AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



MARK SCHEME

4.4.2 REACTIONS OF ACIDS (PACK 5)

SCORE	PERCENTAGE
/218	%

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Q1.

(a) H^+

1

(b) nitric (acid) **or** HNO_3

1

zinc (oxide) or ZnO

1

this order only

(c) dissolved in water

1

(d) any value from 0 to less than 8

1

(e) **Level 2:** The method would lead to the production of a valid outcome. Key steps are identified and logically sequenced.

3–4

Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

- add universal indicator **or** wide range indicator

indicator turns blue / purple / violet (because pH = 14)
or has highest pH or is an alkali
so A is sodium hydroxide

indicator turns red (because pH = 2)
or has lowest pH **or** is an acid
so B is phosphorus oxide

indicator turns green (because pH = 7)
or neutral
so C is silicon dioxide

- add solid to water

A and B dissolve; C does not
so C is silicon dioxide

[9]

Q2.

Level 3: Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

5–6

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Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1–2

No relevant content

0

Indicative content

- uses sulfuric acid not hydrochloric acid
  or sulfuric acid needed
- uses copper carbonate / oxide not calcium carbonate
  or copper carbonate / oxide needed
- add solid until solid remains **or** is in excess **or** no more reacts / dissolves
  so that most / all of the acid reacts
- filter
  to remove excess **or** unreacted carbonate / oxide / solid
- heat gently **or** partially evaporate **or** leave
  until crystals appear **or** to crystallise

for **level 3** the correct chemicals must have been selected

[6]

Q3.

(a) **Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

5–6

Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1–2

No relevant content

0

Indicative content

A is sodium oxide
B is phosphorus oxide
C is magnesium oxide
D is silicon dioxide

linked statements:

A is sodium oxide
because it has highest pH **or** pH = 14 **or** is a strong alkali

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B is phosphorus oxide
because it has lowest pH **or** pH = 3 **or** is an acid

C is magnesium oxide
because it has 2nd highest pH **or** pH = 9 **or** is a (weak) alkali

D is silicon dioxide
because it is neutral **or** pH = 7

or

A and B are sodium oxide **or** phosphorus oxide
because both soluble **or** no solid remains

C is magnesium oxide
because it will be the colourless solution with solid remaining

D is silicon dioxide
because it will be the colourless liquid with solid remaining

for **level 3** the solids must be correctly identified

(b) dilution by a factor of 100

allow pH changes by 1 when solution is diluted by factor of 10
or
allow pH changes by 2

1

(pH =) 5

1

*an answer of (pH=) 5 gains **2** marks*

[8]

Q4.

(a) hydrogen **or** H_2

allow hydrogen gas
ignore H without the 2 subscript

1

(b) filtration / filter

*allow magnet **or** decant*
ignore heating

1

(c) (Mg) $\frac{0.12}{24}$ or 0.005 (moles)

mark is for ÷ by 24

1

(Fe) $\frac{2}{3} \times 0.005 = 0.00333 \times 56$

mark is for $\times \frac{2}{3}$

1

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(mass Fe) = 0.00333 × 56

mark is for × 56

1

= 0.1866 (g)

1

= 187 (mg)

1

*an answer of 280 (mg) scores **4** marks*

*an answer of 0.280 scores **3** marks (no ratio from equation)*

*184 scores **0** [= (3 × 24) + (2 × 56)]*

OR

$$(\text{Mg}) = \frac{0.12}{(3 \times 24 =)72} (1)$$

$$= 0.00166 \textbf{ or } \frac{1}{600} \text{ (moles) (1)}$$

(mass of Fe) = 0.00166

$$\textbf{or } \frac{1}{600} \times 112(2 \times 56) \text{ (1)}$$

= 0.1866 (g) (1)

187 (mg) (1)

OR

72 g Mg ⟶ 112g Fe (1)

$$1 \text{ g Mg} \rightarrow \frac{112}{72} \textbf{ or } 1.56 \text{ g Fe (1)}$$

$$0.12 \text{ g Mg} \rightarrow \frac{112}{72} \times 0.12 \text{ (1)}$$

= 0.1866 (g) (1)

= 187 (mg) (1)

