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EDEXCEL GCSE CHEMISTRY: QUESTIONS BY TOPIC

Chemical Changes (3)

GCSE Chemistry (Foundation) Topic 3

12 questions · 119 marks · Mark schemes included

Pearson Edexcel GCSE (9-1) Chemistry 1CH0, Foundation Tier, June 2018 - June 2025

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HOW TO USE THIS BOOKLET

Questions run from the lowest mark tariff to the highest, so similar questions sit together.

Click any row below to jump straight to that question.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

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QUESTIONS

12 questions · 119 marks · lowest tariff first



6-MARK QUESTIONS

1 question in this booklet



1 A student investigates the reaction that occurs when zinc carbonate is heated.

Figure 1 shows the apparatus the student uses.

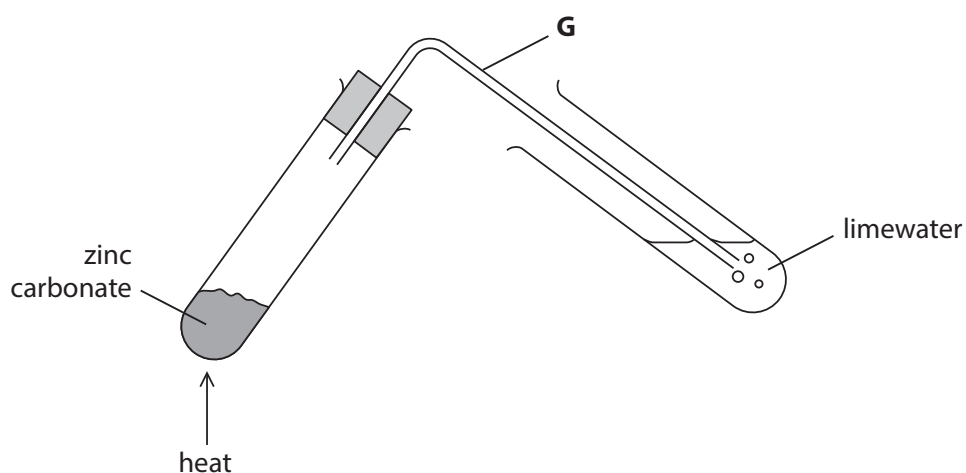


Figure 1

(a) What is the name of the piece of apparatus labelled **G** in Figure 1?

(1)

- ☐ **A** testing tube
- ☐ **B** heating tube
- ☐ **C** delivery tube
- ☐ **D** boiling tube

(b) State what apparatus should be used to heat the zinc carbonate in Figure 1.

(1)

.....

(c) The word equation for the reaction that occurs when zinc carbonate is heated is



The carbon dioxide bubbles through the limewater.

State what is seen when carbon dioxide bubbles through the limewater.

(1)

(d) Another student investigates the change in mass that takes place when zinc carbonate is heated.

(i) Figure 2 shows the results the student records at the start of the investigation.

mass of empty test tube	14.62 g
mass of test tube + zinc carbonate	17.83 g

Figure 2

Using the results in Figure 2, calculate the mass of zinc carbonate in the test tube.

(1)

mass of zinc carbonate = ... g

(ii) The student then

- heats the test tube containing the zinc carbonate for five minutes
- places the hot test tube on a bench mat to cool
- finds the mass of the test tube and contents.

Describe what the student should do next to make sure that all the zinc carbonate has reacted completely.

(2)

(Total for Question 1 = 6 marks)



7-MARK QUESTIONS

1 question in this booklet



3 This question is about electrolysis.

(a) Which statement describes what happens during electrolysis?

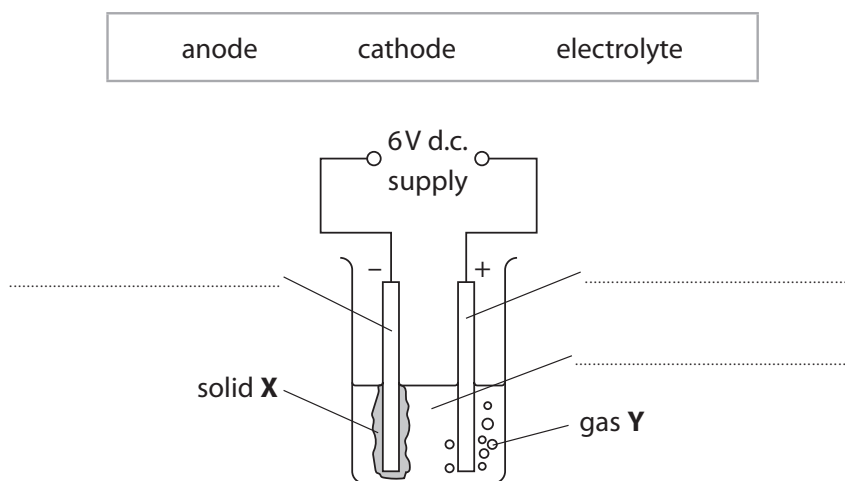
(1)

- ☒ **A** atoms are decomposed
- ☒ **B** ionic compounds are decomposed
- ☒ **C** mixtures are separated
- ☒ **D** molecules are separated

(b) Figure 5 shows the electrolysis of copper chloride solution.

(i) Use the words from the box to complete the labelling of the diagram in Figure 5.

(2)



- (ii) The products of the electrolysis shown in Figure 5 are solid **X** and gas **Y**.

Draw **one** straight line from each product to its name.

(2)

product

name

solid **X**

carbon

chlorine

copper

gas **Y**

hydrogen

- (iii) The experiment is repeated using powdered solid copper chloride instead of copper chloride solution.

Nothing happens and no products are formed.

Explain why nothing happens and no products are formed.

(2)

.....

.....

.....

.....

(Total for Question 3 = 7 marks)



9-MARK QUESTIONS

2 questions in this booklet



- 6 (a) Hydrochloric acid reacts with solid **B**.
Solid **B** is an alkali.

A student carries out an experiment to see how the pH changes when different masses of solid **B** are added to dilute hydrochloric acid.

The student uses the following method.

step 1 use a measuring cylinder to measure out 100cm³ of dilute hydrochloric acid

step 2 pour the acid into a beaker

step 3 measure the pH with a pH probe

step 4 add half a spatula of solid **B** and stir

step 5 repeat steps 3 and 4 until the pH stops changing.

- (i) Give a safety precaution that should be taken during the experiment.

(1)

- (ii) Give an improvement to step 4 that would produce more accurate results.

(1)

- (iii) What is the most likely change in pH during the experiment?

(1)

☐ **A** from 1 to 7

☐ **B** from 1 to 12

☐ **C** from 7 to 12

☐ **D** from 12 to 1

- (iv) If some methyl orange indicator is added to the acid in step 2, the mixture changes colour during the experiment.

State the colour change.

(2)

colour at start in acid colour at end



- (b) Concentrated hydrochloric acid can be broken down using electricity. The apparatus that can be used is shown in Figure 6.

