edexcel

GCSE (9-1) Chemistry

Sample Assessment Materials

Pearson Edexcel Level 1/Level 2 GCSE (9-1) in Chemistry (1CH0)

First teaching from September 2016

First certification from June 2018

Issue 1

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Contents

Introduction

The Pearson Edexcel Level 1/Level 2 GCSE (9-1) in Chemistry is designed for use in schools and colleges. It is part of a suite of GCSE qualifications offered by Pearson.

These sample assessment materials have been developed to support this qualification and will be used as the benchmark to develop the assessment students will take.

General marking guidance

- All candidates must receive the same treatment. Examiners must mark the last candidate in exactly the same way as they mark the first.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than be penalised for omissions.
- Examiners should mark according to the mark scheme – not according to their perception of where the grade boundaries may lie.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification/indicative content will not be exhaustive.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, a senior examiner must be consulted before a mark is given.
- Crossed-out work should be marked **unless** the candidate has replaced it with an alternative response.

Subject specific marking guidance

Symbols, terms used in the mark scheme

- Round brackets ( ): words inside round brackets are to aid understanding of the marking point but are not required to award the point
- Curly brackets { }: indicate the beginning and end of a list of alternatives (separated by obliques) where necessary to avoid confusion
- Oblique /: words or phrases separated by an oblique are alternatives to each other and either answer should receive full credit.
- ecf: indicates error carried forward which means that a wrong answer given in an early part of a question is used correctly to a later part of a question.

You will not see 'owtte' (or words to that effect). Alternative correct wording should be credited in every answer unless the ms has specified specific.

The Additional Guidance column is used for extra guidance to clarify any points in the mark scheme. It may be used to indicate:

- what will not be accepted for that marking point in which case the phrase 'do not accept' will be alongside the relevant marking point
- it might have examples of possible acceptable answers which will be adjacent to that marking point

Specific Marking Guidance for Levels Based Mark Schemes

Step 1 – Finding the right level

The first stage is to decide which level the answer should be placed in. Examiners should first make a holistic judgement on which level most closely matches the student response and place it within that level. Students will be placed in the level that best describes their answer.

Answers can display characteristics from more than one level, and where this happens examiners must use their professional judgement to decide which level is most appropriate using a 'best-fit' approach. For example if a student's work mainly evidences the skills of level 2 but has some level 3 skills present the response would be placed in level 2 but the mark awarded would be towards the top of level 2, reflecting the evidence given from level 3.

Step 2 – Determining the mark

After a level has been decided on, the next stage is to decide on the mark within the level. The instructions below tell you how to reward responses within a level. Examiners should be prepared to use the full range of marks available in a level and not restrict marks to the middle.

Examiners should start at the middle of the level (or the upper middle mark if there is an even number of marks) and then move the mark up or down to find the best mark.

To do this, you should take into account how far the answer meets the requirements of the level:

- If it meets the requirements fully, you should be prepared to award full marks within the level. The top mark in the level is used for answers that are as good as can realistically be expected within that level.
- If it only barely meets the requirements of the level, examiners should consider awarding marks at the bottom of the level. The bottom mark in the level is used for answers that are the weakest that can be expected within that level.
- The middle marks of the level are used for answers that have a reasonable match to the descriptor. This might represent a balance between some characteristics of the level that are fully met and others that are only barely met.

Write your name here

Surname	Other names

Pearson Edexcel
Level 1/Level 2 GCSE (9-1)

Centre Number	Candidate Number

Chemistry

Paper 1

Foundation Tier

Sample Assessment Materials for first teaching September 2016

Time: 1 hour 45 minutes

Paper Reference
1CH0/1F

You must have:
Calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- Calculators may be used.
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

Information

- The total mark for this paper is 100
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an asterisk (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

S50045A

S 5 0 0 4 5 A 0 1 3 2

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Answer ALL questions. Write your answers in the spaces provided.

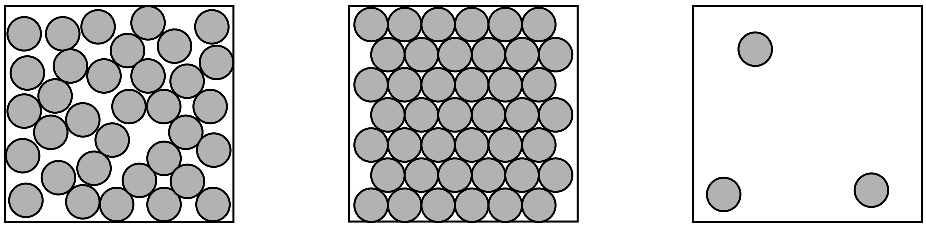
Some questions must be answered with a cross in a box ☒.
If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 There are three states of matter, solid, liquid and gas.

(a) The three boxes in Figure 1 show the arrangement of particles in different states.

(i) Under each box write the name of the state of matter shown.

(2)



....

Figure 1

(ii) A student is given some solid wax.

Use words from the box to name **two** pieces of equipment that the student should use to convert the solid wax into a liquid.

Bunsen burner	test tube	filter funnel
burette	pipette	

(2)

1 ....

2 ....

(b) Some liquid is left in a warm room.

After a few days no liquid can be seen.

Give the name of the process that has occurred.

(1)

....

(c) The freezing point of water is 0 °C.

(i) Describe how the movement and arrangement of water particles changes when water is cooled from 10 °C to –10 °C.

(2)

....

....

....

....

(ii) What is the structure of water?

(1)

☒ **A** ionic

☒ **B** simple molecular (covalent)

☒ **C** giant covalent

☒ **D** metallic

(Total for Question 1 = 8 marks)

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2 Ammonium phosphate and ammonium sulfate are made from ammonia.

These compounds can be used as fertilisers.

(a) Ammonia solution is alkaline.

Which of the following could be used to show that ammonia solution is alkaline?

(1)

- ☒ **A** conical flask
- ☒ **B** pH meter
- ☒ **C** pipette
- ☒ **D** thermometer

(b) Give **one** advantage of using fertilisers made from ammonia rather than using manure.

(1)

....

....

(c) The fertiliser ammonium phosphate was made by reacting ammonia solution with dilute phosphoric acid.

(i) In the first step, 25 cm^3 of dilute phosphoric acid was placed in a beaker.

Give the name of a piece of apparatus that could be used to measure out the 25 cm^3 dilute phosphoric acid.

(1)

....

(ii) Complete the word equation for this reaction.

(1)

ammonia + ... → ....

(iii) Some ammonium phosphate solution was made.

Describe how pure, dry crystals of ammonium phosphate are obtained from the ammonium phosphate solution.

(2)

....

....

....

....

(d) The formula of ammonium sulfate is $(NH_4)_2SO_4$.

What is the empirical formula of ammonium sulfate?

(1)

- ☒ **A** NHSO
- ☒ **B** NH_2SO_2
- ☒ **C** NH_4SO_4
- ☒ **D** $N_2H_8SO_4$

(Total for Question 2 = 7 marks)

3 Unreactive metals are found as uncombined metals in the Earth's crust.

(a) Which of the following metals is found uncombined in the Earth's crust?

(1)

☒ **A** aluminium

☒ **B** gold

☒ **C** sodium

☒ **D** zinc

(b) When iron oxide is heated with carbon, iron is produced.

(i) Complete the word equation for the reaction.

(2)

iron oxide + carbon → .... + ...

(ii) What happens to the iron oxide during this reaction?

(1)

☒ **A** the iron oxide burns

☒ **B** the iron oxide is neutralised

☒ **C** the iron oxide is oxidised

☒ **D** the iron oxide is reduced

(c) Copper ore contains copper carbonate, $CuCO_3$.

In the first stage of the extraction process, the copper carbonate is decomposed by heating to form copper oxide, CuO, and carbon dioxide.

$$CuCO_3 \rightarrow CuO + CO_2$$

When 100 g of copper carbonate is decomposed completely in this way, it is found that the total mass of products is 100 g.

Give a reason why the starting mass of copper carbonate is **always** the same as the mass of the products formed.

(1)

....

....

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(d) Zinc can be extracted from its ore by electrolysis or by heating the ore with carbon.

Give a reason for the method that is used.

(1)

....

....

(e) Figure 2 gives information about aluminium and tin.

metal	cost of 1 kg / £	amount in Earth's crust / %
aluminium	1.31	8
tin	12.60	0.0002

Figure 2

Give **two** reasons why it could be more important to recycle tin than to recycle aluminium. Use the information in Figure 2.

(2)

Reason 1

....

....

Reason 2

....

....

(Total for Question 3 = 8 marks)

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4 An electrolysis experiment is carried out on different solutions, **J**, **K** and **L**.

Electricity is passed through each solution as shown in Figure 3.

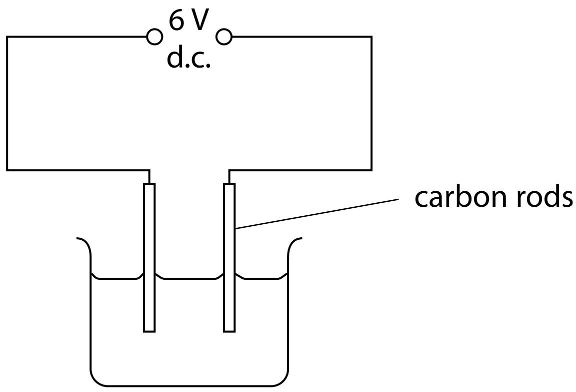

Figure 3

Any products formed at the electrodes are identified.

The results are given in Figure 4.

solution	solution conducts electricity	product at cathode	product at anode
J	yes	copper	chlorine
K	no	none	none
L	yes	hydrogen	chlorine

Figure 4

(a) (i) State an improvement that can be made to the circuit to show that a current is flowing during the electrolysis.

(1)

....

Some of these solutions are electrolytes.

(ii) State what is meant by the term **electrolyte**.

(2)

....

....

....

....

(iii) Which of **J**, **K** and **L** are electrolytes?

(1)

☒ **A** **K** only

☒ **B** **J** and **L** only

☒ **C** **K** and **L** only

☒ **D** **J**, **K** and **L**

(b) Copper sulfate solution was electrolysed for five minutes using copper electrodes.

Figure 5 shows the mass of the anode and of the cathode before electrolysis and after electrolysis.

	anode	**cathode**
mass of electrode before electrolysis / g	1.16	1.28
mass of electrode after electrolysis / g	0.85	1.57

Figure 5

Calculate the mass of copper deposited.

(2)

mass of copper deposited = ... g

(c) Identify the products formed at the anode and cathode when molten potassium iodide is electrolysed.

(2)

Anode ....

Cathode ....

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(d) In a different electrolysis, molten sodium fluoride is decomposed.

$$2NaF \rightarrow 2Na + F_2$$

(relative atomic masses: F = 19, Na = 23)
(relative formula mass NaF = 42)

Calculate the maximum mass of sodium that could be formed from 168 g of sodium fluoride.

(2)

mass = ... g

(Total for Question 4 = 10 marks)

5 (a) Give **two** advantages for electroplating some metal objects.

(2)

....

....

(b) Solder is an alloy of tin and lead.

A sample of a solder was made by mixing 22.5 g of lead with 15.0 g of tin.

Calculate the percentage of tin in this solder.

(2)

percentage of tin = ... %

(c) The rusting of an iron nail was investigated by setting up three test tubes, as shown in Figure 6.

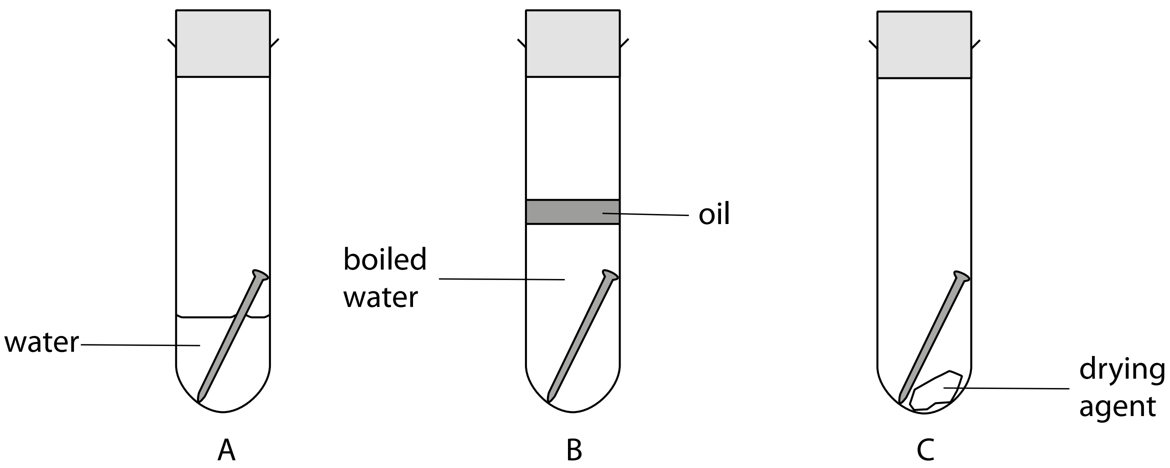

Figure 6

State and justify the result you would see in each tube after one week.

(3)

A ....

....

B ....

....

C ....

....

(d) An iron bucket is coated in zinc.
Over many years of use, the iron bucket has been scratched and left outside in the rain. Although some of the zinc coating has been removed to expose iron, the iron bucket has not rusted.

Explain why the iron has not rusted.

(2)

....

....

....

....

(Total for Question 5 = 9 marks)

6 The apparatus in Figure 7 shows a piece of magnesium ribbon being heated.

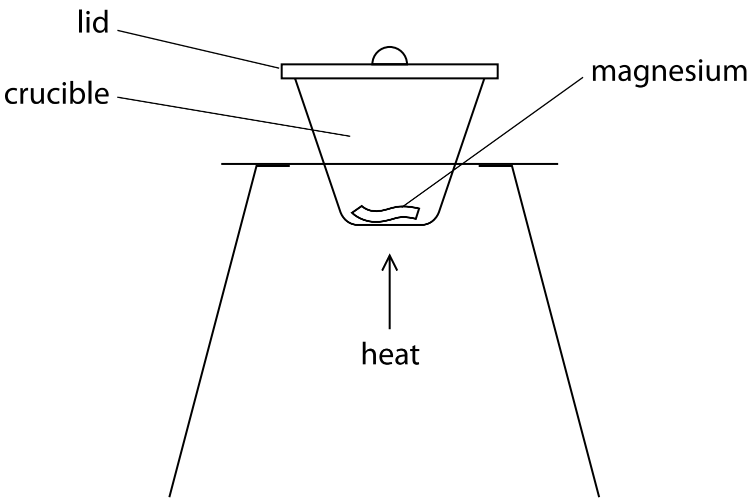

Figure 7

During the heating, the magnesium reacts with oxygen from the air. The lid of the crucible was raised slightly from time to time. Magnesium oxide was formed as a white powder. The experiment was repeated with different masses of magnesium.

The results are shown in Figure 8.

experiment	mass of magnesium used / g	mass of magnesium oxide formed / g	mass of oxygen in magnesium oxide / g
1	0.10	0.16	0.06
2	0.15	0.24	0.09
3	0.25	0.40	0.15
4	0.30	0.48	0.18
5	0.35	0.49	0.14
6	0.50	0.80	0.30

Figure 8

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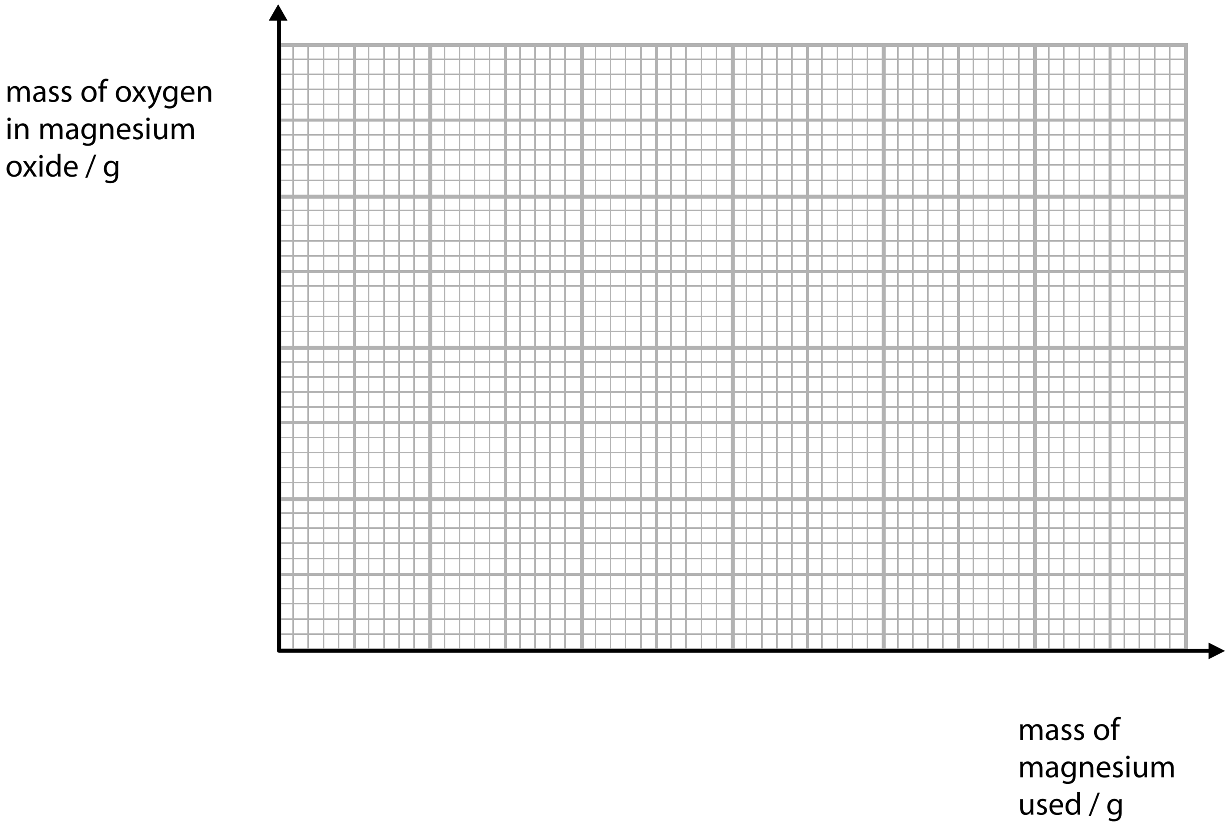
(a) (i) Draw a graph of the mass of oxygen in magnesium oxide against the mass of magnesium used.

(3)



(ii) The result for experiment 5 is anomalous.
The masses were all measured accurately.

Suggest a reason for this anomalous result.

(1)

....

....

(b) Balance the equation for the reaction of magnesium with oxygen to form magnesium oxide.

(1)

.... Mg + ... O_2 → .... MgO

(c) Calcium nitrate contains calcium ions and nitrate ions.

Calculate the relative formula mass of calcium nitrate, $Ca(NO_3)_2$.
(relative atomic masses: Ca = 40, N = 14, O = 16)

(2)

relative formula mass = ...

(d) Two oxides of lead, **R** and **S**, were analysed.

The empirical formula of oxide **R** was found to be PbO.

The results of the analysis of oxide **S** showed it contained 0.207 g of lead combined with 0.032 g of oxygen.

Show, by calculation, that the two oxides had different empirical formulae.
(relative atomic masses: O = 16, Pb = 207)

(3)

(Total for Question 6 = 10 marks)

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7 Substances can be pure or they can be mixtures.

(a) Which of these is a mixture?

(1)

☒ **A** chlorine

☒ **B** sodium

☒ **C** sodium chloride

☒ **D** sodium chloride solution

(b) Figure 9 shows some mixtures to be separated and possible methods of separation.