*an answer of 185−190 (mg) scores **5** marks*

*an answer of 0.185−0.19 scores **4** marks*

(d) Fe^{3+}

1

(because) reduction is gain <u>of electrons</u>

allow change in oxidation state / (+)3 to 0

1

$Fe^{3+} + 3e^{(-)} \longrightarrow Fe$

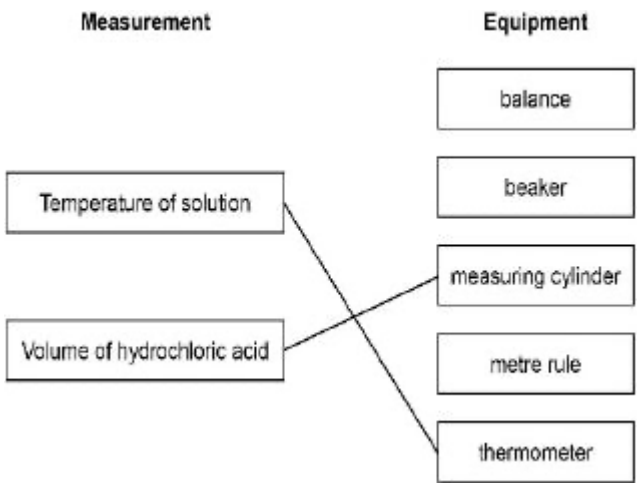
1

[10]

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Q5.

(a)



1
1

(b) $(\text{mean} =) \frac{6.1 + 6.1 + 6.4}{3}$

1

= 6.2 (°C)

*allow an answer of 6.6 (°C) for **1** mark*

1

*an answer of 6.2 (°C) scores **2** marks*

(c) use a lid on the polystyrene cup

1

(d) sodium chloride

allow NaCl

1

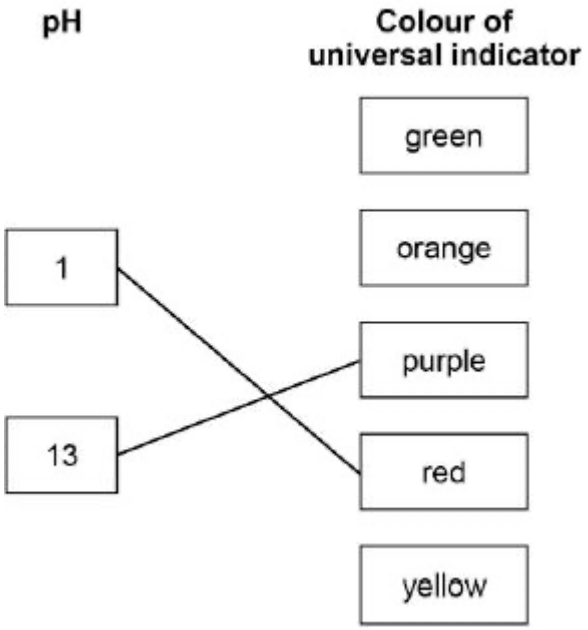
water

allow H_2O

1

(e)

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1
1

[9]

Q6.

(a) limewater

allow calcium hydroxide solution

1

(which) turns cloudy / milky (when carbon dioxide is added)

must link to limewater

1

(b) **Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

5–6

Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.

3–4

Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

- use hydrochloric acid
- place acid in suitable container e.g. beaker
- add (a spatula of) magnesium carbonate
- stir

- continue adding magnesium carbonate until in excess
- when solid remains **or** no more effervescence occurs
- filter to remove excess magnesium carbonate

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- using filter paper and funnel
- pour solution into evaporating dish

- evaporate water till crystallisation point reached
- using electric heater or Bunsen burner and a water bath
- leave to cool
- until crystals form
- pour off excess water **or** filter
- dry crystals in cool oven or with filter paper

[8]

Q7.

(a) all points correct

allow a tolerance of ± half a small square
*allow **1** mark if 3 **or** 4 points are correct*

2

line of best fit (0–20 cm^3 hydrochloric acid added)

1

extrapolation of both lines to cross

1

(b) correct value determined from their drawn lines of best fit

allow a tolerance of ± half a small square

1

(c) 1×10^{-2} °C

1

(d) any **two** from:
- repeat the experiment **and** calculate the mean
- use a lid
- insulate the polystyrene cup
- measure sodium hydroxide with a pipette / burette
- use smaller intervals for addition of hydrochloric acid

allow add hydrochloric acid in intervals of 1 or 2 cm^3

allow record temperature when 25 cm^3 of hydrochloric acid is added

2

(e) any **six** from:
- pH at start is 13 / 14

allow values between 8−14
- because sodium hydroxide is an alkaline solution as it contains OH^- ions
- as hydrochloric acid added the pH decreases
- because the H^+ ions react with OH^- ions
- this is a neutralisation reaction
- when (excess) hydrochloric acid added, H^+ ion concentration increases
- as H^+ ion concentration increases by a factor of 10, the pH value decreases by 1
- when excess hydrochloric acid added, pH is 0 / 1

allow pH values between 0−6

ignore reference to indicator colours

6

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(f) $(\text{concentration} =) 1.4 \times \frac{1000}{25}$