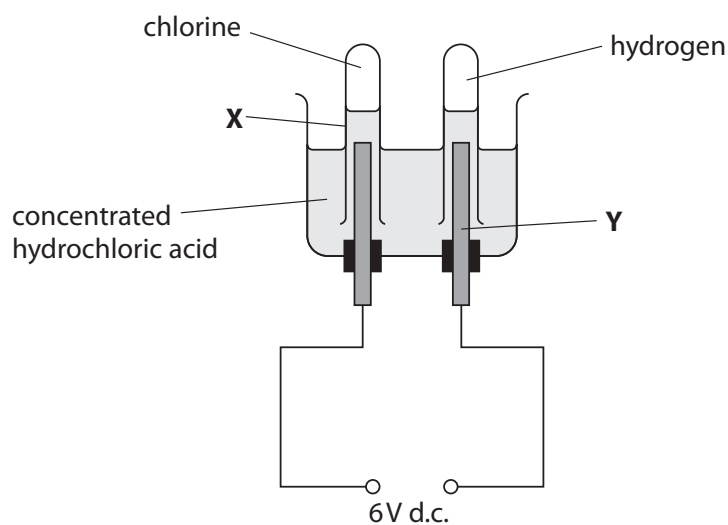


Figure 6

- (i) Give the name of the piece of apparatus labelled **X**.

(1)

- (ii) The rod labelled **Y** in Figure 6 is made of graphite.

What is the name of this piece of apparatus?

(1)

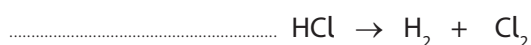
- ☐ **A** electrode
- ☐ **B** electrolysis
- ☐ **C** electrolyte
- ☐ **D** electron

- (iii) Give **one** reason why graphite is a suitable material to make **Y**.

(1)

- (iv) Complete the balanced equation for the reaction that occurs.

(1)



(Total for Question 6 = 9 marks)

- 5 (a) When lead nitrate solution and potassium chloride solution are mixed, potassium nitrate and a precipitate of lead chloride are formed.

(i) Complete the word equation for this reaction.

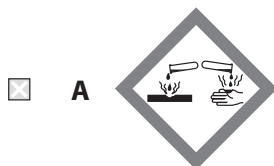
(1)

lead nitrate + ... → + lead chloride

(ii) Lead nitrate is toxic.

Which hazard symbol should be on a container of lead nitrate?

(1)



- (b) A student put 5 cm^3 of potassium carbonate solution into a test tube and added 2 cm^3 of calcium nitrate solution.

A precipitate formed and was allowed to settle as shown in Figure 7.

The height of the precipitate was measured.

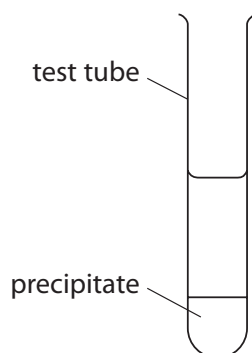


Figure 7

- (i) Give the name of the piece of apparatus the student should use to find the volume of the potassium carbonate solution.

(1)

- (ii) The student repeated the experiment.

The results are shown in Figure 8.

experiment	height of precipitate in cm
1	2.4
2	2.7
3	2.4

Figure 8

Use the data in Figure 8 to calculate the mean height of the precipitate.

(2)

mean height of precipitate = ... cm



- (iii) Describe how a pure, dry sample of the precipitate could be obtained from the mixture in the test tube.

(3)

.....

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.....

- (iv) The student investigated whether increasing the volume of calcium nitrate solution increased the height of the precipitate formed.
- They repeated the experiment using different volumes of calcium nitrate.
- State **one** variable that should be controlled in this investigation.

(1)

.....

(Total for Question 5 = 9 marks)



10-MARK QUESTIONS

1 question in this booklet



- 4 (a) In the 19th century, Mendeleev arranged the elements known at the time to form his periodic table.

Mendeleev's periodic table is different from the modern periodic table.

State **one** difference between Mendeleev's periodic table and the modern periodic table.

(1)

- (b) Aluminium oxide reacts with hydrochloric acid to form a salt and water.

- (i) State the name of the salt formed.

(1)

- (ii) In this reaction aluminium oxide is a base.

State the type of reaction that takes place when an acid reacts with a base.

(1)

- (c) Gallium, Ga, is in the same group of the modern periodic table as aluminium.

The formula of aluminium oxide is Al_2O_3 .

- (i) Predict the formula of gallium oxide.

(1)

- (ii) Gallium oxide has a very high melting point.

Gallium oxide does not conduct electricity when solid but does conduct electricity when molten.

What type of substance is gallium oxide?

(1)

- ☐ A giant covalent
- ☐ B ionic
- ☐ C metallic
- ☐ D simple molecular

- (d) Figure 5 shows the changes of state for gallium and the arrangement of particles in liquid gallium.

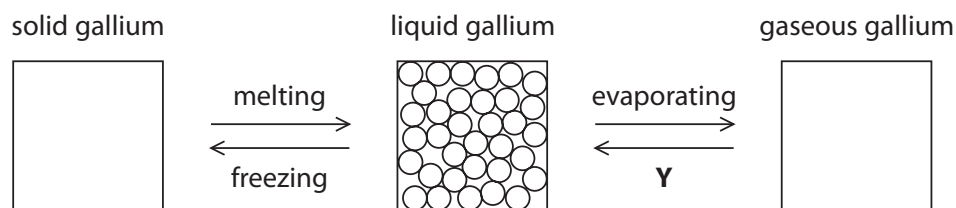


Figure 5

- (i) Complete the boxes for solid gallium and gaseous gallium by drawing the arrangement of the particles in each of these physical states.

(2)

- (ii) Give the name of the change of state labelled **Y** in Figure 5.

(1)

- (e) Gallium metal is a conductor of electricity.

Explain how metals conduct electricity.

(2)

(Total for Question 4 = 10 marks)

11-MARK QUESTIONS

6 questions in this booklet



- 8 Figure 11 shows the apparatus that can be used to electrolyse sodium sulfate solution using inert electrodes.

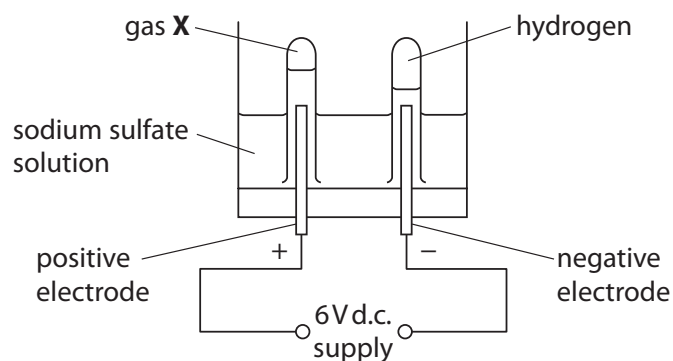


Figure 11

- (a) Hydrogen is produced at the negative electrode during electrolysis.

(i) Describe the test to show the gas is hydrogen.

(2)

.....

.....

.....

.....

(ii) What is the name of gas **X** that forms at the positive electrode?

(1)

- ☐ **A** ammonia
- ☐ **B** oxygen
- ☐ **C** nitrogen
- ☐ **D** sulfur dioxide

(iii) State what is meant by the term **electrolysis**.

(2)

.....

.....

.....

.....

- (b) The sodium sulfate solution was made by dissolving 28.4 g of sodium sulfate in water to make 250 cm^3 of solution.