Place a tick (✓) in one box in each row of the table to show the best method to separate the first named substance from each of the mixtures.

(3)

substance to separate	**method of separation**			
	crystallisation	**filtration**	**simple distillation**	**fractional distillation**
sand from a mixture of sand and sodium chloride solution				
copper sulfate crystals from copper sulfate solution				
useful liquids from crude oil				

Figure 9

(c) Paper chromatography was used to separate a mixture of blue and red inks. A spot of the mixture was placed on chromatography paper as shown in Figure 10.

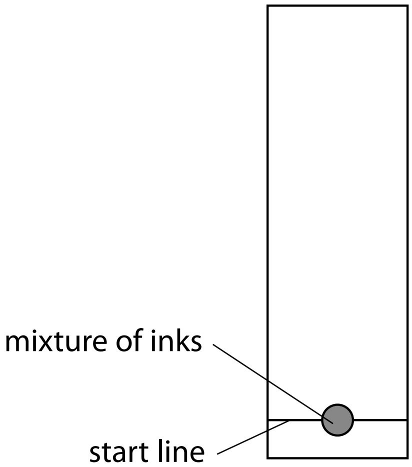

Figure 10

(i) Give a reason why the start line is drawn in pencil rather than in ink.

(1)

....

....

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(ii) The chromatography paper, with the spot of mixture on it, was placed in a beaker with the bottom of the paper in solvent.

On Figure 11, complete the diagram showing the position of the chromatography paper with the spot of mixture at the start of the experiment.

(1)

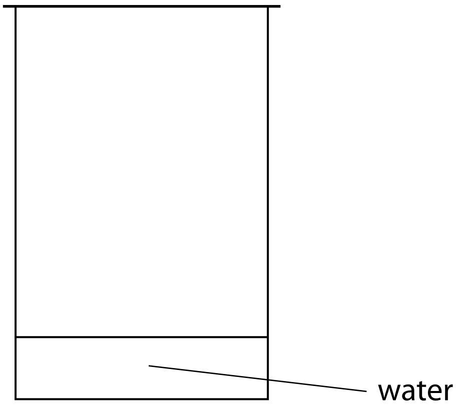

Figure 11

(iii) The chromatography was carried out and the result is shown in Figure 12.

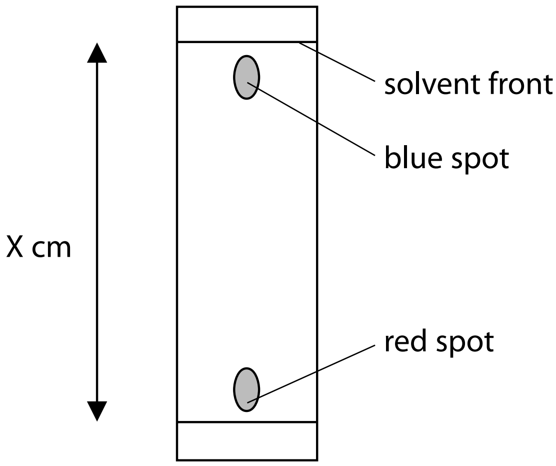

Figure 12

The blue spot had moved 14.5 cm and the solvent front had moved 15.3 cm.

Calculate the R_f value of the substance in the blue spot, giving your answer to 2 significant figures.

$$R_f \text{ value} = \frac{\text{distance travelled by a dye}}{\text{distance travelled by solvent front}}$$

(2)

R_f value = ...

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(d) P, Q, R and S are mixtures of food colourings.

They are investigated using paper chromatography.

Figure 13 shows the chromatogram at the end of the experiment.

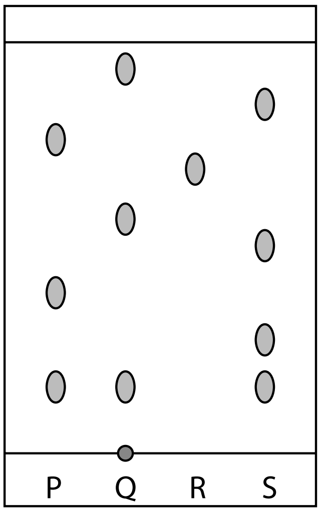

Figure 13

(i) Which mixture contains an insoluble food colouring?

(1)

☒ **A** mixture **P**

☒ **B** mixture **Q**

☒ **C** mixture **R**

☒ **D** mixture **S**

(ii) Give a change that could be made to the experiment to obtain an R_f value for the insoluble colouring.

(1)

....

....

(iii) Explain, by referring to Figure 13, which mixture is separated into the greatest number of soluble food colourings by this chromatography experiment.

(2)

....

....

....

....

(Total for Question 7 = 12 marks)

8 A titration is to be carried out to find the concentration of a solution of sodium hydroxide.

The sodium hydroxide solution is titrated with dilute sulfuric acid.

The available apparatus includes a burette, a pipette, a funnel, a conical flask and an indicator.

(a) State one safety precaution that must be taken when using sodium hydroxide solution and dilute sulfuric acid.

(1)

....

....

....

(b) The sodium hydroxide solution is made by dissolving 4.3 g of sodium hydroxide in water and making the solution up to 250 cm^3 with water.

Calculate the concentration of the solution in g dm^{-3}.

(2)

concentration = ... g dm^{-3}

(c) Write the balanced equation for the reaction of dilute sulfuric acid, H_2SO_4, with sodium hydroxide.

(2)

....

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(d) The results of titrations to determine how much of an acid is required to neutralise a given volume of an alkaline solution are shown in Figure 14.

	titration 1	titration 2	titration 3	titration 4
final burette reading (cm^3)	27	27.40	29.20	29.30
initial burette reading (cm^3)	0	2.10	4.00	3.50
volume of acid used (cm^3)	27	25.30	25.20	25.80

Figure 14

Two of the titrations in Figure 14 should **not** be used to calculate the mean volume of acid required.

Identify each titration and give a reason why it should not be used in the calculation of the mean.

(2)

....

....

....

....

*(e) Describe the experimental procedure to carry out a titration to find the exact volume of sulfuric acid needed to neutralise 25.0 cm^3 of sodium hydroxide solution and obtain pure, dry crystals of sodium sulfate.

(6)

(Total for Question 8 = 13 marks)

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9 Ionic compounds contain ions.

(a) The numbers of electrons, neutrons and protons in four particles, **W**, **X**, **Y** and **Z**, are shown in Figure 15.

particle	electrons	neutrons	protons
W	9	10	9
X	10	14	12
Y	16	16	16
Z	18	18	16

Figure 15

Explain which particle, **W**, **X**, **Y** or **Z**, is a negative ion.

(2)

....

....

....

....

(b) Lithium fluoride, LiF, is an ionic compound.

It contains lithium cations and fluoride anions.

The electronic configurations of a lithium atom and of a fluorine atom are shown in Figure 16.

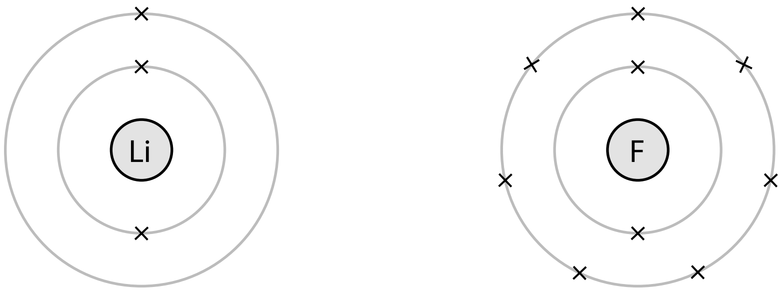

Figure 16

Complete Figure 17 to show the electronic configurations and charges of the ions in lithium fluoride.

(4)

charge on ion ....   charge on ion ....

Figure 17

*(c) Figure 18 shows the ability of different substances to conduct electricity.

substance	conducts electricity
solid calcium chloride	no
molten calcium chloride	yes
diamond	no
zinc	yes

Figure 18

Explain these results by referring to the structures of the substances.

(6)

(Total for Question 9 = 12 marks)

10 The method used to prepare a salt depends on its solubility in water.

(a) Complete Figure 19 by placing one tick in each row to show whether the salt is soluble or insoluble.

(2)

salt	soluble	insoluble
ammonium chloride		
lithium sulfate		
magnesium carbonate		

Figure 19

(b) Lead nitrate solution mixed with sodium sulfate solution forms lead sulfate as a precipitate.

$$Pb(NO_3)_2 + Na_2SO_4 \rightarrow PbSO_4 + 2NaNO_3$$

In an experiment, the theoretical yield of lead sulfate for this reaction was 2.85 g. In the experiment only 2.53 g of lead sulfate is obtained.

Calculate the percentage yield of lead sulfate in this experiment.

Give your answer to two significant figures.

(3)

percentage yield = ... %

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(c) The method used to make the lead sulfate is:

- pour 100 cm^3 lead nitrate solution into a beaker
- add drops of sodium sulfate solution until a precipitate is seen
- allow the precipitate to settle to the bottom of the beaker
- pour off the liquid
- use a spatula to transfer the solid lead sulfate onto a filter paper.

Explain **two** ways of improving this experimental method in order to increase the amount and quality of lead sulfate that could be obtained from 100 cm^3 of lead nitrate solution.

(4)

....

....

....

....

....

....

....

....

(d) Ammonium nitrate is produced from ammonia and nitric acid on a large scale in industry.

Ammonium nitrate can also be made in the laboratory by titrating ammonia solution with dilute nitric acid.

$$NH_3 + HNO_3 \rightarrow NH_4NO_3$$

Ammonium nitrate crystals can then be obtained by evaporating off some of the water from the solution.

Give **two** reasons why this laboratory method is not suitable for use on a large scale in industry.

(2)

....

....

....

....

(Total for Question 10 = 11 marks)

TOTAL FOR PAPER = 100 MARKS

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The Periodic Table of the Elements

Key

relative atomic mass **atomic symbol** name atomic (proton) number

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

***** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.***

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

Paper 1 Foundation

Question number	Answer	Mark
1(a)(i)	liquid solid gas • all three correct (2) • one/two correct (1)	**(2)**

Question number	Answer	Mark
1(a)(ii)	• Bunsen burner (1) • test tube (1)	**(2)**

Question number	Answer	Additional guidance	Mark
1(b)	evaporation	do not accept 'boiling'	**(1)**

Question number	Answer	Mark
1(c)(i)	An answer that provides a description by making reference to **two** of the following points: • molecules become closer (1) • molecules lose energy (1) • molecules slow down (1)	**(2)**

Question number	Answer	Mark
1(c)(ii)	B	**(1)**

Question number	Answer	Mark
2(a)	B	**(1)**

Question number	Answer	Mark
2(b)	Any **one** advantage from: • reliable composition of fertiliser • produced in large quantities as required • all soluble therefore fertiliser will reach roots as required	**(1)**

Question number	Answer	Additional guidance	Mark
2(c)(i)	measuring cylinder	allow burette or pipette	**(1)**

Question number	Answer	Mark
2(c)(ii)	(ammonia) + phosphoric acid → ammonium phosphate	**(1)**

Question number	Answer	Mark
2(c)(iii)	An answer that combines the following points of application of knowledge and understanding to provide a logical description: • first heat the solution/leave water to evaporate (1) • and then filter off/dry crystals formed (1)	**(2)**

Question number	Answer	Mark
2(d)	D	**(1)**

Question number	Answer	Mark
3(a)	B	**(1)**

Question number	Answer	Mark
3(b)(i)	• iron (1) • carbon dioxide/carbon monoxide (1)	**(2)**

Question number	Answer	Mark
3(b)(ii)	D	**(1)**

Question number	Answer	Mark
3(c)	all the original atoms have simply been rearranged in the products.	**(1)**

Question number	Answer	Mark
3(d)	heating with carbon is used as it is cheaper than using electrolysis.	**(1)**

Question number	Answer	Mark
3(e)	• tin costs {much/about 10 times} more than aluminium (1) • amount of tin in Earth much smaller than the amount of aluminium (1)	**(2)**

Question number	Answer	Mark
4(a)(i)	• connect {lamp/ammeter} in series (1)	**(1)**

Question number	Answer	Mark
4(a)(ii)	• a substance that conducts electricity (1) • when molten or in aqueous solution (1)	**(2)**

Question number	Answer	Mark
4(a)(iii)	B	**(1)**

Question number	Answer	Additional guidance	Mark
4(b)	• copper is deposited on the cathode, therefore mass deposited = 1.57 − 1.28 (1) • = 0.29 (g) (1)	Award full marks for correct numerical answer without working.	**(2)**

Question number	Answer	Mark
4(c)	• iodine at the anode (1) • potassium at the cathode (1)	**(2)**

Question number	Answer	Mark
4(d)	• 84 g sodium fluoride → 46 g of sodium (1) • so 168 g sodium fluoride → 92 g of sodium (1) **or** • 168 ÷ 42 = 4 (mol NaF) (1) • 4 × 23 = 92 (g) (1)	**(2)**

Question number	Answer	Mark
5(a)	• improve appearance (1) • help prevent corrosion (1)	**(2)**

Question number	Answer	Additional guidance	Mark
5(b)	% of tin in alloy = $\frac{15.0}{(15.0+22.5)} \times 100$ (1) = 40.0 (%) (1)	Award full marks for correct numerical answer without working.	**(2)**

Question number	Answer	Mark
5(c)	• A will rust, as there is air/oxygen and water present (1) • B will not rust, as there is no air/oxygen present (1) • C will not rust, as no water is present (1)	**(3)**

Question number	Answer	Mark
5(d)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): • (iron has not rusted because) zinc is more reactive than iron (1) • so zinc corrodes instead of iron (1)	**(2)**

Question number	Answer	Additional guidance	Mark
6(a)(i)	• axes with linear scale that use more than half of each edge of the grid (1) • all points correctly plotted to ± half a square (1) • single straight line passing through all points except result 5 (1)	5 points plotted correctly (i.e. one error) allow ecf from plotting error	**(3)**

Question number	Answer	Mark
6(a)(ii)	Any **one** reason from: • not all magnesium reacted • incomplete reaction • some magnesium oxide lost	**(1)**

Question number	Answer	Mark
6(b)	$\mathbf{2}Mg + O_2 \rightarrow \mathbf{2}MgO$/$Mg + \mathbf{\frac{1}{2}}O_2 \rightarrow MgO$	**(1)**

Question number	Answer	Additional guidance	Mark
6(c)	40 + 2 × (14 + 16 × 3) (1) = 164 (1)	Award full marks for correct numerical answer without working.	**(2)**

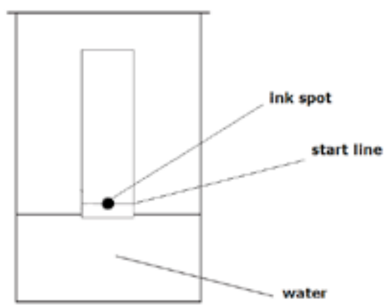
Question number	Answer	Mark
6(d)	• divide mass by relative atomic mass — lead $\frac{0.207}{207} = 0.001$ — oxygen $\frac{0.032}{16} = 0.002$ (1) • divide by the smaller $\frac{0.001}{0.001} = 1$ $\frac{0.002}{0.001} = 2$ (1) empirical formula PbO_2 which is different to that of compound R (1)	**(3)**

Question number	Answer	Mark
7(a)	D	**(1)**

Question number	Answer	Mark
7(b)	One mark for each correct row.	(3)

substance to separate	method of separation: crystallisation	filtration	simple distillation	fractional distillation
sand from a mixture of sand and sodium chloride solution		✓		
copper sulfate crystals from copper sulfate solution	✓			
useful liquids from crude oil				✓

Question number	Answer	Mark
7(c)(i)	pencil is insoluble in the solvent (but chromatography would separate the ink in an ink line)	**(1)**

Question number	Answer	Mark
7(c)(ii)	Correct position of chromatography paper with start line and ink spot above surface of water 	**(1)**

Question number	Answer	Additional guidance	Mark
7(c)(iii)	• R_f = 14.5 / 15.3 = 0.9477 (1) • = 0.95 answer to 2 significant figures (1)	Award full marks for correct numerical answer without working.	**(2)**

Question number	Answer	Mark
7(d)(i)	B	**(1)**

Question number	Answer	Mark
7(d)(ii)	use a different solvent.	**(1)**

Question number	Answer	Mark
7(d)(iii)	an explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (1 mark): • mixture S (1) • because it gives the greatest number of spots/gives four spots (1)	**(2)**

Question number	Answer	Mark
8(a)	any **one** precaution from: • wear gloves to prevent contact with skin/safety (1) • spectacles to prevent contact with eyes (1)	**(1)**

Question number	Answer	Additional guidance	Mark
8(b)	1000 cm^3 contain $\frac{4.3 \times 1000}{250}$ (1) 1 dm^3 contains 17.1 ($g\,dm^{-3}$) (1)	Award full marks for correct numerical answer without working.	**(2)**

Question number	Answer	Additional guidance	Mark
8(c)	$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$ • correct formulae (1) • balancing (1)	Do not award 2 if incorrect balancing added.	**(2)**

Question number	Answer	Mark
8(d)	• {titration 1/27 cm^3} should not be used because burette readings {not precise/not accurate/not read to 2 d.p.} (1) • {titration 4/25.80 cm^3} should not be used because volume of used (25.80 cm^3) not concordant with other two (1)	**(2)**

Question number	Indicative content
***8(e)**	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1 (6 marks)** • rinse pipette with alkali and burette with acid • measure alkali using a pipette into suitable container e.g. flask/beaker and place flask on a white tile • add a few drops of indicator/suitable named indicator (eg methyl orange/phenolphthalein) • fill burette with acid and read volume of acid in burette • add acid from burette to the flask slowly swirling the flask until {indicator just changes colour/correct colour change for named indicator (eg methyl orange yellow to peach/orange, phenolphthalein pink to colourless)/solution is neutral} • read volume of acid in burette at end of titration • repeat experiment until concordant results • mix the same volume of alkali with the volume of acid determined from the titration but do not add indicator • pour solution into an evaporating basin then {heat solution/leave the water to evaporate} until pure salt crystals are left • dry crystals using absorbent paper

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) • Presents a description which is not logically ordered and with significant gaps. (AO1)
Level 2	3-4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) • Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) • Presents a description that has a well-developed structure which is clear, coherent and logical. (AO1)

Question number	Answer	Additional guidance	Mark
9(a)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (1 mark): • a negative ion must have more electrons than protons in the particle (1) • therefore Z will have a 2– charge (1)	Do not allow any comparison involving neutrons.	**(2)**

Question number	Answer	Mark
9(b)	• Li ion with empty outer shell (1) • 1+ charge on Li (1) • 8 electrons on outer shell of F (1) • 1– charge on F (1)	**(4)**

Question number	Indicative content
***9(c)**	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO2 (6 marks)** • solid calcium chloride contains ions/cations/anions which are charged particles • solid calcium chloride does not conduct because charged particles are not free to move because they are held together by strong electrostatic forces/ionic bonds in lattice • molten calcium chloride solution conducts because ions/cations/anions are present which are charged particles and are free to move • the ions have separated and move to electrode of opposite charge • diamond does not conduct because it is giant molecular covalent with no free electrons • outer electrons of carbon atoms used in bonding • zinc metallic structure consists of delocalised free electrons which can move between layers of metals atoms/cations

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	• The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2) • Lines of reasoning are unsupported or unclear. (AO2)
Level 2	3-4	• The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2) • Lines of reasoning mostly supported through the application of relevant evidence. (AO2)
Level 3	5-6	• The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO4) • Lines of reasoning are supported by sustained application of relevant evidence. (AO2)

Question number	Answer	Mark
10(a)	<table><tr><th>salt</th><th>soluble</th><th>insoluble</th></tr><tr><td>ammonium chloride</td><td>✓</td><td></td></tr><tr><td>lithium sulfate</td><td>✓</td><td></td></tr><tr><td>magnesium carbonate</td><td></td><td>✓</td></tr></table> • All three correct (2) • Any two correct (1)	**(2)**

Question number	Answer	Additional guidance	Mark
10(b)	• mass values in correct places (1) • multiplication by 100 (1) • correct final answer to two significant figures (1)	$\frac{2.53}{2.85} \times 100 = 88.8\%$ 89% (to 2 s.f.) award full marks for correct numerical answer without working	**(3)**

Question number	Answer	Mark
10(c)	An explanation that combines identification – improvement of the experimental procedure (maximum 2 marks) and justification/reasoning, which must be linked to the improvement (maximum 2 marks): • add excess sodium sulfate solution rather than a few drops (1) • so more reaction occurs to form more lead sulfate (1) • filter the reaction mixture rather than pour off the liquid (1) • so none of the lead sulfate is lost on separation (1) • wash the lead sulfate (1) • so the impurities are removed (1) • place the lead sulfate in an oven/warm place (1) • so the lead sulfate is dry (1)	**(4)**

Question number	Answer	Mark
10(d)	• volumes of solution too large for titration method (1) • large volumes of liquid need to be heated and then allowed to crystallise (1)	**(2)**

Write your name here

Surname	Other names

Pearson Edexcel
Level 1/Level 2 GCSE (9-1)

Centre Number	Candidate Number

Chemistry

Paper 2

Foundation Tier

Sample Assessment Materials for first teaching September 2016

Time: 1 hour 45 minutes

Paper Reference
1CH0/2F

You must have:
a calculator
a ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- Calculators may be used.
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an asterisk (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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PEARSON

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒.
If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 The Earth's early atmosphere was different from that of the Earth's atmosphere today.

