electrode) metal ring cathode (-ve cathode) rotate the metal ring/agitate remove the metal ring, wash and dry	6
		Total: 6