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

Give your answer to three significant figures.

(3)

.....

.....

.....

.....

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

- (c) The ions present in sodium sulfate are

sodium	Na^+
sulfate	SO_4^{2-}

Write the formula of sodium sulfate using this information.

(1)

.....

- (d) (i) In Figure 11, the gases given off at the electrodes are collected in test-tubes. However, the actual volume of gases cannot be measured using these test-tubes.

Suggest what apparatus could be used in place of the test-tubes in Figure 11 to measure the volume of gases given off.

(1)

.....

- (ii) State what could be added into the circuit to show a current is flowing during electrolysis.

(1)

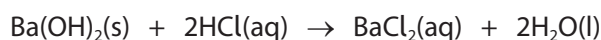
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(Total for Question 8 = 11 marks)



- 8 Barium hydroxide reacts with dilute hydrochloric acid to form barium chloride and water.

(a) The equation for the reaction is



Which row of the table shows the correct state of each of the substances in the equation for the reaction?

(1)

		barium hydroxide	hydrochloric acid	barium chloride	water
☐	A	solid	aqueous	aqueous	liquid
☐	B	solid	liquid	solid	aqueous
☐	C	aqueous	aqueous	solid	liquid
☐	D	aqueous	liquid	aqueous	aqueous

- (b) A student wanted to investigate how the pH of the mixture changes as barium hydroxide is added to dilute hydrochloric acid.

They followed this method.

step 1 measure out 50.0 cm^3 of dilute hydrochloric acid into a beaker using a measuring cylinder

step 2 use a glass rod to place a drop of the acid onto a piece of universal indicator paper and record the pH

step 3 add 0.2 g of barium hydroxide to the acid in the beaker and stir

step 4 use the glass rod to place a drop of the mixture onto a new piece of universal indicator paper and record the pH again

step 5 repeat steps 3–4 until there is no further change in the pH.

- (i) Name a piece of equipment which could be used to measure out 50.0 cm^3 of dilute hydrochloric acid more accurately than the measuring cylinder.

(1)



- (ii) Describe how the pH of the mixture is determined when a drop of it is placed on the universal indicator paper.

(2)

- (iii) In the method, universal indicator paper is used to determine the pH.

Explain why litmus paper would not be a suitable indicator to use in this experiment.

(2)



(iv) Figure 14 shows the student's results.

mass of barium hydroxide in g	pH of mixture
0.0	1
0.2	1
0.4	1
0.6	1
0.8	2
1.0	7
1.2	12
1.4	13
1.6	13

Figure 14

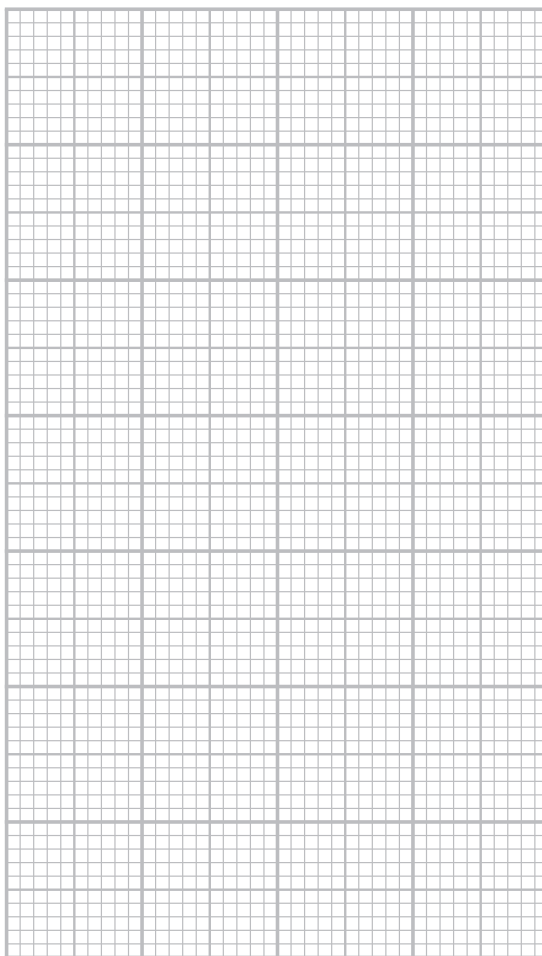
On the grid opposite:

- Add suitable scales to the vertical and horizontal axes.
- Plot a graph of the pH of the mixture against the mass of barium hydroxide.

(3)



pH of
the mixture



mass of barium hydroxide in g



(c) Figure 15 shows a hazard symbol placed on a container of barium hydroxide.



Figure 15

(i) What is the meaning of the hazard symbol in Figure 15?

(1)

- ☐ A flammable
- ☐ B health hazard
- ☐ C oxidising
- ☐ D toxic

(ii) Barium hydroxide is also corrosive.

Give **one** precaution that the student should take when using barium hydroxide.

(1)

.....

.....

(Total for Question 8 = 11 marks)

- 8** In an experiment, powdered calcium hydroxide was added to dilute hydrochloric acid and the pH was measured.

The method used was

step 1 measure 200 cm³ dilute hydrochloric acid into a beaker

step 2 add 0.1 g of powdered calcium hydroxide to the beaker

step 3 find the pH of the mixture

step 4 repeat steps 2 and 3 until the pH stops changing.

- (a) State what should be done after **step 2** to make sure that any reaction is complete.

(1)

- (b) Complete the word equation for the reaction.

(2)

calcium hydroxide + hydrochloric acid →

- (c) Which row of the table shows the state symbols for powdered calcium hydroxide and dilute hydrochloric acid in the balanced chemical equation?

(1)

	calcium hydroxide	hydrochloric acid
☐ A	aq	l
☐ B	l	aq
☐ C	s	aq
☐ D	s	l

(d) The results of the experiment are shown in Figure 12.

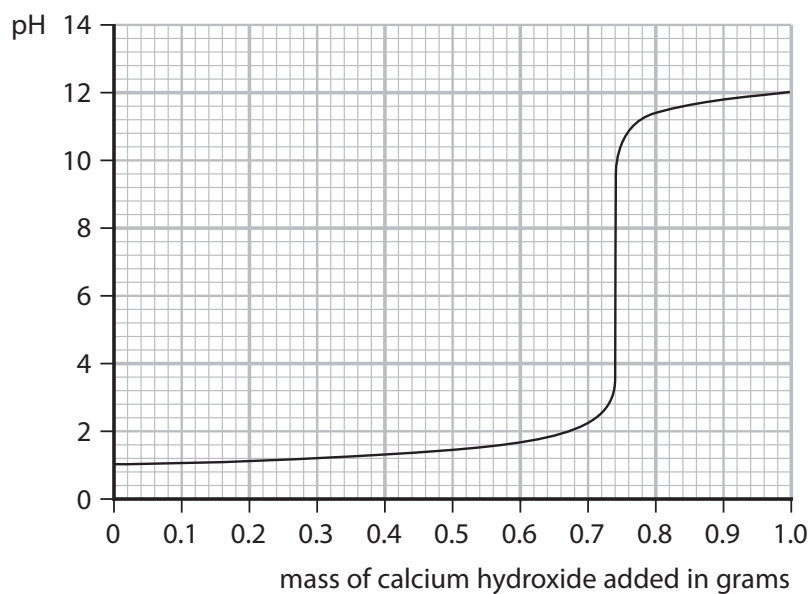


Figure 12

(i) Using Figure 12, give the pH of the acid at the start of the experiment.