(a) The Earth's early atmosphere was formed by

(1)

☐ **A** animals breathing.

☐ **B** global warming.

☐ **C** plants growing.

☐ **D** volcanic activity.

(b) Figure 1 shows some data about the composition of gases present in the Earth's early atmosphere and today's atmosphere.

	composition (%)	
gas	**Earth's early atmosphere**	**today's atmosphere**
nitrogen	4	78
oxygen	<0.01	21
argon	<0.01	0.9
gas X	95	0.04
ammonia	0.5	<0.001
sulfur dioxide	0.5	<0.001

Figure 1

Explain, using the data, the identity of gas X.

(2)

....

....

....

....

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(c) Figure 2 shows the concentration of carbon dioxide in the atmosphere above Hawaii from 1960 to 2010.

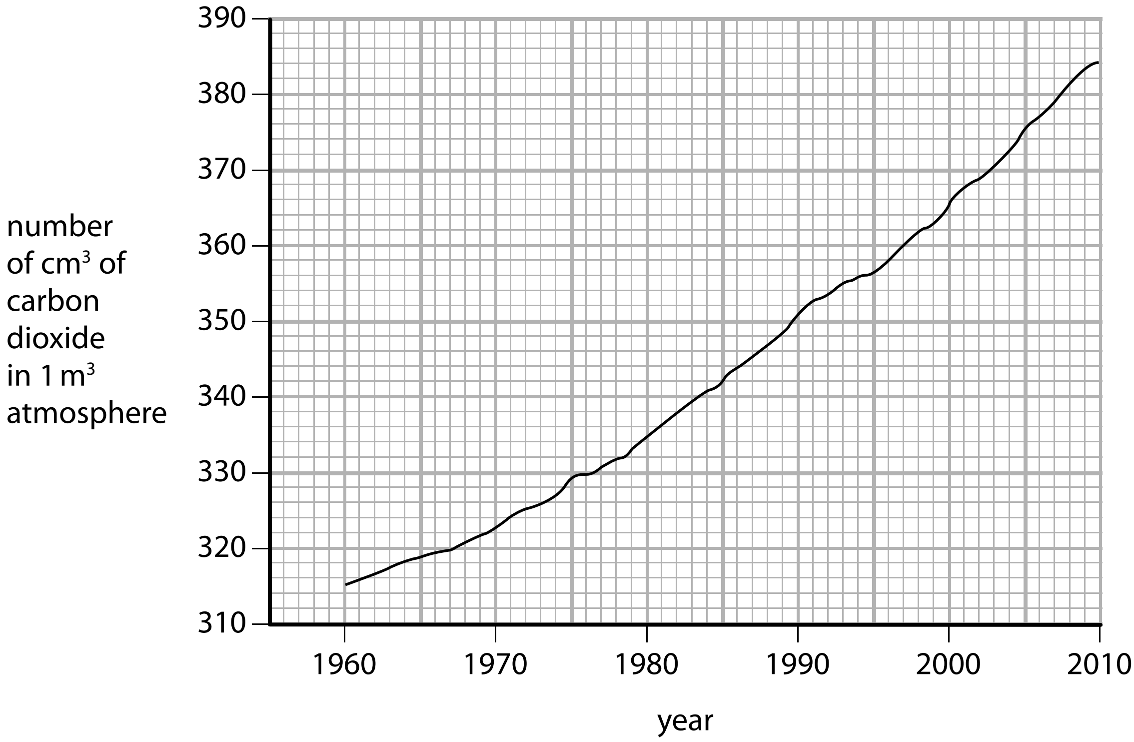

Figure 2

(i) Use the graph to calculate the increase in the volume of carbon dioxide in 1 m^3 of atmosphere from 1960 to 2010.

(2)

increase in volume of carbon dioxide = ... cm^3

(ii) Describe how carbon dioxide is released into today's atmosphere.

(2)

....

....

....

....

(Total for Question 1 = 7 marks)

2 (a) The atomic symbols of the first twenty elements in the periodic table are shown in Figure 3.

						H											He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca																

Figure 3

(i) From the position of beryllium, Be, in the periodic table, beryllium is most likely to be a

(1)

☒ **A** metal

☒ **B** halogen

☒ **C** compound

☒ **D** gas at room temperature

(ii) Give the symbol of the element that is in period 2 and in group 3.

(1)

....

(iii) State the number of electron shells in an atom of potassium, K.

(1)

....

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(b) Figure 4 shows information about some of the elements in group 7 of the periodic table.

element	melting point / °C	boiling point / °C
fluorine	–220	–188
chlorine	–101	–35
bromine	7	59
iodine	114	184

Figure 4

Astatine is below iodine in group 7 of the periodic table.

Estimate the boiling point of astatine.

(1)

boiling point of astatine = ... °C

(c) Chlorine reacts with potassium iodide to form iodine and potassium chloride.

Complete the word equation for the reaction between bromine and potassium astatide.

(2)

bromine + potassium astatide → +

(d) Hydrogen reacts with chlorine to form hydrogen chloride.

$$H—H + Cl—Cl \rightarrow 2H—Cl$$

The symbol — is used to show a covalent bond.

The electronic configuration of hydrogen is 1.
The electronic configuration of chlorine is 2.8.7.

Draw the dot-and-cross diagram for the molecule of hydrogen chloride.
Show outer electrons only.

(2)

(Total for Question 2 = 8 marks)

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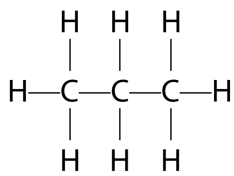
3 The structure of a molecule of propane is shown as



(a) Give the names of the elements combined together in propane.

(2)

(b) Propane can burn completely in oxygen to form carbon dioxide and water.

(i) Write the word equation for this reaction.

(2)

(ii) Propane is a fuel.

Give the reason why fuels are burned.

(1)

(c) Which product is formed when there is incomplete combustion of propane?

(1)

☒ **A** sulfur dioxide

☒ **B** oxygen

☒ **C** hydrogen

☒ **D** carbon monoxide

(d) Which of the following is the formula of a hydrocarbon?

(1)

☒ **A** C_6H_5OH

☒ **B** CH_2OHCH_2OH

☒ **C** $H_2C{=}CHCH_2CH_3$

☒ **D** $C_6H_{12}Cl_2$

(Total for Question 3 = 7 marks)

4 (a) When solid ammonium chloride is shaken with water, a colourless solution forms and the temperature changes from 20 °C to 16 °C.

Give the name of the type of heat change occurring.

(1)

....

(b) A student carries out an experiment to measure accurately the temperature changes when different metals are added to iron(II) sulfate solution.

The method for the experiment is:

- measure 25 cm^3 of iron(II) sulfate solution and pour into a container
- record the initial temperature of the solution
- add excess magnesium ribbon
- record the highest temperature of the mixture
- repeat the experiment using excess copper turnings, then using excess zinc foil.

(i) State a suitable container for the iron(II) sulfate solution in this experiment.

(1)

....

(ii) State what the student should do to the mixtures during the experiment.

(1)

....

(iii) Figure 5 shows the results obtained by the student.

metal added to iron(II) sulfate solution	temperature rise / °C
magnesium	6.0
copper	0.0
zinc	2.8

Figure 5

Explain the order of reactivity of the metals magnesium, copper and zinc using the results.

(2)

....

....

....

....

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(iv) Explain how the student could improve the method to make a fairer comparison of the temperature change produced by the different metals.

(2)

....

....

....

....

(v) The iron(II) sulfate solution contained 6.2 g of iron(II) sulfate in 50 cm^3 of solution.

Calculate the concentration of the iron(II) sulfate solution in $g\,dm^{-3}$.

(2)

concentration = ... $g\,dm^{-3}$

(Total for Question 4 = 9 marks)

5 A student used the equipment in Figure 6 to investigate the rate of reaction between zinc and excess dilute hydrochloric acid.

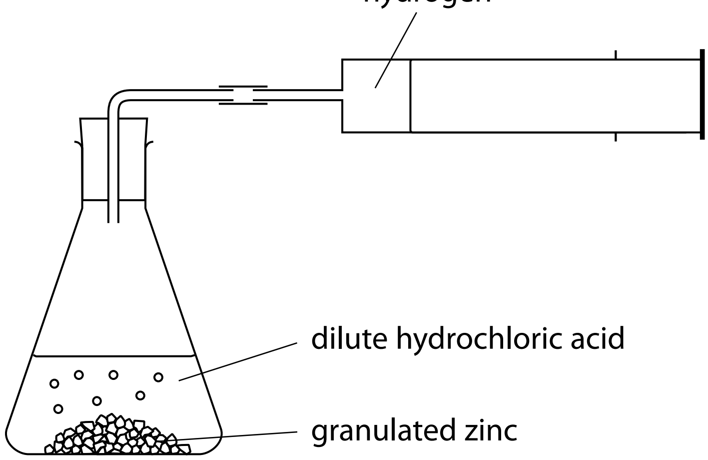


Figure 6

The student uses the following method:

- place a known mass of granulated zinc into the conical flask
- pour 25 cm^3 of dilute hydrochloric acid (an excess) into the conical flask and fit the bung quickly into the neck of the flask
- measure the volume of gas produced every 20 seconds until after the reaction finishes.

Figure 7 shows the results.

time / s	volume of hydrogen / cm^3
0	0
20	42
40	66
60	75
80	80
100	82
120	82
140	82

Figure 7

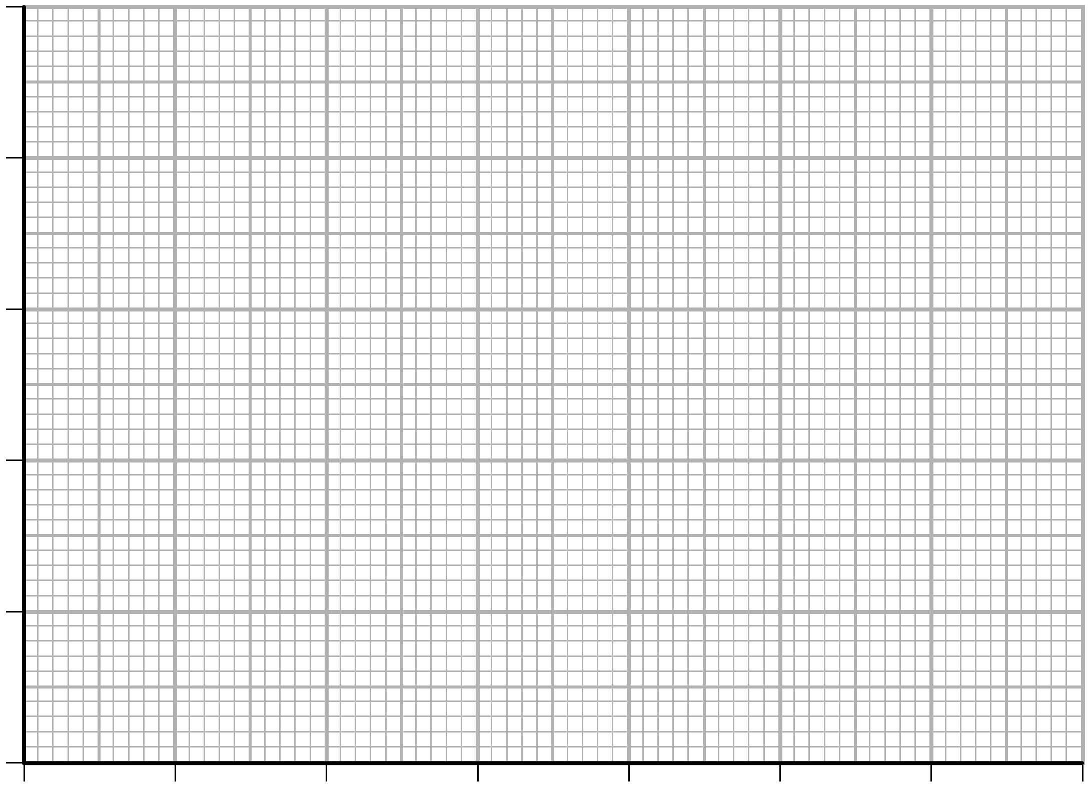
(a) Give the name of a piece of equipment that can be used to measure 25 cm^3 of dilute hydrochloric acid accurately.

(1)

....

(b) Draw a graph of the volume of hydrogen gas produced against time using the grid.

(3)



(c) The average rate of reaction in the first 20 seconds in cm^3 of hydrogen produced per second is

(1)

☒ **A** 2.1

☒ **B** 8.4

☒ **C** 21

☒ **D** 84

(d) The student repeated the experiment keeping all conditions the same but using the same mass of powdered zinc instead of granulated zinc.

On the grid above sketch the graph you would expect when the experiment is repeated using powdered zinc.
Label your line **A**.

(2)

(e) Sodium thiosulfate solution, $Na_2S_2O_3$, reacts with dilute hydrochloric acid as shown in the equation.

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

The rate of this reaction can be investigated by mixing the reactants and finding the time taken for a precipitate of sulfur to become visible.

A student wants to investigate the effect of changing the temperature on the rate of this reaction.

Devise a method the student could use to find out how the time taken for the precipitate of sulfur to become visible changes with temperature.

(3)

(Total for Question 5 = 10 marks)

6 Alcohols and carboxylic acids are important organic compounds.

Figure 8 shows the names and formulae of three alcohols in a homologous series.

name	formula
methanol	CH_3OH
ethanol	C_2H_5OH
propanol	C_3H_7OH

Figure 8

(a) Predict the formula of the alcohol that has **five** carbon atoms in its molecule, using the information in Figure 8.

(1)

....

(b) Calculate the relative formula mass of ethanol, C_2H_5OH.

(relative atomic masses: H = 1, C = 12, O = 16)

(2)

relative formula mass = ...

(c) Ethanol can be oxidised to form ethanoic acid.

Draw the structure of a molecule of ethanoic acid, showing all the covalent bonds.

(2)

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(d) The temperature rise in water when liquid fuels burn can be found using the equipment shown in Figure 9.

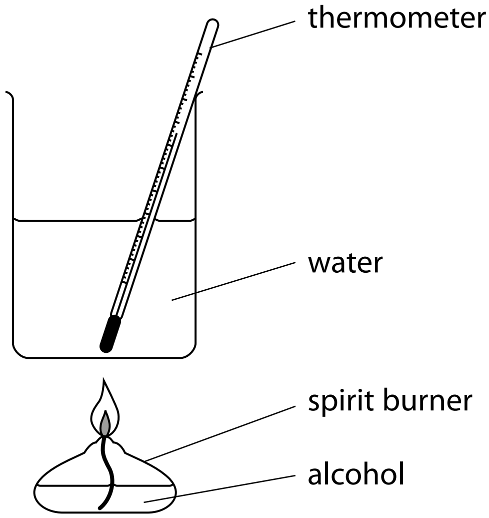

Figure 9

(i) A student compares the temperature rise produced in the water when propanol burns with the temperature rise produced when ethanol burns.

State **two** factors that the student must keep the same in both experiments in order to have a fair comparison.

(2)

1 ....

....

2 ....

....

(ii) The results for the two alcohols are shown in Figure 10.

alcohol	mass of alcohol burned / g	temperature rise / °C
ethanol	0.33	20
propanol	0.28	20

Figure 10

Explain, using only the information in Figure 10, why propanol might be the better fuel.

(2)

....

....

....

....

(Total for Question 6 = 9 marks)

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7 This question is about some of the elements in groups 1 and 2 of the periodic table.

(a) The atomic number of lithium is 3.
The mass number of a lithium atom is 7.

Which row of the table shows the number of protons, neutrons and electrons in an atom of lithium-7?

(1)

	number of protons	number of neutrons	number of electrons
☒ **A**	3	3	4
☒ **B**	3	4	3
☒ **C**	4	3	7
☒ **D**	7	4	3

(b) Lithium, sodium and potassium are in group 1 of the periodic table.

State, in terms of the electrons in their atoms, what the atoms of lithium, sodium and potassium have in common.

(1)

....

(c) Magnesium has atomic number 12.
Magnesium exists as magnesium-24, magnesium-25 and magnesium-26 atoms.

Explain, in terms of protons and neutrons, why these atoms are isotopes of magnesium.

(2)

....

....

....

....

(d) Magnesium and calcium are in group 2 of the periodic table. They are less reactive than the metals in group 1.

Calcium reacts with water to form calcium hydroxide, $Ca(OH)_2$, and hydrogen, H_2.

$$Ca(s) + 2H_2O(l) \rightarrow Ca(OH)_2(s) + H_2(g)$$

Describe what would be **seen** when a piece of calcium is dropped into a container of water.

(2)

....

....

....

....

(e) Magnesium reacts very slowly with cold water but it reacts faster with steam, H_2O, to form magnesium oxide, MgO, and hydrogen.

Write the balanced equation for the reaction between magnesium and steam.

(2)

....

(f) The electronic configurations of magnesium and calcium are

magnesium	2.8.2
calcium	2.8.8.2

When magnesium and calcium react with water they form positive ions.

Suggest an explanation, in terms of their electronic configurations, why calcium is more reactive than magnesium.

(2)

....

....

....

....

(g) A sample of calcium bromide contains 0.2 g calcium and 0.8 g bromine by mass.

Calculate the empirical formula of calcium bromide.

(relative atomic masses: Ca = 40, Br = 80)

(3)

empirical formula = ...

(Total for Question 7 = 13 marks)

8 Crude oil is a mixture of hydrocarbons.

It can be separated into fractions.

(a) Which of these mixtures shows formulae of substances that could be in the gaseous fraction of crude oil?

(1)

☒ **A** C_2H_4, C_3H_8, $C_4H_{10}O$

☒ **B** C_2H_4, C_3H_7Br, C_4H_{10}

☒ **C** C_2H_6, C_3H_8, C_4H_{10}

☒ **D** C_2H_6, C_3H_7Br, $C_4H_{10}O$

(b) Figure 11 shows the percentages of the fractions in crude oil from three different oil wells.

	percentage of fraction in crude oil from		
fraction	**oil well A**	**oil well B**	**oil well C**
gases	1	6	9
petrol	2	15	24
kerosene	6	14	20
diesel oil	7	10	16
fuel oil	26	28	30
bitumen	58	27	1

Figure 11

(i) State which oil well produces a crude oil containing the highest percentage of the high boiling point fractions.

