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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S 5 0 0 4 6 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 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.

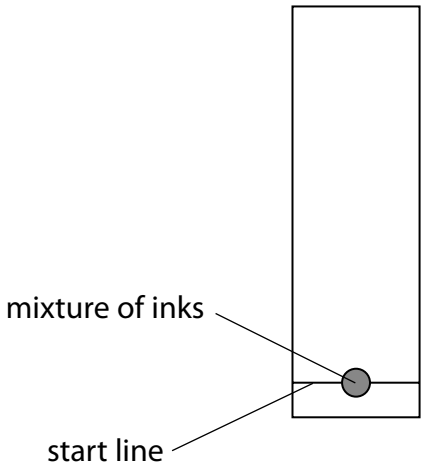

Figure 1

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

(1)

.....

.....

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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 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)

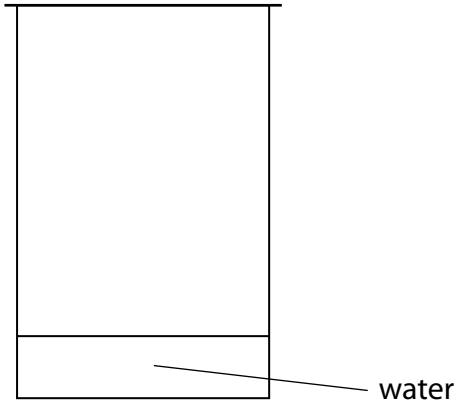

Figure 2

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

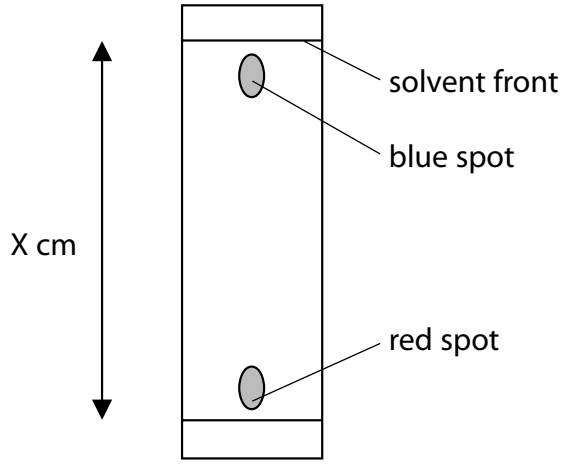

Figure 3

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.

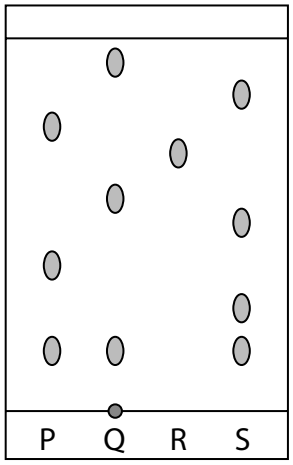

Figure 4

(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)

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) 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 = ...

(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.

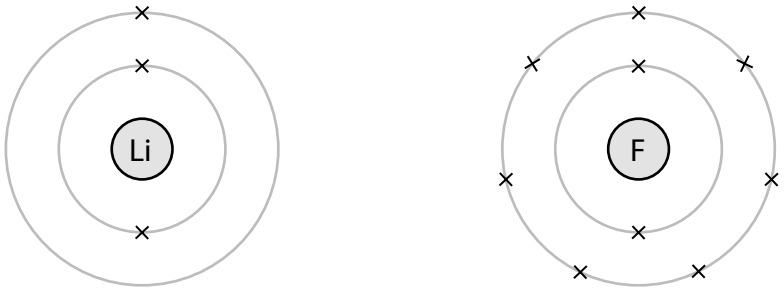

Figure 6

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)

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 .....

.....

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(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.

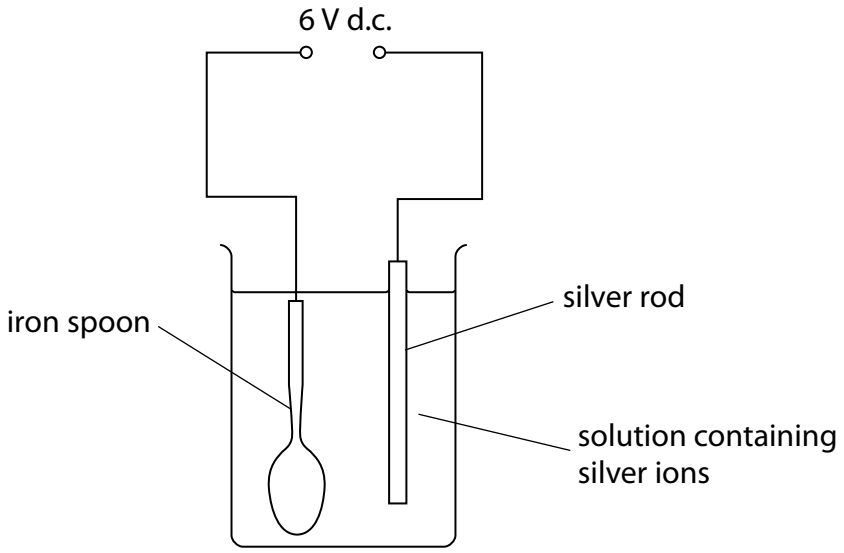

Figure 10

(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

(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.

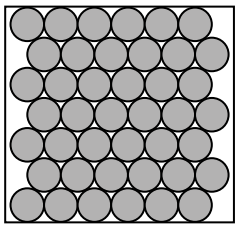

Figure 13

(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)

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

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*(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)

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

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						

Key

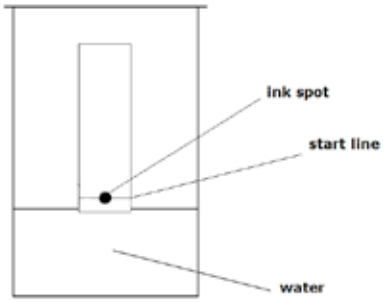
relative atomic mass
atomic symbol
name
atomic (proton) number

**** 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 $\frac{10.0}{2\times53.5}\times 2 \times 24 = 4.49\ dm^3$ 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)**