(1)

pH = ...

(ii) Using Figure 12, give the mass of calcium hydroxide required to make a neutral mixture.

(1)

mass of calcium hydroxide = ... g

(iii) Explain why the pH starts at a low value and ends at a higher value.

(3)

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.....

(e) State what should be used to measure the pH of the mixture in this experiment.

(1)

(f) The calcium hydroxide used is corrosive to the eyes and an irritant to skin.

Using this information, state **one** safety precaution that should be taken during the experiment when using any corrosive substance.

(1)

(Total for Question 8 = 11 marks)



8 Barium hydroxide reacts with dilute hydrochloric acid to form barium chloride solution and water.

- (a) (i) Complete the balanced equation for the reaction by adding a **number** in front of HCl(aq).

(1)



- (ii) State what you would **see** during the reaction.

(1)

- (b) A student investigated how the pH of the mixture changed as barium hydroxide was added to dilute hydrochloric acid.

The student used this method.

step 1 measure out 50 cm³ of dilute hydrochloric acid into a beaker using a measuring cylinder

step 2 use a glass rod to place a drop of the acid onto a piece of universal indicator paper and record the pH

step 3 add one spatula measure of barium hydroxide to the acid in the beaker and stir

step 4 use the glass rod to place a drop of the mixture onto a new piece of universal indicator paper and record the pH again

step 5 repeat steps 3 and 4 until there is no further change in the pH.

- (i) Name a piece of equipment that could be used to measure the pH of a substance more accurately than universal indicator paper.

(1)

- (ii) Explain why, in step 3, the mixture was stirred after adding the barium hydroxide.

(2)

- (iii) Figure 13 shows the student's results.

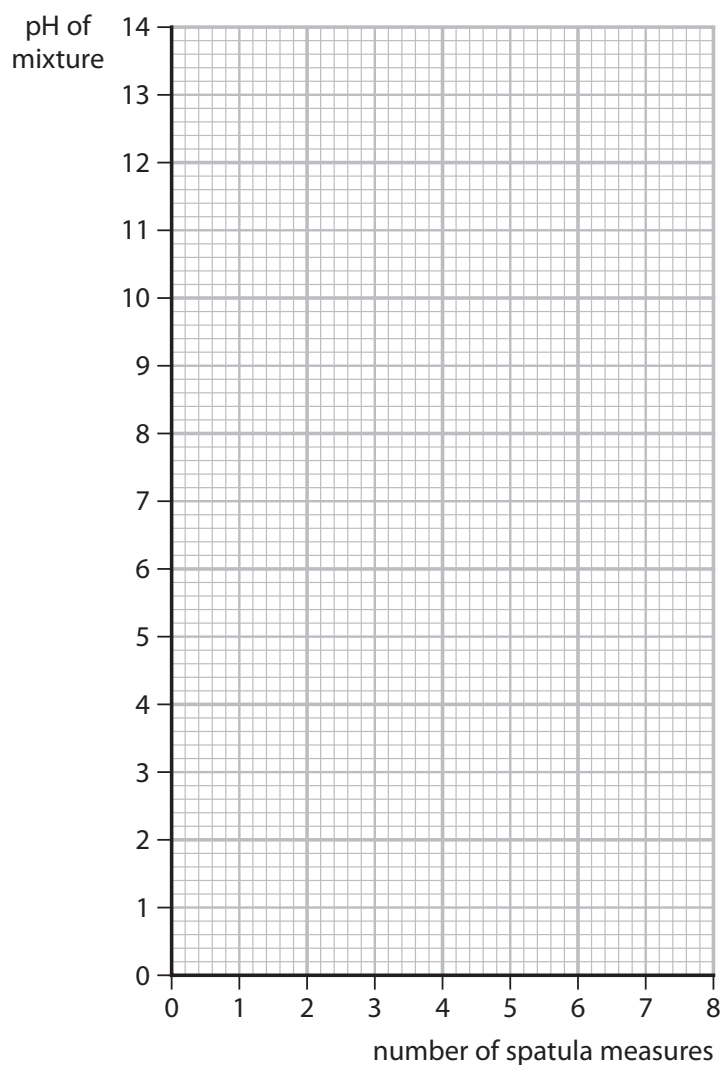
number of spatula measures of barium hydroxide	pH of mixture
0	1
1	1
2	1
3	1
4	3
5	8
6	12
7	13
8	13

Figure 13



Plot a graph of the pH of the mixture against the number of spatula measures of barium hydroxide.

(3)



- (iv) Use the graph to find the pH of the mixture when 4.5 spatula measures of barium hydroxide are added.

(1)

pH of the mixture = ...



(c) Figure 14 shows a hazard symbol on the container of barium hydroxide.



Figure 14

What is the meaning of the hazard symbol in Figure 14?

(1)

- ☐ A corrosive
- ☐ B health hazard
- ☐ C oxidising
- ☐ D toxic

(d) The barium hydroxide was measured in spatulas.

State **one** way that the measuring of the barium hydroxide could be improved.

(1)

.....

.....

.....

(Total for Question 8 = 11 marks)

9 Silver nitrate and potassium chloride are ionic compounds that are soluble in water.

(a) When potassium chloride solution is added to a solution of silver nitrate, a white precipitate forms.

(i) Complete the equation for this reaction, including the missing state symbol.

(2)



(ii) Give the name of the white precipitate that forms.

(1)

.....

(iii) State and explain how the white precipitate can be separated from the reaction mixture.

(3)

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(b) Silver nitrate solution conducts electricity.

Solid silver also conducts electricity.

Describe how silver nitrate solution conducts electricity and how solid silver conducts electricity.

(3)

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- (c) A bottle containing an unknown solution is labelled with the two hazard symbols shown in Figure 16.

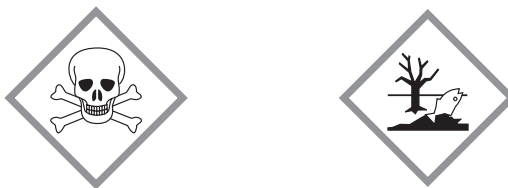


Figure 16

- (i) What are the meanings of these two symbols?

(1)

- ☐ **A** flammable and toxic
- ☐ **B** harmful and dangerous to the environment
- ☐ **C** toxic and dangerous to the environment
- ☐ **D** toxic and harmful

- (ii) State a safety step that should be taken when using the unknown solution.

(1)

.....

.....

(Total for Question 9 = 11 marks)

10 Phosphoric acid is important in the production of fertilisers.

- (a) (i) A few drops of litmus solution are added to a sample of dilute phosphoric acid.

What is the colour of the mixture formed?

(1)

- ☐ **A** colourless
- ☐ **B** green
- ☐ **C** purple
- ☐ **D** red

- (ii) State why litmus cannot be used to measure pH.

(1)

.....

.....

- (b) Phosphoric acid can react to form phosphate salts which are used in fertilisers.