(1)

....

(ii) A barrel of crude oil from oil well B weighs 130 kg.

Calculate the mass of kerosene in this barrel.

(1)

.... kg *(c) Diesel is the fuel used in most bus engines.

Research is being carried out into the use of hydrogen, instead of diesel, as a fuel for buses.

Discuss the advantages and disadvantages of using hydrogen, rather than diesel, as a fuel for buses.

(6)

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....

(d) Fractions of crude oil contain alkanes.

A sample of decane, $C_{10}H_{22}$, was cracked using the apparatus in Figure 12.

This produced a mixture of products, including ethene.

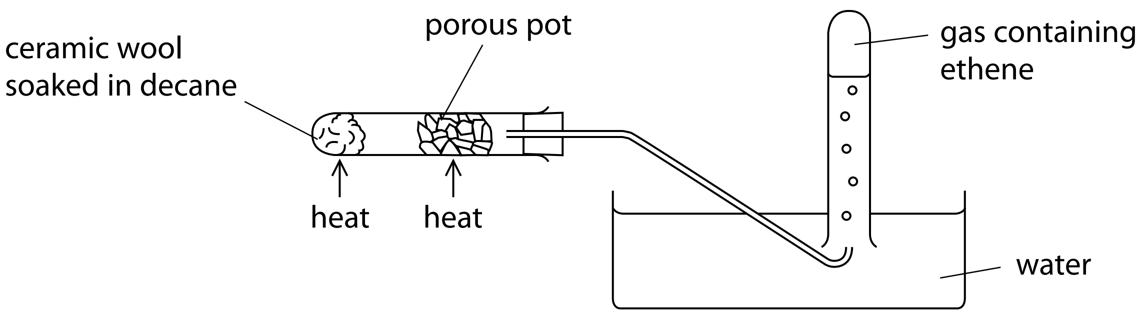

Figure 12

(i) Explain how ethene is produced using the apparatus in Figure 12.

(3)

....

....

....

....

....

....

(ii) One molecule of decane produced two molecules of propene, C_3H_6, and one molecule of product **Z**.

$C_{10}H_{22} \rightarrow 2C_3H_6$ + product **Z**

What is the formula of product **Z**?

(1)

☒ **A** C_4H_8

☒ **B** C_4H_{10}

☒ **C** C_7H_{14}

☒ **D** C_7H_{16}

(Total for Question 8 = 13 marks)

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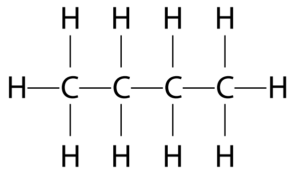
9 Alkanes and alkenes are hydrocarbons.

The structure of a molecule of butane is shown.



(a) Which of the following is the empirical formula for butane?

(1)

- ☒ **A** CH
- ☒ **B** CH_2
- ☒ **C** C_2H_5
- ☒ **D** C_4H_{10}

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(b) The graph in Figure 13 shows the boiling points of some alkanes plotted against the number of carbon atoms in one molecule of each alkane.

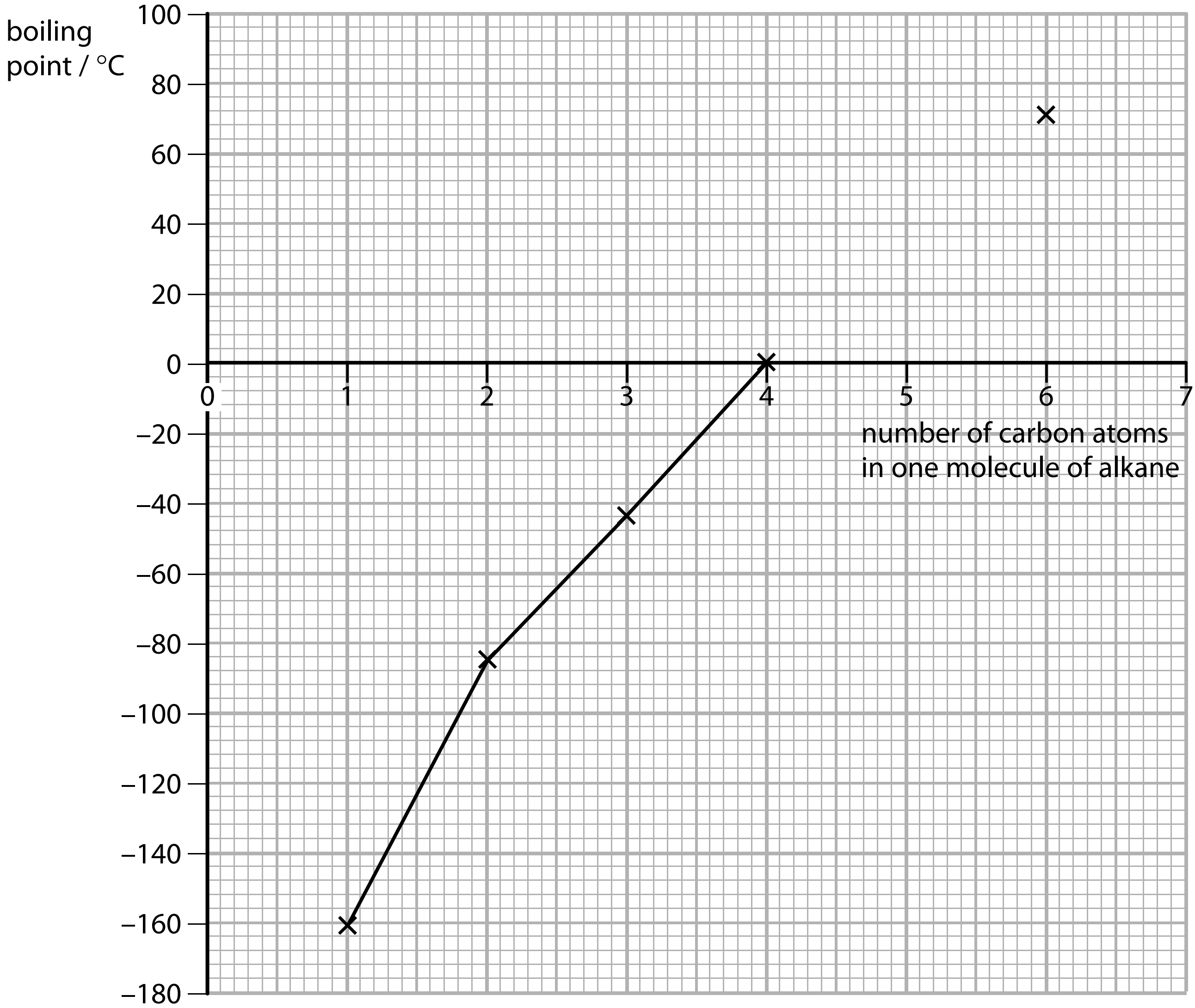


Figure 13

A molecule of pentane contains five carbon atoms.
Use the graph to estimate the boiling point of pentane.

(1)

boiling point of pentane = ... °C

(c) Figure 14 shows some information about the alkenes, ethene and propene.

Complete the table. The structure of propene must show all covalent bonds.

(2)

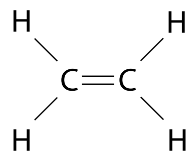
name of alkene	molecular formula	structure
ethene		
propene	C_3H_6	

Figure 14

(d) Alkenes burn completely to produce carbon dioxide and water.

Balance the equation for the complete combustion of butene gas, C_4H_8.

(1)

$$C_4H_8 + \text{.......................}\ O_2 \rightarrow \text{.......................}\ CO_2 + \text{.......................}\ H_2O$$

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(e) Butene reacts with steam to produce butanol.

$$C_4H_8 + H_2O \rightarrow C_4H_9OH$$

(i) Calculate the maximum mass of butanol, C_4H_9OH, that can be produced when 1.4 kg of butene, C_4H_8, reacts with excess steam.

(relative atomic masses: H = 1, C = 12, O = 16
relative molecular mass of butene, C_4H_8 = 56)

(3)

mass of butanol = ... kg

(ii) What type of reaction takes place between butene and steam?

(1)

☒ **A** addition

☒ **B** dehydration

☒ **C** neutralisation

☒ **D** substitution

(f) A sample of each of three hydrocarbons, **X**, **Y** and **Z**, was shaken with bromine water. Bromine water is orange coloured.

The results are:

X orange mixture becomes colourless

Y orange mixture becomes colourless

Z mixture remains orange

Using the results, comment on the structures of the hydrocarbons **X**, **Y** and **Z**.

(2)

....

....

....

....

(g) Alkenes are used to make polymers.

Figure 15 shows the repeating unit of a polymer.

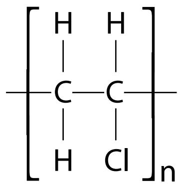

Figure 15

Draw the structure of a molecule of the monomer that was used to produce this polymer.

(1)

(h) Bottles can be made of polymers, such as poly(ethene), and of glass.

Give **one** advantage of a bottle made of a polymer rather than a bottle made of glass.

(1)

....

....

(Total for Question 9 = 13 marks)

10 Qualitative tests can be used to identify ions in substances.

(a) Sodium hydroxide solution is warmed with a solution of ammonium ions. Ammonia gas is given off.

Describe the test to show the gas is ammonia.

(2)

....

....

....

....

(b) Two tests were carried out on copper sulfate solution.

(i) Sodium hydroxide solution was added to a small amount of copper sulfate solution.
A blue precipitate of copper hydroxide formed.

Complete the word equation for the reaction.
Include state symbols.

(2)

copper sulfate (aq) + sodium hydroxide (aq) $\rightarrow$ .... (..........) + ... (..........)

(ii) Dilute hydrochloric acid was added to a different sample of copper sulfate solution. Barium chloride solution was then added.

State what would be **seen**.

(1)

....

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*(c) A technician found some colourless crystals in an unlabelled beaker in a laboratory.

The technician knew that the substance was potassium chloride, potassium carbonate, sodium chloride or sodium iodide.

Plan a series of tests the technician could carry out to identify the colourless crystals.

(6)

(Total for Question 10 = 11 marks)

TOTAL FOR PAPER = 100 MARKS

The Periodic Table of the Elements

Key

relative atomic mass **atomic symbol** name atomic (proton) number

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

***** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.***

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

Paper 2 Foundation

Question number	Answer	Mark
1(a)	D	(1)

Question number	Answer	Mark
1(b)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (1 mark): • gas X is carbon dioxide (1) • because the percentage of gas has fallen markedly (1)	(2)

Question number	Answer	Additional guidance	Mark
1(c)(i)	• 384 and 315 used from graph (1) • 384 − 315 = 69 (cm^3) (1)	Allow 384 to 385 in 2010 and 314 to 316 in 1960. Second mark consequential on values read from graph. Award full marks for correct numerical answer without working.	(2)

Question number	Answer	Additional guidance	Mark
1(c)(ii)	An answer that provides a description by making reference to one of the following linked pairs: • burning/(complete) combustion (1) • of carbon compounds/(fossil) fuels/wood/rubbish/plastic (1) OR • respiration/gas exhaled/breathing/ decaying (1) • from plants/animals/organisms (1) OR • eruption (releases gas) (1) • from volcanic activity/volcanoes (1)	Allow any type of fuel except hydrogen. Allow heating limestone.	(2)

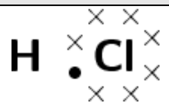
Question number	Answer	Mark
2(a)(i)	A	(1)

Question number	Answer	Additional guidance	Mark
2(a)(ii)	B	Allow boron.	(1)

Question number	Answer	Mark
2(a)(iii)	4	**(1)**

Question number	Answer	Additional guidance	Mark
2(b)	Any temperature > 184 (°C).	Ignore units.	**(1)**

Question number	Answer	Additional guidance	Mark
2(c)	astatine (1) + potassium bromide (1)	Allow products in either order.	**(2)**

Question number	Answer	Additional guidance	Mark
2(d)	 • One shared pair of electrons in molecule (1) • Rest of molecule correct, conditional on shared pair (1)	Allow any combination of dots and crosses.	**(2)**

Question number	Answer	Mark
3(a)	• carbon (1) • hydrogen (1)	**(2)**

Question number	Answer	Mark
3(b)(i)	propane + oxygen → carbon dioxide + water • LHS (1) • RHS (1)	**(2)**

Question number	Answer	Mark
3(b)(ii)	to {release/produce} {heat/energy}	**(1)**

Question number	Answer	Mark
3(c)	D	**(1)**

Question number	Answer	Mark
3(d)	C	**(1)**

Question number	Answer	Mark
4(a)	endothermic	(1)

Question number	Answer	Mark
4(b)(i)	Any one from: • beaker (1) • polystyrene cup (1) • conical flask (1)	(1)

Question number	Answer	Mark
4(b)(ii)	Stir the mixtures with the thermometer	(1)

Question number	Answer	Mark
4(b)(iii)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (1 mark): • order of reactivity from most reactive to least reactive magnesium, zinc, (iron), copper (1) • because the most reactive shows biggest temperature rise/least reactive shows lowest temperature rise (1)	(2)

Question number	Answer	Additional guidance	Mark
4(b)(iv)	An explanation that combines identification – improvement of the experimental procedure (1 mark) and justification/reasoning which must be linked to the improvement (1 mark): • use magnesium, zinc and copper as powders (1) • so they have the same/similar size particles/surface area/shape (1)	allow other acceptable answers, e.g. use same mass / no moles of each	(2)

Question number	Answer	Additional guidance	Mark
4(b)(v)	1000 cm^3 contain $\frac{\underline{6.2 \times 1000}}{50}$ (1) 1 dm^3 contains 124 ($g\,dm^{-3}$) (1)	Award full marks for correct numerical answer without working.	(2)

Question number	Answer	Mark
5(a)	Measuring cylinder/burette/pipette	(1)

Question number	Answer	Additional guidance	Mark
5(b)	• axes with linear scale that use more than half of each edge of the grid and labelled with units from the table (1). • all points correctly plotted to ± half a square (1). • single straight line passing through all points and the origin (1).	7 points plotted correctly (i.e. one error) (1) allow ecf from plotting error.	**(3)**

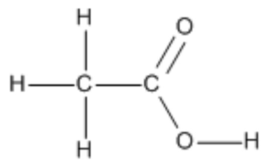
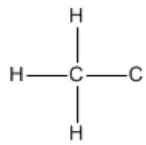
Question number	Answer	Mark
5(c)	A	**(1)**

Question number	Answer	Mark
5(d)	Line A on graph: • steeper curve/curve drawn to left of original (1) • levelling off at 82 cm^3 (1)	**(2)**

Question number	Answer	Mark
5(e)	An answer that combines the following points to provide a method: • suitable method of warming the solutions, e.g. water bath, Bunsen burner with tripod and gauze and measure the temperature of each solution using a thermometer (1) • use the same volumes of the solutions in each experiment (1) • measure the time for the precipitate to form (and obscure a cross placed under the reaction vessel) using a stop watch/clock (1)	**(3)**

Question number	Answer	Mark
6(a)	$C_5H_{11}OH$	**(1)**

Question number	Answer	Additional guidance	Mark
6(b)	(2 × 12) + (5 × 1) + 16 + 1 (1) = 46 (1)	Award full marks for correct numerical answer without working.	**(2)**

Question number	Answer	Additional guidance	Mark
6(c)	 Structure to show 2 carbon atoms with 3 hydrogens joined to one of them (1)  Rest of structure correct (1)	Allow OH	(2)

Question number	Answer	Mark
6(d)(i)	Any two from: • mass/volume of water (1) • height of container above wick (1) • length of wick/height of flame (1) • the container needs to be the same {shape/size/material} (1) • same number of moles of alcohol (1)	**(2)**

Question number	Answer	Mark
6(d)(ii)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (1 mark): • the same temperature rise is achieved (1) • using a lower mass of alcohol/propanol (1)	**(2)**

Question number	Answer	Mark
7(a)	B	**(1)**

Question number	Answer	Mark
7(b)	They (contain) same number of outer shell electrons/all have 1 electron in outer shell.	**(1)**

Question number	Answer	Additional guidance	Mark
7(c)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): • all magnesium atoms have 12 protons (1) • however Mg-24 has 12 neutrons, Mg-25 has 13 neutrons, Mg-26 has 14 neutrons (1)	Ignore references to atomic number and to mass number/relative atomic mass. Allow magnesium atoms contain same number of protons but different numbers of neutrons (1)	**(2)**

Question number	Answer	Additional guidance	Mark
7(d)	An answer that combines the following points of understanding to provide a logical description: • (hydrogen produced as a gas so) there would be {effervescence/fizzing/ bubbles} (1) • calcium hydroxide produced as a solid so the water would {go cloudy/a white precipitate would form} (1)	Allow: • calcium would move (around) (1) • calcium would decrease in size/disappears/ dissolves (1)	**(2)**

Question number	Answer	Mark
7(e)	$Mg + H_2O \rightarrow MgO + H_2$ • LHS (1) • RHS (1)	**(2)**

Question number	Answer	Additional guidance	Mark
7(f)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): • in calcium the outermost electron(s) {are further away from nucleus/experience(s) greater shielding} (from the nucleus) (as shown by the electronic configuration) (1) • therefore less attraction between nucleus and electron(s)/the electron(s) is/are easier to remove (1)	Allow answers in terms of why reactivity of magnesium is less than that of calcium.	**(2)**

Question number	Answer	Additional guidance	Mark
7(g)	• divides mass by relative atomic mass (1) • calculates simplest ratio (1) • expresses ratio correctly as empirical formula (1)	<u>Example of calculation</u> Ca : Br $\frac{0.2}{40}$: $\frac{0.8}{80}$ 0.005 : 0.01 1 : 2 empirical formula $CaBr^2$ formula alone scores max	**(3)**

Question number	Answer	Mark
8(a)	C	**(1)**

Question number	Answer	Mark
8(b)(i)	(oil well) C	**(1)**

Question number	Answer	Mark
8(b)(ii)	(oil well) A	**(1)**

Question number	Indicative content
*8(c)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1 (6 marks)** Answers must compare advantages of using hydrogen instead of diesel • plenty of water/raw material • limited supplies of crude oil • hydrogen produces only water as waste • diesel also produces carbon dioxide • carbon dioxide emissions may cause global warming • diesel undergoes incomplete combustion • diesel also produces carbon and/or carbon monoxide • carbon is formed as soot and makes objects dirty • carbon monoxide is a toxic gas • hydrogen can be obtained from the water produced. with disadvantages of using hydrogen instead of diesel • hydrogen gas has to be manufactured • energy/electricity is needed to produce hydrogen • producing electricity from non-renewable resources produces carbon dioxide • hydrogen is expensive to produce • problems of storage of large volumes of flammable gas • stronger/heavier/bigger fuel tanks needed • hydrogen is a gas and leaks easily if the fuel system is damaged • there are limited outlets for buying hydrogen.

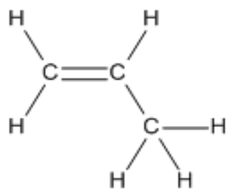
Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents a discussion with some structure and coherence. (AO1)
Level 2	3–4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents a discussion that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5–6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents a discussion that has a well-developed structure which is clear, coherent and logical. (AO1)

Question number	Answer	Additional guidance	Mark
8(d)(i)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (2 marks): • when the decane is heated it vaporises/turns to a gas (1) • decane vapour/gas breaks down as it comes in contact with hot porous pot (1) • large molecules of decane produce smaller molecules, including ethene (1)	Do not allow this point if ethene passes over hot porous pot.	**(3)**

Question number	Answer	Mark
8(d)(ii)	B	**(1)**

Question number	Answer	Mark
9(a)	C	**(1)**

Question number	Answer	Mark
9(b)	36 °C (±2)	**(1)**

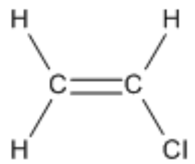
Question number	Answer	Mark
9(c)	• Molecular formula – C_2H_4 (1) • Structure (1) 	**(2)**

Question number	Answer	Mark
9(d)	$C_4H_8 + 6O_2 \rightarrow 4CO_2 + 4H_2O$	**(1)**

Question number	Answer	Additional guidance	Mark
9(e)(i)	• Calculates relative molecular mass of C_4H_9OH (1) • Calculates mass of C_4H_9OH produced (1) • Final answer = 1.9 (kg) (1)	Example of calculation: relative molecular mass of $C_4H_9OH = (4 \times 12) + (9 \times 1) + 16 + 1 = 74$ mass of C_4H_9OH produced = $(74 \div 56) \times 1.4$ Accept 1.85 (kg) Award full marks for use of moles/correct numerical answer without working.	**(3)**

Question number	Answer	Mark
9(e)(ii)	A	**(1)**

Question number	Answer	Mark
9(f)	• X and Y are both unsaturated/contain {multiple/double} bonds/alkenes (1) • Z is saturated/contains no {multiple/double} bonds/alkane (1)	**(2)**

Question number	Answer	Additional guidance	Mark
9(g)		Ignore bond angles.	**(1)**

Question number	Answer	Additional guidance	Mark
9(h)	Any **one** from the following points: polymer • is lighter/has a lower density (1) • is more resistant to shattering (1)	Ignore any reference to cost.	**(1)**

Question number	Answer	Additional guidance	Mark
10(a)	An answer that provides a description by making reference to: • test gas with moist (red) litmus paper (1) • turns blue (1)	Allow universal indicator paper/pH paper (1) and yellow to blue/purple (1).	**(2)**

Question number	Answer	Additional guidance	Mark
10(b)(i)	(copper sulfate(aq) + sodium hydroxide(aq) →) copper hydroxide(s) + sodium sulfate(aq) • sodium sulfate identified as a product (1) • (sodium sulfate)(aq) **and** copper hydroxide(s) both state symbols matched to the correct product (1)	allow Na_2SO_4 allow copper(II) hydroxide/ $Cu(OH)_2$	**(2)**

Question number	Answer	Mark
10(b)(ii)	white precipitate/ppt/solid	**(1)**

Question number	Indicative content
*10(c)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO3 (6 marks)** Any logical description of tests which result in identification of all four substances. Plans may include: • flame test • description of carrying out a flame test • if the flame is yellow/not lilac, sodium ions present • if the flame is lilac/not yellow, potassium ions present • add dilute {hydrochloric/nitric} acid to the solid • if bubbles of gas form then carbonate ions present • bubble gas through limewater • if limewater turns milky/cloudy, carbon dioxide present • make a solution of the crystals in water • add dilute nitric acid • (if no reaction with acid) add silver nitrate solution • if there is a white precipitate, chloride ions present • if there is a yellow precipitate, iodide ions present. Alternative test for halide ions: • make a solution of the crystals in water • add chlorine water • then cyclohexane • if the cyclohexane/top layer turns purple, iodide ions present.

Level	Mark	Descriptor
	0	No awardable content.
Level 1	1–2	• Analyses the scientific information but understanding and connections are flawed. (AO3) • An incomplete plan that provides limited synthesis of understanding. (AO3)
Level 2	3–4	• Analyses the scientific information and provides some logical connections between scientific enquiry, techniques and procedures. (AO3) • A partially completed plan that synthesises mostly relevant understanding, but not entirely coherently. (AO3)
Level 3	5–6	• Analyses the scientific information and provide logical connections between scientific concepts throughout. (AO3) • A well-developed plan that synthesises relevant understanding coherently. (AO3)

Write your name here

Surname	Other names

Pearson Edexcel
Level 1/Level 2 GCSE (9-1)

Centre Number	Candidate Number

Chemistry

Paper 1

Higher Tier

Sample Assessment Materials for first teaching September 2016

Time: 1 hour 45 minutes

Paper Reference
1CH0/1H

You must have:
Calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- Calculators may be used.
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

Information

- The total mark for this paper is 100
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an asterisk (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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PEARSON

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒.
If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Mixtures of coloured substances can be separated by paper chromatography.

(a) Paper chromatography was used to separate a mixture of blue and red inks.
A spot of the mixture was placed on chromatography paper as shown in Figure 1.

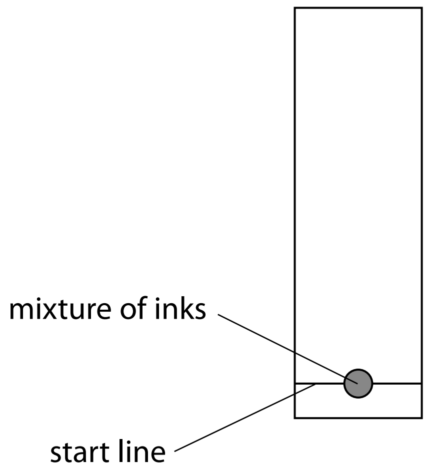

Figure 1

(i) Give a reason why the start line is drawn in pencil rather than in ink.

(1)

....

....

(ii) The chromatography paper, with the spot of mixture on it, was placed in a beaker with the bottom of the paper in water.

On Figure 2, complete the diagram showing the position of the chromatography paper with the spot of mixture at the start of the experiment.

(1)

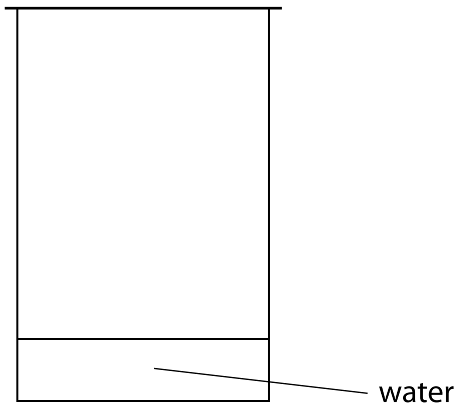

Figure 2

(iii) The chromatography was carried out and the result is shown in Figure 3.

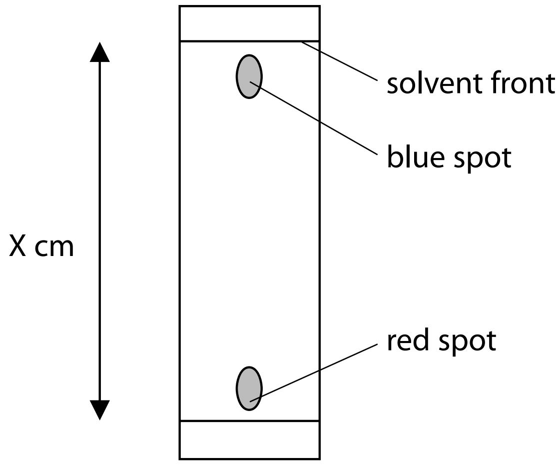

Figure 3

The blue spot had moved 14.5 cm and the solvent front had moved 15.3 cm.

Calculate the R_f value of the substance in the blue spot, giving your answer to 2 significant figures.

$$R_f \text{ value} = \frac{\text{distance travelled by a dye}}{\text{distance travelled by solvent front}}$$

(2)

R_f value = ...

(b) **P**, **Q**, **R** and **S** are mixtures of food colourings.
They are investigated using paper chromatography.
Figure 4 shows the chromatogram at the end of the experiment.

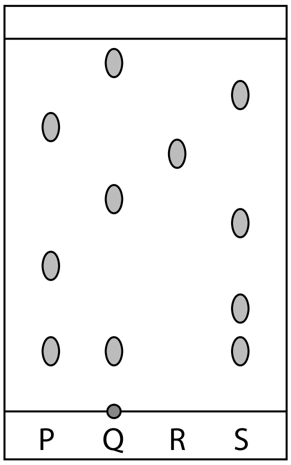

Figure 4

(i) Which mixture contains an insoluble food colouring?

(1)

- ☒ **A** mixture **P**
- ☒ **B** mixture **Q**
- ☒ **C** mixture **R**
- ☒ **D** mixture **S**

(ii) Give a change that could be made to the experiment to obtain an R_f value for the insoluble colouring.

(1)

....

....

(iii) Explain, by referring to Figure 4, which mixture is separated into the greatest number of soluble food colourings by this chromatography experiment.

(2)

....

....

....

....

(Total for Question 1 = 8 marks)

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2 Ionic compounds contain ions.

(a) The numbers of electrons, neutrons and protons in four particles, **W**, **X**, **Y** and **Z**, are shown in Figure 5.

particle	electrons	neutrons	protons
W	9	10	9
X	10	14	12
Y	16	16	16
Z	18	18	16

Figure 5

Explain which particle, **W**, **X**, **Y** or **Z**, is a negative ion.

(2)

....

....

....

....

(b) Calculate nitrate contains calcium ions and nitrate ions.

Calculate the relative formula mass of calcium nitrate, $Ca(NO_3)_2$.
(relative atomic masses: Ca = 40, N = 14, O = 16)

(2)

relative formula mass = ...

(c) Lithium fluoride, LiF, is an ionic compound.

It contains lithium cations and fluoride anions.

The electronic configurations of a lithium atom and of a fluorine atom are shown in Figure 6.

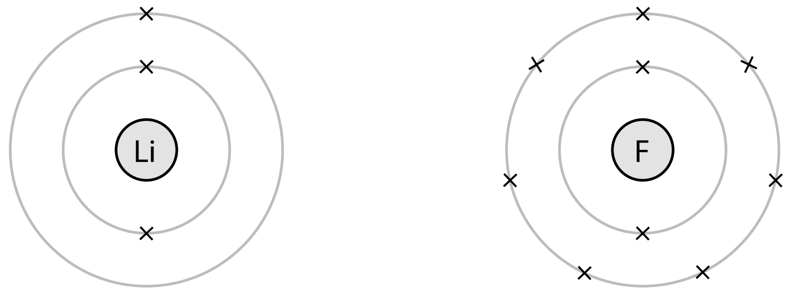

Figure 6

Complete Figure 7 to show the electronic configurations and charges of the ions in lithium fluoride.

(4)

charge on ion ....   charge on ion ....

Figure 7

(Total for Question 2 = 8 marks)

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3 A student carried out an experiment to see how reactive different metals are when they are placed in dilute hydrochloric acid.

A sample of each metal was placed in a separate test tube of acid.

(a) When zinc reacts with dilute hydrochloric acid, a gas is given off and zinc chloride is formed.

(i) Which gas is given off?

☒ **A** carbon dioxide

☒ **B** chlorine

☒ **C** hydrogen

☒ **D** oxygen

(1)

(ii) What is the formula of zinc chloride?

☒ **A** ZnCl

☒ **B** Zn_2Cl

☒ **C** $ZnCl_2$

☒ **D** Zn_2Cl_2

(1)

(b) In the experiment, the student used the same amount of each metal in a finely powdered form.

State **two** factors, concerning the hydrochloric acid, which should also be controlled to produce valid results.

(2)

1 ....

....

2 ....

....

(c) Part of the reactivity series is shown in Figure 8.

most reactive	magnesium
	aluminium
	iron
least reactive	silver

Figure 8

Iron is extracted from its ore by heating with carbon.
Aluminium is extracted from its ore using a different method.

(i) Give the name of the method used to extract aluminium.

(1)

....

(ii) Explain why aluminium is extracted by a different method rather than heating the ore with carbon.

(2)

....

....

....

....

(d) The extraction of iron involves the reduction of iron oxide, Fe_2O_3, by carbon monoxide, CO. During this reaction, the iron oxide is reduced to iron, Fe, and the carbon monoxide is oxidised to carbon dioxide.

Write the balanced equation for the reaction.

(2)

....

(Total for Question 3 = 9 marks)

4 The method used to prepare a salt depends on its solubility in water.

(a) Complete Figure 9 by placing one tick in each row to show whether the salt is soluble or insoluble.

(2)

salt	soluble	insoluble
ammonium chloride		
lithium sulfate		
magnesium carbonate		

Figure 9

(b) Lead nitrate solution mixed with sodium sulfate solution forms lead sulfate as a precipitate.

$$Pb(NO_3)_2 + Na_2SO_4 \rightarrow PbSO_4 + 2NaNO_3$$

The theoretical yield of lead sulfate for this reaction was 2.85 g.
The actual yield of lead sulfate obtained was 2.53 g.

Calculate the percentage yield of lead sulfate in this experiment.

Give your answer to two significant figures.

(3)

percentage yield = ... %

(c) The method used to make the lead sulfate is:

- pour 100 cm^3 lead nitrate solution into a beaker
- add drops of sodium sulfate solution until a precipitate is seen
- allow the precipitate to settle to the bottom of the beaker
- pour off the liquid
- use a spatula to transfer the solid lead sulfate onto a filter paper

Explain **two** ways of improving this experimental method to increase the amount and quality of lead sulfate obtained from the same volume of lead nitrate solution.

(4)

....

....

....

....

....

....

....

....

(d) Ammonium nitrate is produced from ammonia and nitric acid on a large scale in industry.

Ammonium nitrate can also be made in the laboratory by titrating ammonia solution with dilute nitric acid.

$$NH_3 + HNO_3 \rightarrow NH_4NO_3$$

Ammonium nitrate crystals can then be obtained by evaporating off some of the water from the solution.

Give **two** reasons why this laboratory method is not suitable for use on a large scale in industry.

(2)

....

....

....

....

(Total for Question 4 = 11 marks)

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5 Objects made from transition metals are sometimes coated with a thin layer of another transition metal to improve their appearance and to protect against corrosion.

(a) Figure 10 shows equipment that can be used to electroplate an iron spoon with silver.

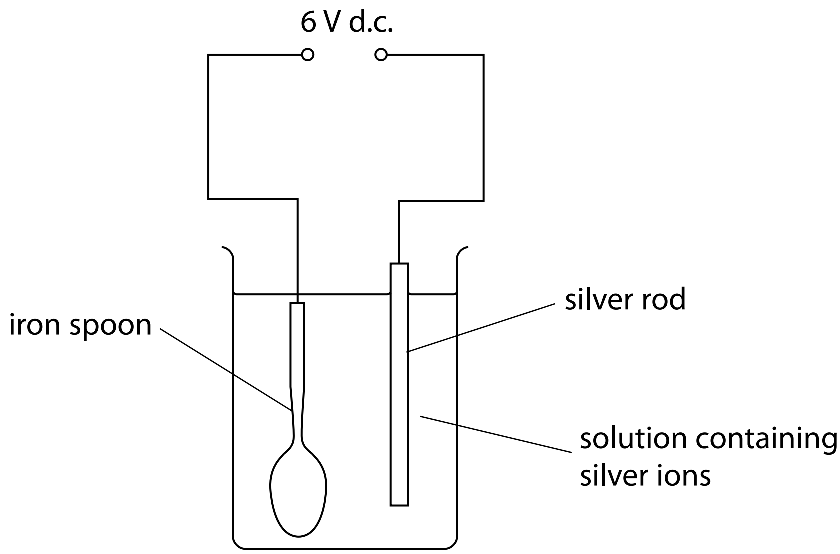

Figure 10

(i) Which row of the table correctly shows the charge on the silver rod electrode and the type of reaction occurring at this electrode?

(1)

		charge	type of reaction
☒	**A**	negative	oxidation
☒	**B**	negative	reduction
☒	**C**	positive	oxidation
☒	**D**	positive	reduction

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(ii) Silver metal is deposited on the spoon.

Which half-equation represents this reaction?

(1)

☒ **A** $Ag + e \rightarrow Ag^{+}$

☒ **B** $Ag \rightarrow Ag^{+} + e^{-}$

☒ **C** $Ag^{+} + e \rightarrow Ag$

☒ **D** $Ag^{+} \rightarrow Ag + e^{-}$

(b) The voltage of a cell is 1.5 V.

Give a reason why this voltage of the cell decreases when the cell is left connected in a circuit.

(1)

....

....

(c) Duralumin is an alloy of aluminium and copper.

The radii of the aluminium and copper atoms are shown in Figure 11.

	radius of atom / m
aluminium	1.43×10^{-12}
copper	1.27×10^{-12}

Figure 11

Explain why copper added to aluminium to form the alloy makes the alloy stronger than pure aluminium.

(2)

....

....

....

....

(d) Gold is often alloyed with other metals when it is used to make jewellery.

The proportion of gold in a piece of gold jewellery is measured in carats.

Pure gold is 24 carats.

A 9 carat gold ring has a mass of 12 g.

Calculate the mass of gold in this ring.

(2)

mass of gold ring = ... g

(Total for Question 5 = 7 marks)

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6 Electrodes are placed in three different solutions, **J**, **K** and **L**.

A 6 V direct current source is connected to the electrodes.

Any products formed at the electrodes are identified.

The results are given in Figure 12.

solution	solution conducts electricity	product at cathode	product at anode
J	yes	copper	chlorine
K	yes	hydrogen	oxygen
L	no	none	none

Figure 12

(a) Explain which solutions are electrolytes.

(2)

....

....

....

....

(b) Which material is most suitable to make the electrodes for the electrolysis of a dilute acid?

(1)

☒ **A** zinc

☒ **B** sulfur

☒ **C** iron

☒ **D** graphite

(c) When a solution of sodium sulfate, Na_2SO_4, is electrolysed, the products formed at the electrodes are hydrogen and oxygen.

Explain the formation of the products at the electrodes.

(4)

....

....

....

....

....

....

....

....

(d) Copper is purified by the electrolysis of copper sulfate solution using an impure copper anode and a pure copper cathode.

Write the half-equation for the formation of a copper atom from a copper ion.

(2)

....

(Total for Question 6 = 9 marks)

7 Sulfur trioxide is produced by reacting sulfur dioxide with oxygen.

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

(a) (i) This reaction takes place in industry at 1–2 atm pressure and can reach a dynamic equilibrium.

Explain the effect on the rate of attainment of equilibrium, if the process is carried out at a pressure higher than 1–2 atm.

(3)

....

....

....

....

....

....

(ii) What volume of oxygen, in cm^3, would react completely with 500 cm^3 sulfur dioxide?

(1)

☒ **A** 500 ÷ 2

☒ **B** 500

☒ **C** 500 × 2

☒ **D** 500 × 32

(b) When there are alternative methods of producing a product, the final pathway is chosen by considering atom economy, cost of energy, yield of product and rates of reactions.

State another factor that should also be considered.

(1)

....

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*(c) The reaction between nitrogen and hydrogen is exothermic.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

If nitrogen and hydrogen were reacted at 150 atm pressure and 300 °C, without a catalyst, some ammonia would be formed.

In the Haber process a pressure of 150 atm and a temperature of 450 °C are used, in the presence of an iron catalyst.

Explain why the conditions used in the Haber process are better than the first set of conditions for the manufacture of ammonia.

(6)

(Total for Question 7 = 11 marks)

8 Figure 13 shows a model of how particles are arranged in a solid.

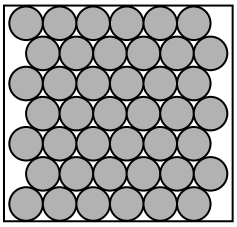

Figure 13

(a) (i) State **two** ways in which this model fails to accurately represent a crystal of sodium chloride.

(2)

1 ....

....

2 ....

....

(ii) Magnesium oxide has a melting point of 2852 °C.

Explain why magnesium oxide has such a high melting point.

(3)

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(b) (i) Carbon dioxide can be formed by the reaction of calcium carbonate, $CaCO_3$, with dilute hydrochloric acid.

Write the balanced equation for this reaction.