Give **two** reasons why farmers use fertilisers on their fields.

(2)

1

.....

2

.....

(c) An experiment was carried out to produce phosphoric acid.

(i) The actual yield for the experiment was 18.62 g.

The theoretical yield for the experiment is 24.50 g.

$$\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

Calculate the percentage yield of this experiment.

(2)

.....

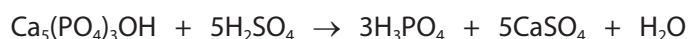
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percentage yield = ...

(ii) The equation for a reaction to make phosphoric acid, H_3PO_4 , is



Calculate the atom economy for the production of phosphoric acid in this reaction.

$$\text{atom economy (\%)} = \frac{\text{total formula mass of desired product}}{\text{total formula mass of all reactants or products}} \times 100$$

(relative formula masses: $\text{Ca}_5(\text{PO}_4)_3\text{OH} = 502$, $\text{H}_2\text{SO}_4 = 98$, $\text{H}_3\text{PO}_4 = 98$, $\text{CaSO}_4 = 136$, $\text{H}_2\text{O} = 18$)

(3)

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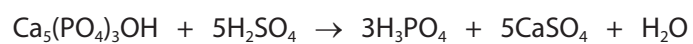
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atom economy = ... %



(iii) The equation for a reaction to produce phosphoric acid is



Explain how the atom economy of the reaction can be increased.

(2)

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(Total for Question 10 = 11 marks)



12-MARK QUESTIONS

1 question in this booklet



8 (a) State **two** characteristic properties of metals.

(2)

property 1.....

property 2.....

(b) Acids are used to make salts.

Give the name of the acid used to make chlorides.

(1)

(c) Salts of metals can be prepared by reacting the metal with an acid to produce the salt and hydrogen.

(i) Describe the test to show that the gas is hydrogen.

(2)

.....

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.....

(ii) Nickel is a metal.

Explain how the structure of a nickel atom, Ni, changes when it forms a nickel ion, Ni^{2+} .

(2)

.....

.....

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- (d) A nickel sulfate solution is made by dissolving 23.5 g of nickel sulfate to make 250 cm^3 of solution.

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

(2)

.....

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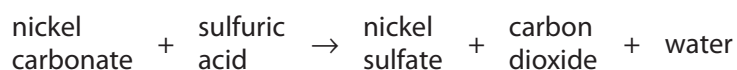
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concentration = ... g dm^{-3}

- (e) Excess solid nickel carbonate is added to dilute sulfuric acid in a beaker.



Nickel sulfate is formed in solution.

Describe how a sample of pure, dry nickel sulfate crystals can be obtained from the mixture of nickel sulfate solution and excess solid nickel carbonate in the beaker.

(3)

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(Total for Question 8 = 12 marks)



MARK SCHEMES

official Pearson Edexcel mark schemes



Question number	Answer	Mark
1(a)	C delivery tube is the only correct answer A, B, D are not correct because they are not the name for the labelled piece of apparatus in Figure 1	(1) AO1-2

Question number	Answer	Additional guidance	Mark
1(b)	Bunsen (burner)	allow spirit burner/ gas burner ignore water bath or any non-laboratory heating methods	(1) AO1-2

Question number	Answer	Additional guidance	Mark
1(c)	goes cloudy / goes milky / white precipitate	allow goes white / white liquid ignore any other observation inc. bubbles/ fizzing/ gas / colour change	(1) AO2-2

Question number	Answer	Additional guidance	Mark
1(d)(i)	3.21 with or without working scores 1 (17.83 – 14.62 =) 3.21	answer must be evaluated reject -3.21 / 3.2 / 3	(1) AO2-1

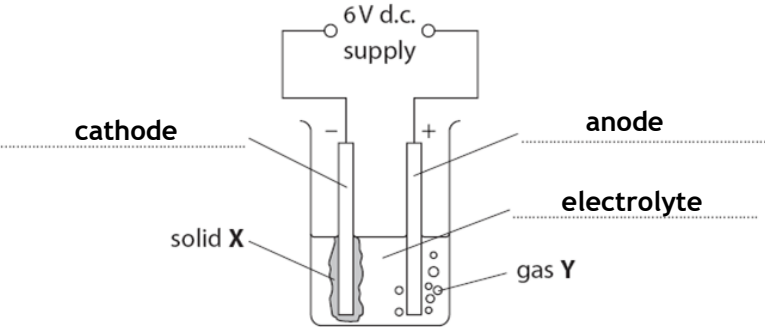


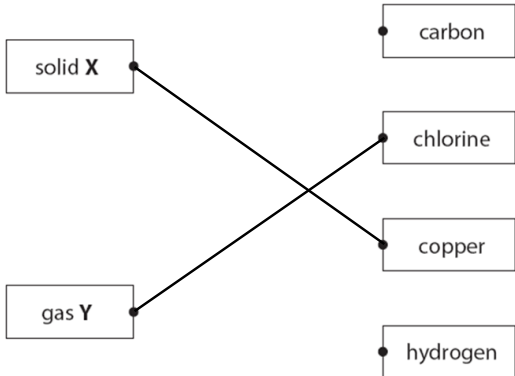
Question number	Answer	Additional guidance	Mark
1(d)(ii)	A description including • (re)heat (the test tube for longer) (1) • to constant mass / until mass does not change/ until bubbles stop / until results do not change (1)	allow (repeat experiment but) heat for <u>more than 5 minutes</u> (1) allow repeat <u>step 1</u> MP2 depends on MP1 allow 'until limewater no longer goes cloudy' For MP2 must give comment about mass/ gas/ results, so ignore vague statements such as 'to see if it changes'	(2) A03-3b

Total for Question 1 = 6 marks



Question number	Answer	Mark
3(a)	B the decomposition of ionic compounds is the only correct answer A, C and D are incorrect statements	A01-1 (1)

Question number	Answer	Additional guidance	Mark
3(b)(i)		All 3 correct scores 2 marks 1 or 2 correct scores 1 mark allow copper chloride solution to replace electrolyte	A01-2 (2)

Question number	Answer	Additional guidance	Mark										
3(b)(ii)	<table><thead><tr><th>product</th><th>name</th></tr></thead><tbody><tr><td> solid X </td><td> carbon </td></tr><tr><td></td><td> chlorine </td></tr><tr><td></td><td> copper </td></tr><tr><td> gas Y </td><td> hydrogen </td></tr></tbody></table> 	product	name	solid X	carbon		chlorine		copper	gas Y	hydrogen	one mark for each line do not award mark if more than one line is drawn from each box on the left	A01-2 (2)
product	name												
solid X	carbon												
	chlorine												
	copper												
gas Y	hydrogen												

Question number	Answer	Additional guidance	Mark
3(b)(iii) Group B	An explanation linking the following - no current will flow / solid ionic compounds do not conduct electricity (1) (because) ions can't move / ions in a lattice (1)	Allow reverse arguments allow no electricity flows do not accept 'nothing happens' ignore charged particles reject electrons/atoms/molecules can't move if no other mark awarded allow 1 mark for 'copper chloride isn't dissolved' / 'it will only work if ions are in solution'	A01-1 (2)