(3)

(ii) The thermal decomposition of copper carbonate forms copper oxide and carbon dioxide.

$$CuCO_3(s) \rightarrow CuO(s) + CO_2(g)$$

15.0 g of pure copper carbonate is decomposed completely.

Calculate the mass of solid produced.

(relative atomic masses: C = 12.0; O = 16.0; Cu = 63.5)

Give your answer to two significant figures.

(2)

mass of solid = ... g

(c) Magnesium reacts with water in the form of steam as shown in the equation.

$$Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2$$

2.4 g of magnesium reacts with sufficient steam for a complete reaction to form 5.8 g of magnesium hydroxide and 0.2 g of hydrogen.

Show, by calculation, that the law of conservation of mass applies to this reaction.

(relative atomic masses: H = 1.0, O = 16, Mg = 24)

(3)

(Total for Question 8 = 13 marks)

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9 Some acids such as hydrochloric acid are described as strong acids.
Some acids such as ethanoic acid are described as weak acids.

(a) (i) Explain the difference between a strong acid and a weak acid.

(2)

....

....

....

....

(ii) Give a reason why adding hydroxide ions to an acid solution leads to an increase in pH.

(1)

....

....

(b) The salt zinc nitrate can be made by reacting zinc oxide, ZnO, with dilute nitric acid, HNO_3.

Write the balanced equation for this reaction.

(2)

....

(c) $50\,cm^3$ of potassium hydroxide solution of concentration $40\,g\,dm^{-3}$ is needed for an experiment.

Calculate the mass of potassium hydroxide that must be dissolved in water to make $50\,cm^3$ of solution of this concentration.

(2)

mass of potassium hydroxide = ... g *(d) Salts of metals can be made by reacting one of the metal's compounds with the appropriate acid.

Plan an experiment to prepare pure, dry crystals of magnesium sulfate, $MgSO_4$, by reacting a suitable magnesium compound with a suitable acid.

You may use equations if you wish.

(6)

(Total for Question 9 = 13 marks)

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10 (a) In an experiment, ammonia gas is made by heating a mixture of ammonium chloride and calcium hydroxide.

$$2NH_4Cl(s) + Ca(OH)_2(s) \rightarrow CaCl_2(s) + 2NH_3(g) + 2H_2O(l)$$

10.0 g of ammonium chloride is added to an excess of calcium hydroxide.

Calculate the maximum volume of ammonia gas that could be formed.

(relative atomic mass H = 1.00, N = 14.0, O = 16.0 and Ca = 40.0; one mole of any gas occupies 24 dm^3 at room temperature and pressure)

(2)

volume = ... dm^3

(b) Sodium hydroxide solution reacts with hydrochloric acid.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

(i) 25.0 cm^3 of 0.100 mol dm^{-3} sodium hydroxide, NaOH, solution is added to 35.0 cm^3 of 0.0750 mol dm^{-3} dilute hydrochloric acid, HCl.

Use the information to determine which reagent is in excess.

(3)

(ii) To find the exact amount of dilute hydrochloric acid that reacts with 25.0 cm^3 of the sodium hydroxide solution, a titration is carried out. Figure 14 shows the results for the titrations.

	1st titration	2nd titration	3rd titration	4th titration
final burette reading / cm^3	37.60	36.20	39.15	38.40
initial burette reading / cm^3	1.80	0.00	3.95	2.10
volume of acid used / cm^3	35.80	36.20	35.20	36.30

Figure 14

In this titration, the accurate volumes of acid used that are within 0.20 cm^3 of each other are considered concordant volumes.

Use the concordant results to calculate the mean volume of hydrochloric acid required.

(1)

mean volume = ... cm^3

(iii) During the titration, the indicator used changed colour at the end point.

Which of the following shows an indicator with the colour change that would be seen in this titration?

(1)

		indicator	colour in alkali	colour at end point
☒	**A**	phenolphthalein	colourless	pink
☒	**B**	phenolphthalein	pink	yellow
☒	**C**	methyl orange	red	yellow
☒	**D**	methyl orange	yellow	orange

(c) In another titration, 25.0 cm^3 of a different sodium hydroxide solution is titrated with 0.200 mol dm^{-3} sulfuric acid, H_2SO_4.

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

24.80 cm^3 of acid are required to neutralise 25.0 cm^3 of the sodium hydroxide solution.

Calculate the concentration of the sodium hydroxide solution, NaOH, in mol dm^{-3}.

(4)

concentration = ... mol dm^{-3}

(Total for Question 10 = 11 marks)

TOTAL FOR PAPER = 100 MARKS

The Periodic Table of the Elements

Key

relative atomic mass **atomic symbol** name atomic (proton) number

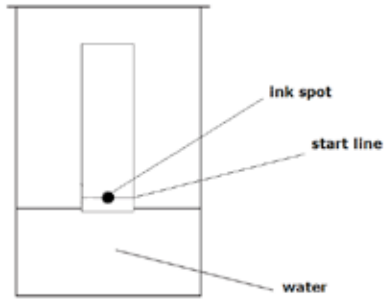
1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

**** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.***

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

Paper 1 Higher

Question number	Answer	Mark
1(a)(i)	Pencil is insoluble in the solvent (but chromatography would separate the ink in an ink line).	(1)

Question number	Answer	Mark
1(a)(ii)	Correct position of chromatography paper with start line and ink spot above surface of water. 	(1)

Question number	Answer	Additional guidance	Mark
1(a)(iii)	• R_f = 14.5 / 15.3= 0.9477 (1) • = 0.95 (answer to 2 significant figures) (1)	Award full marks for correct numerical answer without working.	(2)

Question number	Answer	Mark
1(b)(i)	B	(1)

Question number	Answer	Mark
1(b)(ii)	use a different solvent.	(1)

Question number	Answer	Mark
1(b)(iii)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (1 mark): • mixture S (1) • because it gives the greatest number of spots/gives four spots (1)	(2)

Question number	Answer	Additional guidance	Mark
2(a)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (1 mark): • a negative ion must have more electrons than protons in the particle (1) • therefore Z will have a 2– charge (1)	Do not allow any comparison involving neutrons.	**(2)**

Question number	Answer	Additional guidance	Mark
2(b)	40 + 2 × (14 + 16 × 3) (1) = 164 (1)	Award full marks for correct numerical answer without working.	**(2)**

Question number	Answer	Mark
2(c)	• Li ion with empty outer shell (1) • 1+ charge on Li (1) • 8 electrons on outer shell of F (1) • 1– charge on F (1)	**(4)**

Question number	Answer	Mark
3(a)(i)	C	**(1)**

Question number	Answer	Mark
3(a)(ii)	C	**(1)**

Question number	Answer	Mark
3(b)	Any two of the following points. For the acid, use the same: • volume (1) • concentration (1) • temperature (1)	**(2)**

Question number	Answer	Mark
3(c)(i)	electrolysis (1)	**(1)**

Question number	Answer	Mark
3(c)(ii)	An answer that combines identification- knowledge (1 mark) and understanding (1 mark) and reasoning/justification- understanding (1 mark) • aluminium compounds are more stable than iron compounds (1) • so carbon is not a strong enough reducing agent to produce aluminium from its ore (1)	**(2)**

Question number	Answer	Mark
3(d)	$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ • Correct formulae (1) • Balancing of correct formulae (1)	**(2)**

Question number	Answer	Mark
4(a)	<table><tr><th>salt</th><th>soluble</th><th>insoluble</th></tr><tr><td>ammonium chloride</td><td>✓</td><td></td></tr><tr><td>lithium sulfate</td><td>✓</td><td></td></tr><tr><td>magnesium carbonate</td><td></td><td>✓</td></tr></table> • All three correct (2) • Any two correct (1)	**(2)**

Question number	Answer	Additional guidance	Mark
4(b)	• mass values in correct places (1) • multiplication by 100 (1) • correct final answer to two significant figures (1)	$\frac{2.53}{2.85} \times 100 = 88.8\%$ 89% (to 2 s.f.) Award full marks for correct numerical answer without working.	**(3)**

Question number	Answer	Mark
4(c)	An explanation that combines identification – improvement of the experimental procedure (maximum 2 marks) and justification/reasoning, which must be linked to the improvement (maximum 2 marks): • add excess sodium sulfate solution rather than a few drops (1) • so more reaction occurs to form more lead sulfate (1) • filter the reaction mixture rather than pour off the liquid(1) • so none of the lead sulfate is lost on separation(1) • wash the lead sulfate (1) • so the impurities are removed (1) • place the lead sulfate in an oven/warm place (1) • so the lead sulfate is dry (1)	**(4)**

Question number	Answer	Mark
4(d)	• volumes of solution too large for titration method (1) • large volumes of liquid need to be heated and then allowed to crystallise (1)	**(2)**

Question number	Answer	Mark
5(a)(i)	C	**(1)**

Question number	Answer	Mark
5(a)(ii)	C	**(1)**

Question number	Answer	Mark
5(b)	reactants are being used up (1)	**(1)**

Question number	Answer	Mark
5(c)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (1 mark): • aluminium and copper have different size atoms (1) • and so this prevents the layers of metal atoms from sliding over one another (1)	**(2)**

Question number	Answer	Additional guidance	Mark
5(d)	proportion gold = 9 ÷ 24 (= 0.375) (1) mass = 0.375 × 12 = 4.5 (g) (1)	Award full marks for correct numerical answer without working.	**(2)**

Question number	Answer	Mark
6(a)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): • **J** and **K** are electrolytes (1) • because their solutions conduct electricity and are decomposed (1)	**(2)**

Question number	Answer	Mark
6(b)	D	**(1)**

Question number	Answer	Mark
6(c)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (3 marks): • hydrogen (H^+) and sodium (Na^+) ions attracted to cathode, hydroxide (OH^-) ions and sulfate (SO_4^{2-}) ions attracted to anode (1) • because the ions are attracted to the oppositely charged electrode (1) • 2 hydrogen ions/2 H^+ accept 2 e to form hydrogen molecule/H_2 (1) • 4 hydroxide ions/4 OH^- lose 4 e to form oxygen molecule/O_2 (1)	**(4)**

Question number	Answer	Mark
6(d)	$Cu^{2+} + 2e^- \rightarrow Cu$ • all species (1) • balancing (1)	**(2)**

Question number	Answer	Mark
7(a)(i)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (2 marks): • rate increased/time to reach equilibrium reduced (1) • because gas molecules closer/more concentrated (1) • so increased collision rate/more frequent collisions(1)	**(3)**

Question number	Answer	Mark
7(a)(ii)	A	**(1)**

Question number	Answer	Mark
7(b)	equilibrium position/usefulness of by-products	**(1)**

Question Number	Indicative content
7(c)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1 (6 marks)** The effect of the temperature rise on the rate of attainment of equilibrium and on the equilibrium yield are considered by: • higher temperature reaches equilibrium faster because molecules move faster • therefore there are more frequent collisions because molecules have more energy • therefore more collisions have required energy but yield will be lower • because higher temperature favours endothermic reaction and so equilibrium shifts to left hand side • which is decomposition of ammonia / ammonia reforms elements • catalyst causes reaction to reach equilibrium faster / catalyst increases rates (of both forward and back reactions) • lowers the activation energy (of both forward and back reactions) but does not affect yield • equilibrium position not affected.

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

Question number	Answer	Additional guidance	Mark
8(a)(i)	• particles are same size when they should be different sizes (1) • model is in 2D but crystal is 3D (1)	Allow reverse statements giving correct information.	**(2)**

Question number	Answer	Mark
8(a)(ii)	An explanation that combines identification – knowledge (1 mark) and reasoning/justification – understanding (2 marks): • very strong bonds/ionically bonded (1) • between 2+ cations and 2– anions (1) • so requires lot of energy to separate magnesium and oxide ions to melt the solid (1)	**(3)**

Question number	Answer	Additional guidance	Mark
8(b)(i)	$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$ • all formulae on correct side (2) • balancing (1)	Allow 3/4 formulae (1)	**(3)**

Question number	Answer	Additional guidance	Mark
8(b)(ii)	relative formula mass copper carbonate = 63.5 +12.0 +(3 × 16.0) = 123.5 relative formula mass copper oxide = 63.5 + 16.0 = 79.5 (1) mass copper oxide $= \frac{15.0 \times 79.5}{123.5}$ = 9.7 g to 2 s.f. (1) Answer must be to two significant figures OR moles of copper carbonate $= \frac{15.0}{123.5}$ = 0.121 45 (1) mass of copper oxide = moles $CuCO_3$ × 79.5 = 9.7 g to 2sf (1) Answer must be to two significant figures	Award full marks for correct numerical answer without working.	**(2)**

Question number	Answer	Additional guidance	Mark
8(c)	2.4/24 moles Mg = 0.1 mol (1) and 0.2 moles H_2O has mass 0.2 × formula mass H_2O = 3.6 g (1) total mass reactants = 2.4 + 3.6 = 6.0 g is the same as total mass products = 5.8 + 0.2 = 6.0 g (1)	Award full marks for correct numerical answer without working.	**(3)**

Question number	Answer	Mark
9(a)(i)	An explanation that makes reference to: identification – knowledge (1 mark) and reasoning /justification – knowledge (1 mark): • a strong acid is completely ionised in solution/exists completely as ions (1) • but a weak acid is only partly ionised/exists mainly as molecules with very few ions present (1)	**(2)**

Question number	Answer	Mark
9(a)(ii)	hydroxide ions react with hydrogen ions and reduce the hydrogen ion concentration therefore increase pH (1)	**(1)**

Question number	Answer	Mark
9(b)	$ZnO + 2HNO_3 \rightarrow Zn(NO_3)_2 + 2H_2O$ • zinc nitrate formula (1) • full, balanced equation (1)	**(2)**

Question number	Answer	Additional guidance	Mark
9(c)	mass = $50 \times \frac{40}{1000}$ (1) = 2 (g) (1)	Award full marks for correct numerical answer without working.	**(2)**

Question Number	Indicative content
9(d)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO2 (3 marks)** • suitable acid: sulfuric acid • suitable substance : magnesium oxide / magnesium carbonate / magnesium hydroxide / magnesium • equation for reaction: $MgO + H_2SO_4 \rightarrow MgSO_4 + H_2O$/ $Mg(OH)_2 + H_2SO_4 \rightarrow MgSO_4 + 2H_2O$/ $MgCO_3 + H_2SO_4 \rightarrow MgSO_4 + H_2O + CO_2$/ $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$ **AO3 (3 marks)** • add solid to warmed acid until in excess solid remains (oxide and hydroxide) / add solid a little at a time until no more bubbles (carbonate/metal) • filter off the excess solid, pour remaining solution into an evaporating basin • {heat solution / leave the water to evaporate} • until pure salt crystals form and then dry salt crystals with absorbent paper/leave to dry.

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• The plan attempts to link and apply knowledge and understanding of scientific enquiry, techniques and procedures, flawed or simplistic connections made between elements in the context of the question. (AO2) • Analyses the scientific information but understanding and connections are flawed. An incomplete plan that provides limited synthesis of understanding. (AO3)
Level 2	3–4	• The explanation is mostly supported through linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, some logical connections made between elements in the context of the question. (AO2) • Analyses the scientific information and provides some logical connections between scientific enquiry, techniques and procedures. A partially completed plan that synthesises mostly relevant understanding, but not entirely coherently. (AO3)
Level 3	5–6	• The explanation is supported throughout by linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, logical connections made between elements in the context of the question. (AO2) • Analyses the scientific information and provide logical connections between scientific concepts throughout. A well-developed plan that synthesises relevant understanding coherently. (AO3)

Question number	Answer	Additional guidance	Mark
10(a)	Formula mass ammonium chloride = 14.0 + 4.00 + 35.5 = 53.5 moles of ammonium chloride $= \frac{10.0}{53.5} = 0.187$ (1) volume ammonia = 0.187 × 24 = 4.49 dm^3 (1) or • 2 × 53.5 = 107 g ammonium chloride produces 2 × 24 = 48 dm^3 ammonia (1) • 10.0 g ammonium chloride produces $\frac{10.0}{2 \times 53.5} \times 2 \times 24 = 4.49\ dm^3$ ammonia (1)	Award full marks for correct numerical answer without working.	**(2)**

Question number	Answer	Additional guidance	Mark
10(b)(i)	25 ÷ 1000 × 0.1 = 0.0025 (1) 35 ÷ 1000 × 0.075 = 0.002 625 (1) The acid is in excess (1)	Third mark only awarded as conclusion from calculated data.	**(3)**

Question number	Answer	Mark
10(b)(ii)	$\frac{36.20 + 36.30}{2} = 36.25$ (1)	**(1)**

Question number	Answer	Mark
10(b)(iii)	D	**(1)**

Question number	Answer	Additional guidance	Mark
10(c)	mol of acid = 24.80 ÷ 1000 × 0.200 (= 0.004 96 mol) (1) mol NaOH = 2 × 0.004 96 (= 0.009 92) (1) conc. of NaOH = 0.009 92 ÷ 25.0 × 1000 (1) = 0.3968/0.397 (mol dm^{-3}) (1) or (25.00 × conc NaOH) ÷ 2 = 24.80 × 0.200 (2) conc NaOH = 2 × 24.80 × 0.200 ÷ 25.00 (1) = 0.3968/0.397 (mol dm^{-3}) (1)	Award full marks for correct numerical answer without working. Allow max 3 marks if missing '2 ×' in step 2.	**(4)**

Write your name here

Surname	Other names

Pearson Edexcel
Level 1/Level 2 GCSE (9-1)

Centre Number

Candidate Number

Chemistry

Paper 2

Higher Tier

Sample Assessment Materials for first teaching September 2016

Time: 1 hour 45 minutes

Paper Reference

1CH0/2H

You must have:
a calculator
a ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- Calculators may be used.
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an asterisk (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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S 5 0 0 4 8 A 0 1 2 8

PEARSON

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ⊠.
If you change your mind about an answer, put a line through the box ⊠ and then mark your new answer with a cross ⊠.

1 This question is about changes to the Earth's atmosphere.

(a) Which of the following is a correct statement about the relative amounts of carbon dioxide and oxygen in the Earth's early atmosphere?

(1)

☐ **A** large amount of carbon dioxide and large amount of oxygen

☐ **B** large amount of carbon dioxide and small amount of oxygen

☐ **C** small amount of carbon dioxide and large amount of oxygen

☐ **D** small amount of carbon dioxide and small amount of oxygen

(b) Several processes change the composition of the Earth's atmosphere.

Describe how the composition of the atmosphere is affected by burning fossil fuels.

(2)

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(c) The graphs in Figure 1 and Figure 2 show the concentration of carbon dioxide in the atmosphere and the mean global temperature between 1960 and 2000.

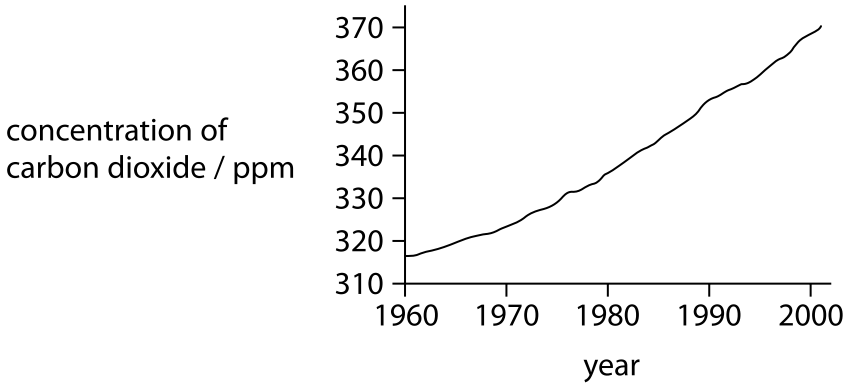

Figure 1

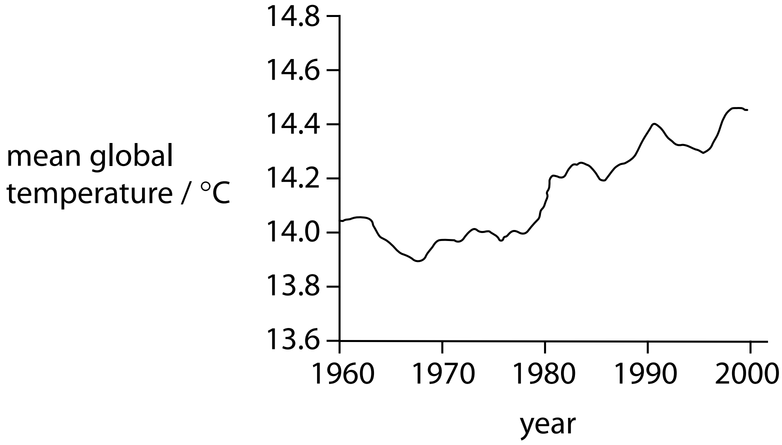

Figure 2

Explain whether these graphs provide evidence that an increase in carbon dioxide is causing the Earth's temperature to rise.

(2)

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....

(d) Which of these pairs of gases are both greenhouse gases?

(1)

☒ **A** nitrogen and methane

☒ **B** nitrogen and oxygen

☒ **C** oxygen and water vapour

☒ **D** water vapour and methane

(Total for Question 1 = 6 marks)

2 Magnesium and calcium are in group 2 of the periodic table. They are less reactive than the metals in group 1.

(a) Calcium reacts with water to form calcium hydroxide, $Ca(OH)_2$, and hydrogen, H_2.

$$Ca(s) + 2H_2O(l) \rightarrow Ca(OH)_2(s) + H_2(g)$$

Describe what would be **seen** when a piece of calcium is dropped into a container of water.

(2)

....

....

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....

(b) Magnesium reacts very slowly with cold water but it reacts faster with steam, H_2O, and forms magnesium oxide, MgO, and hydrogen.

Write the balanced equation for the reaction between magnesium and steam.

(2)

....

(c) The electronic configurations of magnesium and calcium are

magnesium 2.8.2
calcium 2.8.8.2

When magnesium and calcium react with water they form positive ions.

Suggest an explanation, in terms of their electronic configurations, why calcium is more reactive than magnesium.

(2)

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(d) A sample of calcium bromide contains 0.2 g calcium and 0.8 g bromine by mass.

Calculate the empirical formula of calcium bromide.

(relative atomic masses: Ca = 40, Br = 80)

(3)

empirical formula = ...

(Total for Question 2 = 9 marks)

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DO NOT WRITE IN THIS AREA

3 Crude oil is a mixture of hydrocarbons.

It can be separated into fractions.

(a) Which of these mixtures shows formulae of substances that could be in the gaseous fraction of crude oil?

(1)

☒ **A** C_2H_4, C_3H_8, $C_4H_{10}O$

☒ **B** C_2H_4, C_3H_7Br, C_4H_{10}

☒ **C** C_2H_6, C_3H_8, C_4H_{10}

☒ **D** C_2H_6, C_3H_7Br, $C_4H_{10}O$

(b) Figure 3 shows the percentages of the fractions in crude oil from three different oil wells.

	percentage of fraction in crude oil from		
fraction	**oil well A**	**oil well B**	**oil well C**
gases	1	6	9
petrol	2	15	24
kerosene	6	14	20
diesel oil	7	10	16
fuel oil	26	28	30
bitumen	58	27	1

Figure 3

(i) State which oil well contains the greatest combined total of diesel oil and fuel oil.

(1)

....

(ii) State which oil well produces a crude oil containing the highest percentage of the high boiling point fractions.

(1)

....

(c) Fractions of crude oil contain alkanes.

A sample of decane, $C_{10}H_{22}$, cracked using the apparatus in Figure 4.

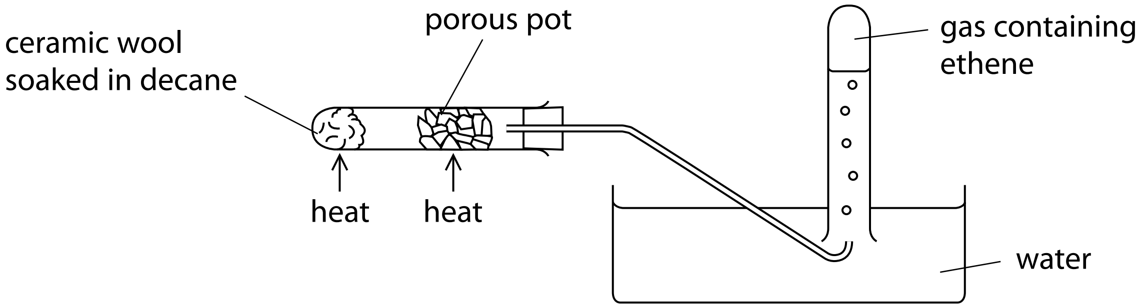

Figure 4

(i) Explain how ethene is produced using the apparatus in Figure 4.

(3)

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(ii) One molecule of decane produced two molecules of propene, C_3H_6, and one molecule of product **Z**.

$C_{10}H_{22} \rightarrow 2C_3H_6$ + product **Z**

What is the formula of product **Z**?

(1)

☒ **A** C_4H_8

☒ **B** C_4H_{10}

☒ **C** C_7H_{14}

☒ **D** C_7H_{16}

(iii) When decane undergoes complete combustion, a mixture of carbon dioxide and water is formed.

Complete the balanced equation for this reaction.

(2)

$$2C_{10}H_{22} + \text{.......................} \; O_2 \rightarrow \text{.......................} \; CO_2 + \text{.......................} \; H_2O$$

(Total for Question 3 = 9 marks)

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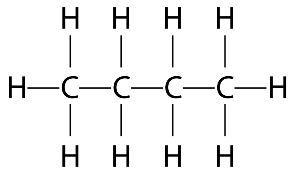
4 Alkanes and alkenes are hydrocarbons.

The structure of a molecule of butane is shown.



(a) Which of the following is the empirical formula for butane?

(1)

☒ **A** CH

☒ **B** CH_2

☒ **C** C_2H_5

☒ **D** C_4H_{10}

(b) Figure 5 shows some information about the alkenes, ethene and propene.

Complete the table. The structure of propene must show all covalent bonds.

(2)

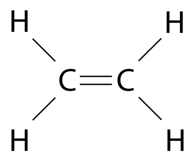
name of alkene	molecular formula	structure
ethene		
propene	C_3H_6	

Figure 5

(c) Butene reacts with steam to produce butanol.

$$C_4H_8 + H_2O \rightarrow C_4H_9OH$$

(i) Calculate the maximum mass of butanol, C_4H_9OH, that can be produced when 1.4 kg of butene, C_4H_8, reacts with excess steam.

(relative atomic masses: H = 1, C = 12, O = 16
relative molecular mass of butene, C_4H_8 = 56)

(3)

mass of butanol = ... kg

(ii) What type of reaction takes place between butene and steam?

(1)

☒ **A** addition

☒ **B** dehydration

☒ **C** neutralisation

☒ **D** substitution

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DO NOT WRITE IN THIS AREA

(d) A sample of each of three hydrocarbons, **X**, **Y** and **Z**, was shaken with bromine water. Bromine water is orange coloured.

The results are:

X orange mixture becomes colourless

Y orange mixture becomes colourless

Z mixture remains orange

Using the results, comment on the structures of the hydrocarbons **X**, **Y** and **Z**.

(2)

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....

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....

(Total for Question 4 = 9 marks)

5 Qualitative tests are used to identify ions.

(a) A student carries out a flame test on an unknown solid.
A red flame is seen.
The student concludes that the solid is lithium carbonate.

Explain why this conclusion is **not** justified.

(2)

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(b) The following tests were carried out on a substance containing two ions.

1. A flame test on the solid substance produced a yellow colour.
2. Dilute hydrochloric acid was added to a solution of the substance followed by a few drops of barium chloride solution.
   A white precipitate formed.

Give the name and formula of the substance.

(2)

Name of substance ....

Formula of substance ....

(c) The test for chloride ions was carried out on a solution.
Dilute nitric acid was added to the solution, followed by a few drops of silver nitrate solution.
A white precipitate formed.

Why is it necessary to add dilute nitric acid in this test?

(1)

☒ **A** To neutralise the solution

☒ **B** Nitrate ions are needed for the test to work

☒ **C** To make sure that no carbonate ions are present

☒ **D** The test only works in alkaline conditions

(d) Sodium hydroxide solution is used to identify some cations present in compounds.

(i) Sodium hydroxide solution is warmed with a solution of ammonium ions. Ammonia gas is given off.

Describe the test to show the gas is ammonia.

(2)

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(ii) Sodium hydroxide solution is also used to distinguish between iron(II) ions, Fe^{2+} and iron(III) ions, Fe^{3+}, in solution.

You are given a solution containing iron(II) ions and another solution containing iron(III) ions.

Describe what is seen when sodium hydroxide solution is added to each of these solutions.

(2)

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....

....

....

(iii) Iron(III) ions, Fe^{3+}, react with hydroxide ions in solution to form iron(III) hydroxide.

Complete the ionic equation for this reaction.

(1)

$Fe^{3+} + 3OH^{-} \rightarrow$ ....

(Total for Question 5 = 10 marks)

6 This question is about properties of materials.

(a) Figure 6 shows some properties of steel and Kevlar®.

property	steel	Kevlar®
density / g cm^{-3}	7.85	1.44
relative strength	1	5
flexibility	low	high
resistance to corrosion	low	high

Figure 6

Body armour, such as a bullet-proof vest, could be manufactured using either of these materials.

Explain **two** reasons why Kevlar® is preferred to steel as the material for body armour.

(4)

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(b) The use of nanoparticles has increased in recent years.

(i) The length of one side of a cube of silver is 2 cm as shown in Figure 7.

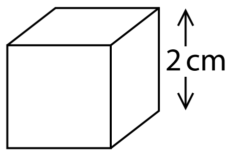

Figure 7

Calculate the surface area to volume ratio of this cube of silver.

(3)

surface area to volume ratio = ...

(ii) Suggest an explanation of why a given mass of silver is more effective as a catalyst when used as nanoparticles rather than in a powder form.

(3)

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(Total for Question 6 = 10 marks)

7 A student investigated the rate of reaction between dilute hydrochloric acid and marble chips (calcium carbonate).

Calcium chloride, carbon dioxide and water are formed.

(a) Complete and balance the equation for the reaction.

(2)

$CaCO_3 + HCl \rightarrow$ .... + ... + ...

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(b) The student investigated the rate by using different sizes of marble chips. In their investigation, the same mass of marble chips was used in each experiment.

The volume of gas given off was measured.

The graph in Figure 8 shows the results.

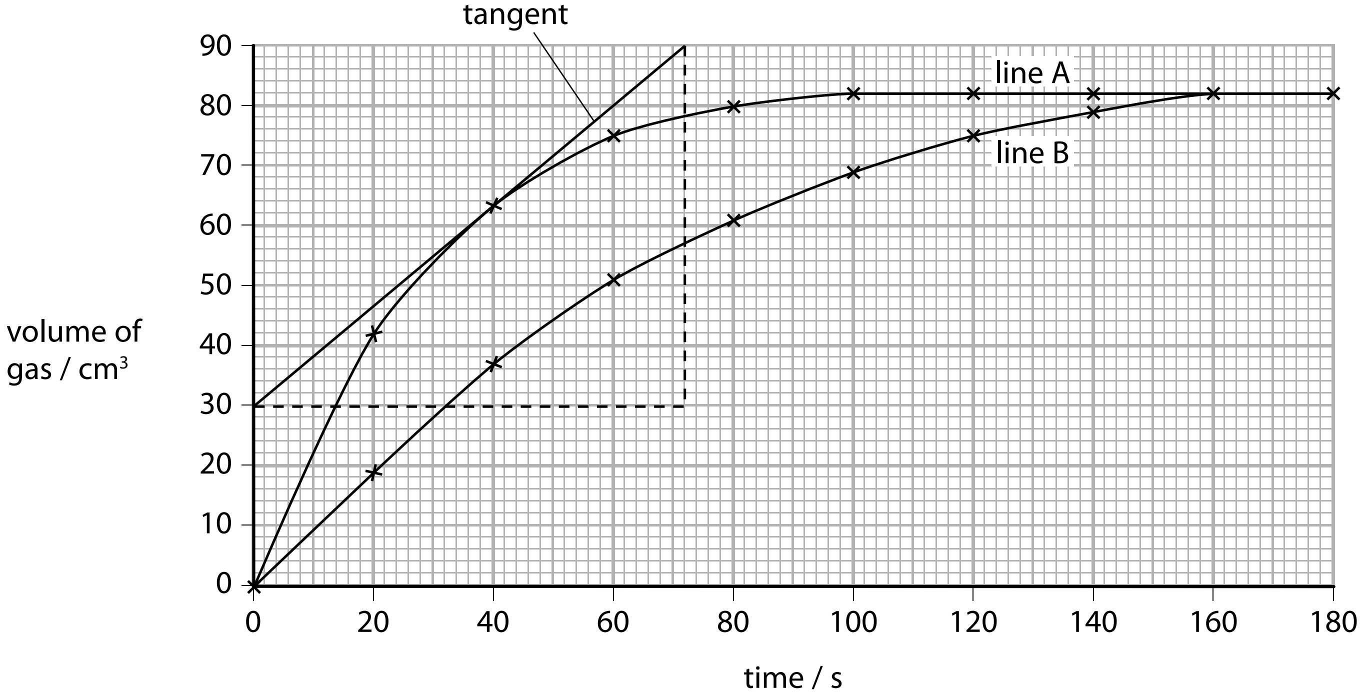

Figure 8

(i) State how the graph shows that line B gives the results for the larger marble chips.

(1)

....

....

(ii) A tangent has been drawn on line A.

Calculate the rate of reaction at this point.

(2)

rate of reaction = ... $cm^3\,s^{-1}$

(c) During any reaction, reactants are used up and the rate of reaction decreases.

Explain, in terms of particles, why the rate of reaction decreases.

(2)

....

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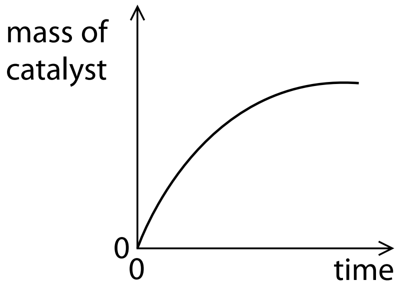
(d) The decomposition of hydrogen peroxide is catalysed by adding a small amount of manganese(IV) oxide.

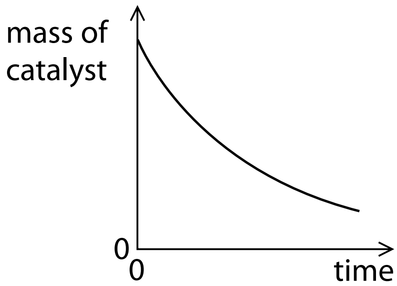
Which of these graphs shows the mass of the catalyst as the reaction takes place?

(1)

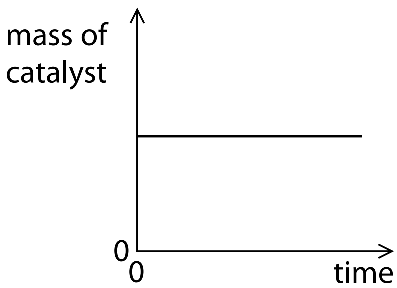
☒ **A**



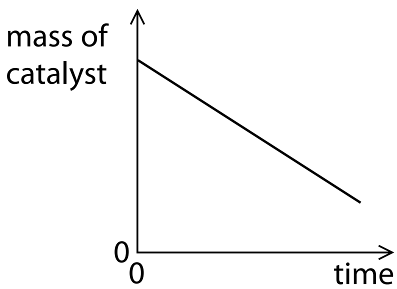
☒ **B**



☒ **C**



☒ **D**



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(e) Two gases, **X** and **Y**, react to give a gaseous product **Z**.

The reaction is carried out under two different sets of conditions in experiments 1 and 2 as shown in Figure 9.

condition	experiment 1	experiment 2
temperature / °C	30	20
pressure / atm	1	2

Figure 9

Explain why it is not possible to predict what the rate of Experiment 2 will be compared with Experiment 1.

(3)

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(Total for Question 7 = 11 marks)

8 The elements chlorine, bromine and iodine are part of group 7 in the periodic table.

(a) The appearances of chlorine, bromine and iodine at room temperature are shown in Figure 10.

halogen	**appearance**
chlorine	green gas
bromine	red-brown liquid
iodine	grey solid

Figure 10

Astatine is the element below iodine in group 7.

Predict the appearance of astatine.

(1)

....

*(b) The order of reactivity of chlorine, bromine and iodine can be determined by carrying out displacement reactions.

Explain how displacement reactions can be used to show the reactivity of these three elements.

(6)

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(c) When iron wool is heated in bromine vapour, it reacts to form iron bromide.

(i) In an experiment, 5.60 g of iron reacted exactly with 24.0 g of bromine, Br_2.

[relative atomic masses: Fe = 56.0, Br = 80.0]

Determine, using this information, the balanced equation for the reaction between iron and bromine.
You must show your working.

(4)

(ii) When iron reacts with bromine, bromide ions are formed.

Explain the type of reaction bromine atoms undergo when they are converted to bromide ions.

(2)

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....

(Total for Question 8 = 13 marks)

9 (a) A student carried out an experiment to prove that candle wax, a hydrocarbon, produces carbon dioxide and water vapour when it burns.

The equipment used is shown in Figure 11.

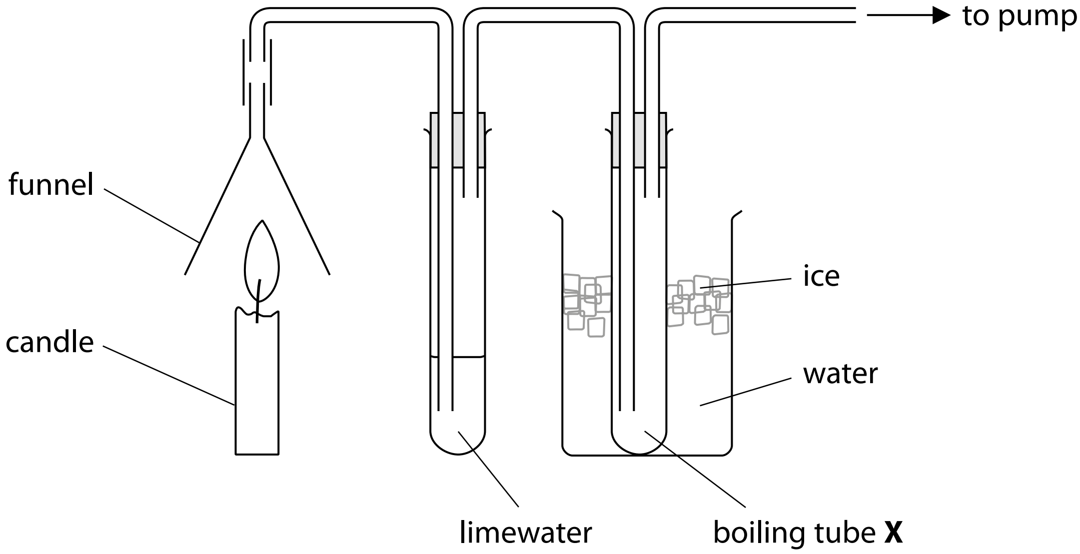

Figure 11

The gas produced from the burning candle is drawn through the apparatus. The limewater turned milky showing that carbon dioxide had been formed.

A small amount of a colourless liquid condensed in boiling tube **X**. The student claimed that this proved that burning candle wax produced water. The teacher said the apparatus had been set up incorrectly and therefore this conclusion about water was not valid.