Total for Question 3 = 7 marks



Question number	Answer	Mark
6(a)(i)	wear safety goggles/ gloves	(1) AO3

Question number	Answer	Additional guidance	Mark
6(a)(ii)	Measure mass of solid/ use a specified mass of solid	ignore changes to stirring ignore use a full spatula	(1) AO3

Question number	Answer	Mark
6(a)(iii)	B from 1 to 12 is the only correct answer. A and C are incorrect because the mixture does not start or end neutral D is incorrect because the pH is changing in the reverse direction	(1) AO2

Question number	Answer	Additional guidance	Mark
6(a)(iv)	start: red/pink (1) end: yellow (1)	allow (1) if colours reversed	(2) AO1

Question number	Answer	Mark
6(b)(i)	test tube/ boiling tube	(1) AO1

Question number	Answer	Mark
6(b)(ii)	A electrode is the only correct answer. B , C and D are incorrect because they are not electrodes.	(1) AO2

Question number	Answer	Additional guidance	Mark
6(b)(iii)	it conducts (electricity)/ is inert	ignore high melting point	(1) AO1

Question number	Answer	Mark
6(b)(iv)	$2 \text{ HCl} \rightarrow \text{H}_2 + \text{Cl}_2$	(1) AO2

Question number	Answer	Mark
5(a)(i)	ON LEFT: potassium chloride AND ON RIGHT: potassium nitrate	A02-1 (1)

Question number	Answer	Mark
5(a)(ii)	D is the correct answer A , B and C are the hazard symbols for corrosive, flammable and harmful	A02-1 (1)

Question number	Answer	Additional guidance	Mark
5(b)(i)	measuring cylinder	allow burette / pipette / syringe	A03-3 (1)

Question number	Answer	Additional guidance	Mark
5(b)(ii) Group A	$2.4 + 2.4 + 2.7 = 7.5$ (1) $\frac{7.5}{3} = 2.5$ (1)	2.5 with or without working scores 2 marks allow ECF for an incorrect evaluation divided by 3 allow $2.4 + 2.4 = 4.8$, $4.8/2 = 2.4$ (1) $2.4 + 2.4 + 2.7 \div 3 = 5.7$ (1) $2.4 + 2.7 + 2.4 \div 3 = 5.9$ (1)	A02-2 (2)



Question number	Answer	Additional guidance	Mark
5(b)(iii) Group A	a description to include the following points First mark Filter (the mixture) (1) Second and third marks A description including two of the following Calcium carbonate / the solid / the residue / precipitate is left on (filter) paper / on the funnel (1) Wash / rinse (the solid/residue/calcium carbonate with distilled water) (1) any method of drying (1)	maximum 1 mark if heat or evaporate or crystallisation method used on mixture or filtrate description or diagram of filtering or diagram of filtering ie (filter) funnel and filter paper do not allow sieving/sifting/draining/decanting do not allow separating funnel pour water over/through solid (in filter paper) clean solid with water do not allow this mark if washing is done after drying eg in an oven / on a windowsill / on a radiator / with filter paper warm it heat it evaporate the water allow 'leave to dry' do not allow just 'dry it (out/off)'	A02-2 (3)

Question number	Answer	Additional guidance	Mark
5(b)(iv) Group A	any one of the following • volume / concentration of {potassium carbonate / carbonate / potassium solution} • concentration of (calcium) nitrate • time allowed for settling	allow amount of (potassium) carbonate ignore 'volume' alone ignore {amount / volume} of calcium nitrate ignore time (alone) allow temperature allow diameter of test tube	A03-3b (1)

Total for Question 5 = 9 marks



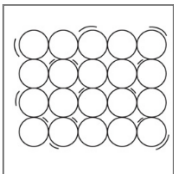
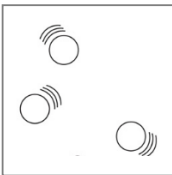
Question number	Answer	Additional guidance	Mark
4(a)	arranged by order of (relative) atomic mass / (in Mendeleev's early periodic table) gaps / missing elements / fewer elements / noble gases were not present	assume answer refers to Mendeleev's table unless specifically referred to modern table so reverse arguments apply	(1)

Question number	Answer	Additional guidance	Mark
4(b)(i)	aluminium chloride	reject 'aluminium chlorine'	(1)

Question number	Answer	Additional guidance	Mark
4(b)(ii)	neutralisation	allow acid + base allow 'acid-base' allow 'exothermic'	(1)

Question number	Answer	Additional guidance	Mark
4(c)(i)	Ga ₂ O ₃	allow Ga ₂ O ₃ / GA ₂ O ₃ reject Ga ² O ³	(1)

Question number	Answer	Mark
4(c)(ii)	B ionic A giant covalent structures do not conduct electricity at all C metallic structures conduct when solid D simple molecular structures do not conduct electricity when molten and have low melting points	(1)

Question number	Answer	Additional guidance	Mark
4(d)(i)	 solid (1) (regular arrangement and touching)  gas (1) (widely spaced, fewer shown)		(2)

Question number	Answer	Additional guidance	Mark
4(d)(ii)	condensing / condensation		(1)

Question number	Answer	Additional guidance	Mark
4(e)	An explanation linking • electrons (1) • can move / are delocalised (1)	MP2 depends on MP1 allow charged particles can move / are delocalised (1)	(2)

Total for Question 4 = 10 marks



Question number	Answer	Additional guidance	Mark
8(a)(i)	A description including • apply lighted splint (1) • gas burns / (squeaky) pop (1)	allow flame / ignite gas ignore 'squeaky pop test' / glowing splint second mark is dependent on first	(2)

Question number	Answer	Mark
8(a)(ii)	B oxygen The only correct answer is B A, C & D these gases are not produced in the electrolysis of sodium sulfate solution	(1)

Question number	Answer	Additional guidance	Mark
8(a)(iii)	• electrical energy / electricity (1) • {decomposes / breaks down / splits} {electrolytes / (ionic) compounds / substances} (1)	allow electric current allow separates ions reject decomposing elements for MP2	(2)

Question number	Answer	Additional guidance	Mark
8(b)	final answer of 114 (g dm ⁻³) with or without working (3) OR $\frac{28.4}{250} (1) (= 0.1136)$ $0.1136 \times 1000 (1) (= 113.6)$ $= 114 \text{ (g dm}^{-3}\text{)} (1)$	allow ECF throughout $\frac{250}{1000} \text{ (dm}^3\text{)} (1) (= 0.250 \text{ (dm}^3\text{)})$ $\frac{28.4}{0.250} (1) (= 113.6)$ OR $\frac{1000}{250} (1) = 4$ $4 \times 28.4 (1) (= 113.6)$ Must have 3sf for MP3 0.114 scores 2 Lose MP1 if rounded incorrectly e.g, to 0.11 or 0.113 but mark on	(3)

Question number	Answer	Additional guidance	Mark
8(c)	Na_2SO_4	allow SO_4Na_2 allow upper case A ignore any charges on ions reject non-subscript 2 & 4	(1)

Question number	Answer	Additional guidance	Mark
8(d)(i)	measuring cylinder(s)	allow alternative apparatus eg graduated test-tube, burette, Hofmann voltameter, gas syringe	(1)

Question number	Answer	Additional guidance	Mark
8(d)(ii)	light bulb / lamp / ammeter	allow alternative equipment eg buzzer ignore voltmeter / data-logger alone	(1)

Total for Question 8 = 11 marks

Question number	Answer	Mark
8(a)	A solid aqueous aqueous liquid is the only correct answer B is incorrect because hydrochloric acid is aqueous C and D are incorrect as barium hydroxide is a solid	(1) AO1-1

Question number	Answer		Mark
8(b)(i)	burette / (volumetric/graduated) pipette	allow syringe ignore any form of measuring cylinder / volumetric flask / dropping pipette	(1) AO3-3b

Question number	Answer	Additional guidance	Mark
8(b)(ii)	A description to include (observe / look at) colour produced on (universal indicator) paper (1) - compare to pH {chart / scale} (1)	allow (paper/solution/mixture) changes colour / specific colours given of UI ignore incorrect linking colour to acidity ignore reference to other indicators ignore reference to pH meters	(2) AO2-2



Question number	Answer	Additional guidance	Mark
8(b)(iii)	An explanation linking - litmus paper only shows if the solution is {acidic / alkaline} (1) - does not show <u>how</u> acidic or alkaline the solution is (1)	allow litmus goes red in acid, blue in alkali / litmus only has 2 colours / only UI gives a wide range of colours / litmus paper does not have a gradual change in colour ignore references to purple and neutral ignore litmus is not {precise / accurate} allow does not give the pH / litmus does not give accurate pH allow litmus paper does not show a gradual change in pH / ORA allow litmus does not give 'strength' of acid/alkali allow litmus paper is qualitative not quantitative (1) reject answers referring to use in test for chlorine	(2) A03 2a 2b

Question number	Answer	Additional Guidance	Mark
8(b)(iv)	- linear scales on both axes (1) {plotted points / best fit line} must cover at least half graph paper in both directions (1) 7 or more points plotted correctly ($\pm$ half a square) (1)	axes must be numbered (pH can start at 1) allow MP2 and MP3 if axes reversed must have numbered scale to score MP3 allow MP1 only for bar chart / histogram reject plotting on scale that uses the values from the table on Y axis (1, 1, 1, 1, 2, 7, 12, 13, 13)	(3) A02-1

Question number	Answer	Mark
8(c)(i)	B health hazard is the only correct answer A, C and D are incorrect as this is the symbol for a health hazard	(1) A01-1



Question number	Answer	Additional guidance	Mark
8(c)(ii)	(safety) goggles / gloves	allow safety glasses / eye protection ignore glasses and all other suggestions	(1) AO1-1



Question number	Answer	Additional guidance	Mark
8(a) Group A	stir/ swirl/ shake (the beaker)	allow mix, warm/ heat ignore wait (until reaction over/ until powder disappears)	A01-2 (1)

Question number	Answer	Additional guidance	Mark
8(b) Group B	in either order: calcium chloride (1) water (1)	allow phonetic spellings but reject calcium chlor ine allow CaCl ₂ but formula must be correct for the mark ignore 'solution'/ any state symbols allow H ₂ O but formula must be correct for the mark if three products given, allow (1) only if both correct products are given. four or more products scores (0)	A02-1 (2)

Question number	Answer	Mark
8(c)	C s aq is the only correct answer A, B and D are not correct because the calcium hydroxide is a solid and the acid is an aqueous solution.	A02-1 (1)

Question number	Answer	Additional guidance	Mark
8(d)(i)	1	allow 0.9 or 1.1	A03-2 (1)

Question number	Answer	Mark
8(d)(ii)	0.74 (g)	A03-2 (1)



Question number	Answer	Additional guidance	Mark
8(d)(iii) Group B	An explanation linking: START - solution is acidic / acids have low pH / high {concentration/ amount} of H^+ ions/ excess H^+ ions (1) REACTION - neutralisation/ $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$/ {the hydroxide/ alkali} <u>reacts</u> with the {acid/ H^+} (1) END {amount/ concentration} of H^+ ions has reduced/ {amount/ concentration} of OH^- ions has increased / excess OH^- ions/ (excess of) hydroxide ions have $\text{pH} > 7$ (1)	allow for low pH: pH less than 7 / pH 1-6 / pH =1 ignore there is no alkali ignore references to 'strong' or weak' allow acid $\rightarrow$ neutral $\rightarrow$ alkali (2) allow calcium hydroxide is {an alkali/a base} ignore description of pattern – as calcium hydroxide added pH increases (0) ignore 'becomes alkaline'/ is alkaline/ is less acidic	A02-1 (3)

Question number	Answer	Additional guidance	Mark
8(e) Group B	pH meter / pH probe	allow universal indicator / pH paper ignore pH scale do not allow any other named indicator, or 'indicator' alone.	A01-2 (1)

Question number	Answer	Additional guidance	Mark
8(f) Group A	goggles / gloves / eye protection	allow safety glasses ignore wearing lab coats ignore references to general lab safety, e.g. tie hair back, stand up	A01-2 (1)

Total for Question 8 = 11 marks



Question number	Answer	Mark
8(a)(i)	$\text{Ba(OH)}_2(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{BaCl}_2(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$	(1) A02-1

Question number	Answer	Additional guidance	Mark
8(a)(ii)	barium hydroxide {disappears / gets smaller} / (it) becomes clear	allow 'solid' for barium hydroxide allow barium hydroxide dissolves ignore any colours mentioned / colour change/ any incorrect observations ignore becomes a {liquid / solution} reject bubbles	(1) A02-2

Question number	Answer	Additional guidance	Mark
8(b)(i)	pH meter	allow pH probe ignore pH paper / data logger / pH scale	(1) A03-3



Question number	Answer	Additional guidance	Mark
8(b)(ii)	An explanation linking: - to ensure that the mixture is evenly spread (1) - to make substances {react / dissolve} / to speed up the {reaction / dissolving} (1)	allow to mix the reactants allow so pH (in mixture) is uniform / concentration is uniform / to get an accurate pH ignore more accurate / valid / fair test allow 'so the reaction is complete' / 'to dissociate all the hydroxide ions'	(2) A02-2

Question number	Answer	Additional Guidance	Mark
8(b)(iii)	all points plotted correctly ($\pm$ half a small square) (2) OR 7/8 points plotted correctly (1) S-shaped line of best fit (1)	line of best fit must go through 7 points if the points are not visible a line going through all correct values scores 3 reject dot-to-dot line / line starting from origin tramlines allowed here but rejected in 8(b)(iv) bar chart scores 0	(3) A02-1



Question number	Answer	Additional guidance	Mark
8(b)(iv)	pH reading at 4.5 spatula measures from their line on graph	allow $\pm$ half a small square on y -axis ignore any candidate working allow ECF from 8(b)(iii) but if no graph line or multiple lines, cannot score. if bar chart has been drawn for 8biii, then mark for 8biv cannot be awarded	(1) A03-2

Question number	Answer	Mark
8(c)	A corrosive is the only correct answer B , C and D are incorrect as this is the symbol for a corrosive substance	(1) A01-1