Explain how the student could modify the equipment to prove that water is produced by burning candle wax.

(2)

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*(b) Polymers are addition or condensation polymers.

Polymers can be formed by using the monomers shown in Figure 12.

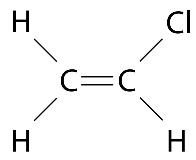
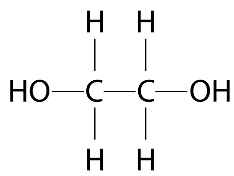
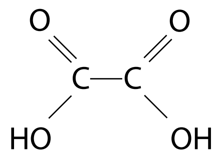
monomer	structure
chloroethene	
ethane-1,2-diol	
ethanedioic acid	

Figure 12

Explain, using appropriate monomers from Figure 12, how different polymers can be formed.

(6)

(c) An alcohol **A**, with molecular formula C_2H_5OH is oxidised to a compound **B** with molecular formula $C_2H_4O_2$.

(i) Compound **B** is not an alcohol and is a member of another homologous series.

State the name of this homologous series.

(1)

....

(ii) Draw the structure of a molecule of compound **A** and a molecule of compound **B**, showing all covalent bonds.

(2)

Compound **A**

Compound **B**

(Total for Question 9 = 11 marks)

10 (a) Each of these substances forms ions in solution.

One mole of the following substances is dissolved in 1 dm^3 of water.

Which solution contains the greatest number of ions?

(1)

☒ **A** ammonium sulfate, $(NH_4)_2SO_4$

☒ **B** iron(III) chloride, $FeCl_3$

☒ **C** magnesium nitrate, $Mg(NO_3)_2$

☒ **D** potassium bromide, KBr

(b) When sodium hydroxide solution is neutralised with an acid there is a temperature change.

A student is given dilute hydrochloric acid and dilute ethanoic acid of the same concentration in $mol\,dm^{-3}$.

Devise a plan to compare the temperature changes produced when sodium hydroxide solution is neutralised with each of these two acids.

(4)

....

....

....

....

....

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....

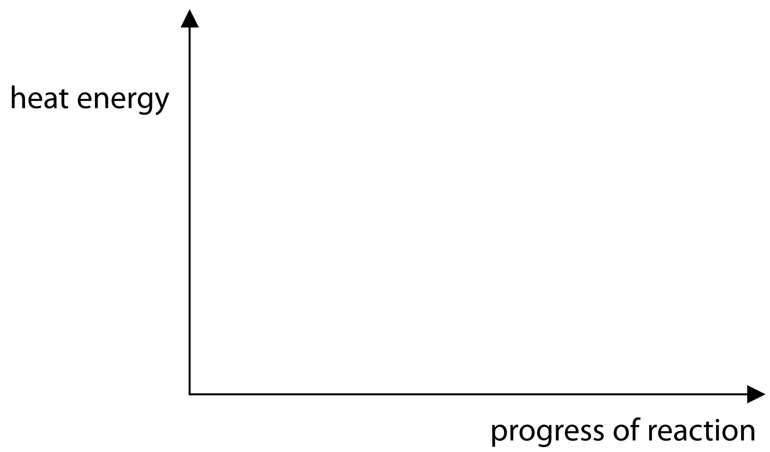
(c) Hydrogen reacts with chlorine to form hydrogen chloride.

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

The reaction is exothermic.

Draw and label the reaction profile diagram for this reaction, identifying the activation energy.

(3)



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(d) The energies of some bonds are shown in Figure 13.

bond	**energy of bond / kJ mol^{-1}**
H—H	436
Cl—Cl	243
H—Cl	432

Figure 13

Hydrogen reacts with chlorine to form hydrogen chloride.

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

Calculate the energy change, in kJ mol^{-1}, for the reaction of 1 mol of hydrogen gas, H_2, with 1 mol of chlorine gas, Cl_2, to form 2 mol of hydrogen chloride gas, HCl.

(4)

energy change = ... kJ mol^{-1}

(Total for Question 10 = 12 marks)

TOTAL FOR PAPER = 100 MARKS

The Periodic Table of the Elements

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

***** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.***

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

Paper 2 Higher

Question number	Answer	Mark
1(a)	B	**(1)**

Question number	Answer	Mark
1(b)	An answer that provides a description by making reference to: • adds carbon dioxide/adds water vapour (1) • removes oxygen (1)	**(2)**

Question number	Answer	Additional guidance	Mark
1(c)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (1 mark): • as concentration of carbon dioxide increases the (mean global) temperature increases (overall) (1) • {but there is no evidence that the increase in (mean global) temperature is caused by the increase in concentration of carbon dioxide/other factors may cause the increase in (mean global) temperature} (1) OR • as concentration of carbon dioxide increases the (mean global) temperature increases (1) • so this does provide evidence that an increase in carbon dioxide is causing the Earth's temperature to rise (1) OR • as concentration of carbon dioxide increases the (mean global) temperature overall increases but {fluctuates/increases and decreases} (1) • so this does not provide evidence that an increase in carbon dioxide is causing the Earth's temperature to rise (1)	Award for conclusion (second mark) only given if reason given	**(2)**

Question number	Answer	Mark
1(d)	D	**(1)**

Question number	Answer	Additional guidance	Mark
2(a)	An answer that combines the following points of understanding to provide a logical description: • (hydrogen produced as a gas so) there would be {effervescence/fizzing/ bubbles} (1) • and (calcium hydroxide produced as a solid so) the water would go {cloudy/a white precipitate would form} (1)	Allow: calcium moves (around) (1) calcium decreases in size/disappears/dissolves (1)	**(2)**

Question number	Answer	Mark
2(b)	$Mg + H_2O \rightarrow MgO + H_2$ • LHS (1) • RHS (1)	**(2)**

Question number	Answer	Additional guidance	Mark
2(c)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): • In calcium the outermost electron(s) {are further away from nucleus /experience(s) greater shielding} (from the nucleus) (as shown by the electronic configuration) (1) • Therefore less attraction between nucleus and electron(s)/ the electron(s) is/are easier to remove (1)	Allow answers in terms of why reactivity of magnesium is less than that of calcium	**(2)**

Question number	Answer	Additional guidance	Mark
2(d)	• divides mass by relative atomic mass (1) • calculates simplest ratio (1) • expresses ratio correctly as empirical formula (1)	<u>Example of calculation</u> Ca : Br $\frac{0.2}{40}$: $\frac{0.8}{80}$ 0.005 : 0.01 1 : 2 empirical formula $CaBr_2$ Formula alone scores max 1	**(3)**

Question number	Answer	Mark
3(a)	C	**(1)**

Question number	Answer	Mark
3(b)(i)	(oil well) C	**(1)**

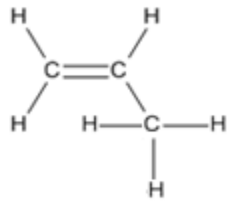
Question number	Answer	Mark
3(b)(ii)	(oil well) A	**(1)**

Question number	Answer	Additional guidance	Mark
3(c)(i)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (2 marks): • when the decane is heated it vaporises/turns to a gas (1) • decane vapour/gas breaks down as it comes in contact with hot porous pot (1) • large molecules of decane produce smaller molecules, including ethene (1)	Do not allow this point if ethane passes over hot porous pot	**(3)**

Question number	Answer	Mark
3(c)(ii)	B	**(1)**

Question number	Answer	Mark
3(c)(iii)	$2C_{10}H_{22}$ + $\mathbf{31}O_2$ → $\mathbf{20}CO_2$ + $\mathbf{22}H_2O$ • LHS (1) • RHS both numbers correct (1)	**(2)**

Question number	Answer	Mark
4(a)	C	**(1)**

Question number	Answer	Additional guidance	Mark
4(b)	• molecular formula – C_5H_{10} (1) • structure (1) 		**(2)**

Question number	Answer	Additional guidance	Mark
4(c)(i)	• calculates relative molecular mass of C_4H_9OH (1) • calculates mass of C_4H_9OH produced (1) • final answer = 1.9 (kg) (1)	<u>Example of calculation</u> Relative molecular mass of C_4H_9OH = $(4 \times 12) + (9 \times 1) + 16 + 1 = 74$ Mass of C_4H_9OH produced = $(74 \div 56) \times 1.4$ Accept 1.85 (kg) Award full marks for use of moles/correct numerical answer without working	**(3)**

Question number	Answer	Mark
4(c)(ii)	A	**(1)**

Question number	Answer	Mark
4(d)	• X and Y are both unsaturated/contain {multiple/double} bonds/alkenes (1) • Z is saturated/contains no {multiple/double} bonds/alkane (1)	**(2)**

Question number	Answer	Mark
5(a)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): • the flame test only confirms the presence of lithium ions/Li^+ (1) • but another test is needed to confirm the identity of the anion/negative ion/CO_3^{2-} (1) OR • the red flame test shows the presence of calcium ions Ca^{2+} and not lithium ions/Li^+ (1) • the student did not test for carbonate ions (1)	**(2)**

Question number	Answer		Mark
5(b)	• name: sodium sulfate (1) • formula: Na_2SO_4 (1)	Allow formula consequential on incorrect name	**(2)**

Question number	Answer	Mark
5(c)	C	**(1)**

Question number	Answer	Additional guidance	Mark
5(d)(i)	An answer that provides a description by making reference to: • test gas with moist (red) litmus paper (1) • turns blue (1)	Allow universal indicator paper/pH paper and yellow to blue/purple	**(2)**

Question number	Answer	Additional guidance	Mark
5(d)(ii)	An answer that provides a description by making reference to: • iron(II) – green/pale green/grey-green **and** precipitate /solid (1) • iron(III) – red-brown/brown **and** precipitate /solid (1)	Allow two correct colours (1)	**(2)**

Question number	Answer	Mark
5(d)(iii)	$(Fe^{3+} + 3OH^-) \rightarrow Fe(OH)_3$	**(1)**

Question number	Answer	Mark
6(a)	An explanation that combines identification via a judgement (maximum 2 marks) to reach a conclusion via justification/reasoning, which must be linked to the judgement (maximum 2 marks): • it is lighter/has a lower density/than steel (1) • so it is easier/more comfortable to wear (1) OR • it is stronger (1) • so it is less likely to be penetrated (1) OR • it is more flexible (1) • so it is easier/more comfortable to wear (1) OR • does not (corrode/rust) (1) • so it will last longer (1)	**(4)**

Question number	Answer	Additional guidance	Mark
6(b)(i)	• calculates total surface area (1) • calculates volume (1) • calculates surface area to volume ratio (1)	<u>Example of calculation</u> Surface area = $6 \times 2 \times 2 = 24\,(\text{cm}^2)$ Volume = $2 \times 2 \times 2 = 8\,(\text{cm}^3)$ Surface area to volume ratio = 24/8 = 3 : 1 Award full marks for correct numerical answer without working	**(3)**

Question number	Answer	Mark
6(b)(ii)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (2 marks): • silver nanoparticles have a much greater surface area to volume ratio than powder (1) OR • silver nanoparticles have a much greater surface area than the same volume of a powder (1) Plus • because chemical reactions take place on the surface of the solid silver catalyst (1) • so there will be more frequent collisions/the rate of reaction will be faster (1) OR • So in a given time, more molecules can come together to react (1)	**(3)**

Question number	Answer	Additional guidance	Mark
7(a)	$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$ • LHS (1) • RHS (1)	Allow products in any order	**(2)**

Question number	Answer	Mark
7(b)(i)	(line B) less steep/(line B) flattens later (1)	**(1)**

Question number	Answer	Mark
7(b)(ii)	• Slope = 60 ÷ 72 (1) • = 0.83(3) ($cm^3\ s^{-1}$) (1)	**(2)**

Question number	Answer	Mark
7(c)	An explanation that makes reference to: identification – knowledge (1 mark) and reasoning/justification – knowledge (1 mark): • fewer particles/as the reactants are used up there will be fewer particles to react/lower concentration of particles (1) • this will result in a lower frequency of collisions so fewer particles reacting in a given time (1)	**(2)**

Question number	Answer	Mark
7(d)	C	**(1)**

Question number	Answer	Mark
7(e)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (2 marks): • the decrease in temperature will cause a decrease in rate of reaction (1) • and the increase in pressure will cause an increase in rate of reaction (1) • because the changes have opposite effects on the rate it is not possible which has the greater effect (1)	**(3)**

Question number	Answer	Mark
8(a)	Candidates relate information given to order of elements in the periodic table to predict: dark grey/black **and** solid/crystals	**(1)**

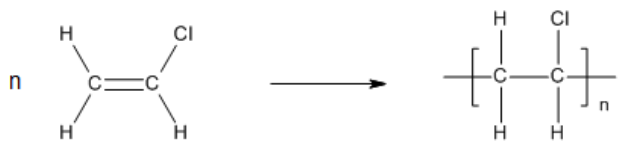
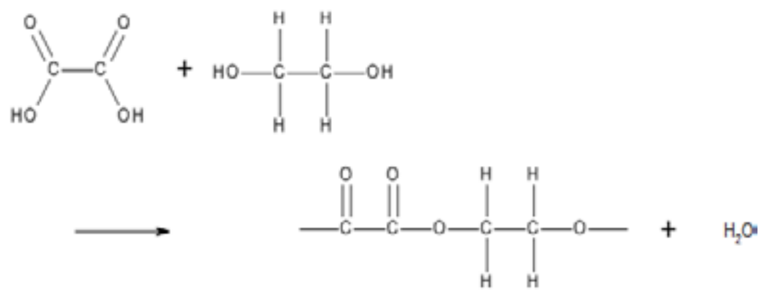
Question number	Indicative content	Mark
*8(b)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1 (6 marks)** • order of reactivity: chlorine > bromine > iodine The order of reactivity supported by suitable experiments from: • add (aqueous) chlorine to a solution of potassium bromide • the solution turns orange/yellow • bromine is produced / $Cl_2 + 2KBr \rightarrow Br_2 + 2KCl$ / $Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$ • (so) chlorine is more reactive than/displaces bromine /oxidises bromide ions • add (aqueous) bromine to a solution of potassium iodide • the solution turns yellow/red/ brown • iodine is produced / $Br_2 + 2KI \rightarrow I_2 + 2KBr$ / $Br_2 + 2I^- \rightarrow I_2 + 2Br^-$ • (so) bromine is more reactive than/displaces iodine/ oxidises iodide ions • add (aqueous) chlorine to a solution of potassium iodide • the solution turns yellow/red/ brown • iodine is produced / $Cl_2 + 2KI \rightarrow I_2 + 2KCl$ / $Cl_2 + 2I^- \rightarrow I_2 + 2Cl^-$ • (so) chlorine is more reactive than/displaces iodine/oxidises iodide ions Allow use of suggested reactions which do not produce a displacement reaction, e.g. add (aqueous) bromine to a solution of a potassium chloride with suitable conclusion/explanation	**(6)**

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas, enquiry, techniques and procedures lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3–4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure, which is mostly clear, coherent and logical. (AO1)
Level 3	5–6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

Question number	Answer	Additional guidance	Mark
8(c)(i)	• calculates mol of Fe (1) • calculates mol of Br^2 (1) • determines simplest ratio/LHS of equation (1) • deduces formula of iron bromide produced/RHS of equation (1) OR • divides mass by relative atomic mass (1) • simplest ratio (1) • empirical formula (1) • deduces LHS to obtain balanced equation (1)	<u>Example of calculation</u> mol Fe = $\frac{5.6}{56}$ = 0.1 mol Br_2 = $\frac{24}{(2\times80)}$ = 0.15 ratio Fe:Br_2 = 2 : 3/ 2Fe + $3Br_2$ $2FeBr_3$/Fe_2Br_6 Fe : Br $\frac{5.6}{56}$: $\frac{24}{80}$ 0.1 : 0.3 1 : 3 $FeBr_3$ $2Fe + 3Br_2 \rightarrow 2FeBr_3$	**(4)**

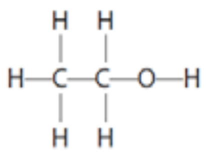
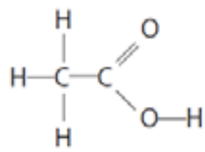
Question number	Answer	Mark
8(c)(ii)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): • bromine atoms are reduced (1) • because electrons are gained to form bromide ions (1)	**(2)**

Question number	Answer	Mark
9(a)	An explanation that combines identification – improvement of the experimental procedure (1 mark) and justification/reasoning which must be linked to the improvement (1 mark): • reverse the boiling tubes/pass gas through the tube in ice water first (1) • so that if any liquid condenses in the tube it must have come from the burning wax (and not from the limewater) (1)	**(2)**

Question number	Indicative content	Mark
*9(b)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Candidates choose appropriate monomers to illustrate the formation of different polymers. • polymer molecules are long chains • made up of simple repeating units • use chloroethene (only) • to form poly(chloroethene) • which is addition polymerisation • use ethane-1,2-diol and ethanedioic acid • to form a polyester • which is condensation polymerisation • one of the bonds in the double bond in chloroethene molecule breaks • and chloroethene molecules join together to form a long chain molecule • equation  • identification of repeat unit • alcohol group combines with a carboxylic acid group • and an ester (link) formed • with a water (molecule) eliminated • equation  • ester link shown • identification of repeat unit	**(6)**

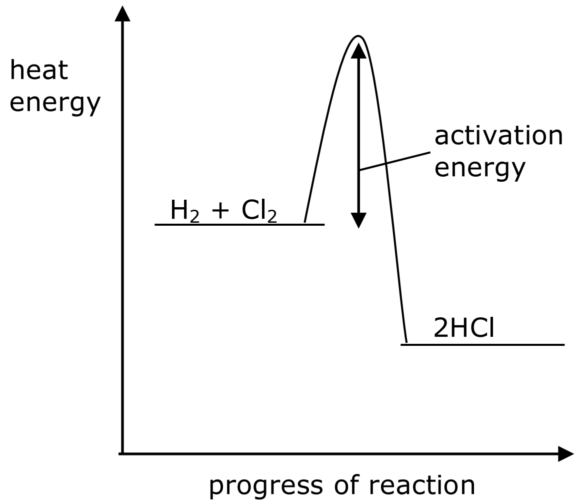
Level	Mark	Descriptor
	0	No awardable content.
Level 1	1–2	• The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2) • Lines of reasoning are unsupported or unclear. (AO2)
Level 2	3–4	• The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2) • Lines of reasoning mostly supported through the application of relevant evidence. (AO2)
Level 3	5–6	• The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2) • Lines of reasoning are supported by sustained application of relevant evidence. (AO2)

Question number	Answer	Marks
9(c)(i)	carboxylic acids	**(1)**

Question number	Answer	Marks
9(c)(ii)	A is  (1) B is  (1)	**(2)**

Question number	Answer	Mark
10(a)	B	**(1)**

Question number	Answer	Marks
10(b)	An answer that combines the following points to provide a plan: • measure known volume of sodium hydroxide solution (1) • add same volume of each of the acids (1) • stir the mixture (1) • record the initial and final temperatures/temperature change (1)	**(4)**

Question number	Answer	Mark
10(c)	 • product line, labelled (2)HCl/product(s), to right of and lower than reactant line, labelled $H^2 + Cl^2$/reactants (1) • curve drawn on diagram (1) • activation energy labelled (1)	**(3)**

Question number	Answer	Additional guidance	Mark
10(d)	• calculates energy needed to break bonds (1) • calculates energy released in forming bonds (1) • calculates energy change (1) • evaluation of final answer with negative sign (1)	<u>Example of calculation</u> Bonds broken = 436 + 243 = 679 ($kJ\ mol^{-1}$) Bonds formed = 2 × 432 = 864 ($kJ\ mol^{-1}$) Energy change = 679 − 864 = −185 ($kJ\ mol^{-1}$) Award full marks for correct numerical answer without working	**(4)**

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