Question number	Answer	Additional guidance	Mark
8(d)	measure the {mass / amount} of the barium hydroxide / use known {masses / amounts} rather than a spatula full each time use a balance / scales	allow weighing / weigh before and after ignore scale	(1) A03-3

Total for Question 8 = 11 marks



Question number	Answer	Additional guidance	Mark
9(a)(i)	aq (1) KNO ₃ (1)	allow AQ / Aq / aQ reject aqueous allow NO ₃ K / K(NO ₃) / (NO ₃)K reject any other formula all letters must be capitals. The 3 must be a subscript.	(2) AO2-1

Question number	Answer	Additional guidance	Mark
9(a)(ii)	silver chloride	reject silver chlor ine ignore solid / precipitate / ppt	(1) AO2-1

Question number	Answer	Additional guidance	Mark
9(a)(iii)	An explanation including any 3 from - filtration (1) <u>pour mixture through</u> {filter funnel / filter paper} (1) {precipitate / residue / solid / AgCl} stays on the paper (1) {solution / filtrate / liquid} goes through (the paper) (1)	allow to filter (mixture) allow <u>pour mixture through</u> {filter / funnel} allow precipitate left behind (in filter / funnel) allow particles too big to go through ignore mixture goes through ignore any additional processes after filtration step if filtration occurs after any other process, e.g. heating, MP1 and MP2 do not score but MP3 and MP4 can be scored diagram can score all MPs	(3) AO3-3a



Question number	Answer	Additional guidance	Mark
9(b)	A description including {silver nitrate / solution} has ions (1) {silver / solid / metal} has delocalised electrons (1) {ions / electrons} move (1)	reject silver nitrate has electrons {that move / delocalised} for MP1 allow {free / sea of} electrons reject <u>silver</u> has ions {that move / delocalised} for MP2 allow charged particles move MP3 for idea of movement of charge (even if, for example, MP1 and/or MP2 reversed or wrong)	(3) AO2-1

Question number	Answer	Mark
9(c)(i)	C toxic and dangerous to the environment is the only correct answer A, B and D are not correct because they are represented by a different combination of hazard symbols	(1) AO1-1

Question number	Answer	Additional guidance	Mark
9(c)(ii)	gloves / safety glasses / goggles / dispose of safely	ignore tie long hair back, wear lab coat or other normal lab practice, PPE, (face) mask, fume cupboard, use tongs, wash hands after	(1) AO1-2

Total for Question 9 = 11 marks



Question number	Answer	Additional guidance	Mark
10(a)(i)	D red is the only correct answer A is incorrect because litmus does not turn colourless B is incorrect because litmus is red in acid C is incorrect because litmus is red in acid		(1) AO2.2

Question number	Answer	Additional guidance	Mark
10(a)(ii)	does not give a {number / value} / does not give a range of colours (1)	allow not precise, 'can't tell the pH value/ number, does not say how acidic/ alkaline, only says if acid or alkali, only has 2 (or 3) colours, only red or blue ignore not accurate, 'you can't tell the pH' ignore how pH should be measured	(1) AO2.2

Question number	Answer	Additional guidance	Mark
10(b)	- provides minerals / phosphorus / phosphates / potassium / nitrogen / nitrates (1) - helps crops grow / plants grow faster / increases crop yield (1)	allow to provide nutrients allow to prevent mineral deficiencies or specific minerals allow grow more food ignore to keep crops healthy / kills pests	(2) AO1.1

Question number	Answer	Additional guidance	Mark
10(c)(i)	76% with or without working scores 2 $\frac{18.62}{24.50} \times 100$ (1) = 76 (1)	No ECF on this question 0.76 scores 1	(2) AO2.1



Question number	Answer	Additional guidance	Mark
10(c)(ii)	$3 \times 98 = 294$ (1) $502 + (5 \times 98) = 992$ / $(3 \times 98) + (5 \times 136) + 18 = 992$ (1) $\frac{294}{992} \times 100 = 29.63709677$ (1)	29.64/ 29.6/ 30 shown with no working, scores 1 only If working shown mark as indicated For MP3: allow 2 or more s.f., answer must be correctly rounded allow ecf for MP3 only if: - numerator is attempt at some multiple of 98 - denominator is attempt using all Mr values from either reactants or products AND answer <100%	(3) A02.1

Question number	Answer	Additional guidance	Mark
10(c)(iii)	an explanation linking - find a use for {calcium sulfate / water / waste product(s) / all products} (1) - so the (formula) mass of the <u>desired product</u> increases (1) OR - find a use for {all products / calcium sulfate and water} (1) - so atom economy is 100% (1)	MP2 dependent on MP1 in both options ignore find an alternative reaction allow specified use, even if incorrect allow 'amount'	(2) A03.2

Total for Question 10 = 11 marks



Question Number	Answer	Additional guidance	Mark
8(a)	any two of the following • high melting points (1) • high boiling points (1) • malleable (1) • conduct electricity (1) • conduct heat (1) • high density (1) • shiny (1) • ductile (1) • strong (1) • sonorous (1)	allow bendy as alternative to malleable ignore solid ignore hard allow good conductor for 1 mark	(2) AO 1 2

Question Number	Answer	Additional guidance	Mark
8(b)	hydrochloric (acid)	allow HCl ignore HCL, hCl, HCL ₂ etc	(1) AO 2 1

Question Number	Answer	Additional guidance	Mark
8(c)(i)	A description including • apply lighted splint (1) • (squeaky) pop (1)	allow flame / ignite gas / fire ignore 'squeaky pop test' / glowing splint second mark is dependent on first	(2) AO 1 1

Question Number	Answer	Additional guidance	Mark
8(c)(ii)	An explanation linking - loss of electron(s) (1) - two electrons (1)	allow gains two electrons for 1 mark zero marks overall if sharing of electrons / gain or loss of protons / positive electrons marks can be awarded for suitably drawn diagram / half equation	(2) AO 1 1

Question Number	Answer	Additional guidance	Mark
8(d)	final answer of 94 (g dm^{-3}) with or without working (2) OR $\frac{23.5}{250}$ (1) (= 0.094) 0.094×1000 (1) OR $\frac{250}{1000}$ (dm^3) (1) (= 0.25 (dm^3)) $\frac{23.5}{0.25}$ (1) OR $\frac{1000}{250}$ (1) = 4 4×23.5 (1)	allow ECF (error carried forward) throughout other final answers: 0.094 / 9.4 (1) 0.000094 or 9.4×10^{-5} (1) 0.25 (dm^3) (1) allow $\frac{250}{23.5} \times 1000$ or 10638(.3) (1)	(2) AO 2 1

Question Number	Answer	Additional guidance	Mark
8(e)	A description to include • filter (1) and two in a logical order from • crystallisation (1) • heat solution (to concentrate) (1) • allow to cool (1) • dry crystals between filter papers (1)	if filtration not first stage, ignore it and give maximum 2 marks allow description of filtration ignore filtration to obtain nickel sulfate (crystals) allow 'leave until water evaporates' / use of water bath / evaporate {water/the solution} allow leave {until crystals form / for a few hours / in a warm place / on a window sill} allow 'dry crystals in (warm) oven' if alternative methods of making nickel sulfate solution described, max 1 mark from last four marking points	(3) AO 2 2

(Total for question 8 = 12 marks)