1

= 56 (g/dm^3)

allow a correctly calculated answer from an incorrect attempt at volume conversion

*an answer of 0.056 (g/dm^3) scores **1** mark*

1

*an answer of 56 (g/dm^3) scores **2** marks*

[16]

Q8.

(a) 3

1

(b) 5

1

(c) water

1

(d) opposite charges attract

1

(e) silver is less reactive than hydrogen

1

(f) oxygen

1

(g) universal indicator

allow other indicators

1

blue / purple

1

[8]

Q9.

(a) continuous

1

independent

1

(b) 31.5 – 24.0

1

7.5 (°C)

*an answer of 7.5 (°C) scores **2** marks*

1

(c) 25.5 – 26(.0) cm^3

1

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(d) did not stir

or

did not wait long enough for the highest temperature to be reached

1

(e) $\frac{40}{1000}$ (or $\frac{1}{20}$)

1

× 80

1

3.2 (g)

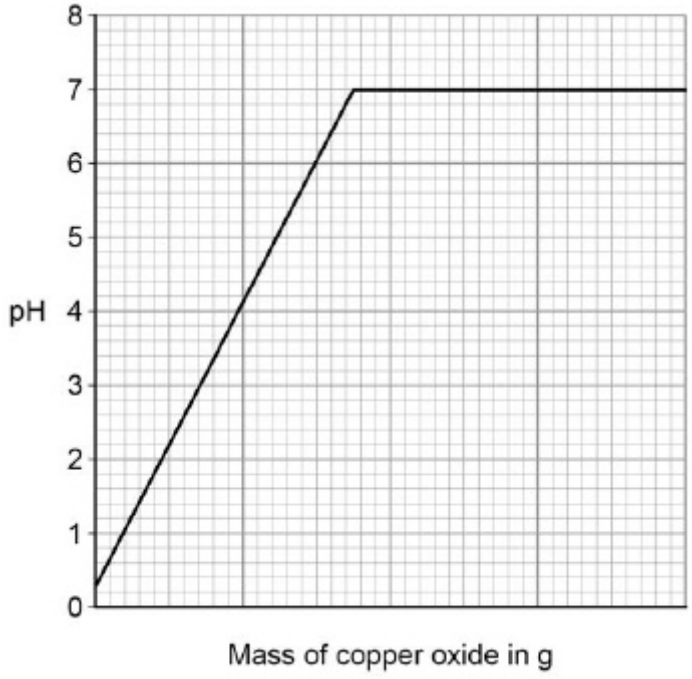
*an answer of 3.2 (g) scores **3** marks*

1

[9]

Q10.

(a)



initial pH of hydrochloric acid is 0–3

1

pH increases as CuO is added

1

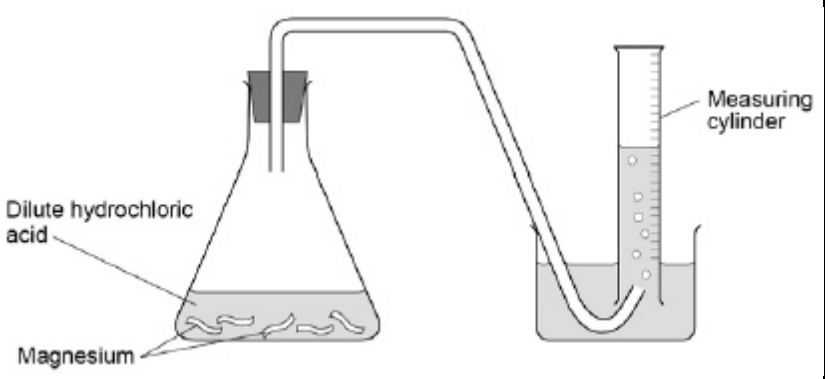
horizontal from pH = 7 (from any mass of copper oxide)

1

(b)

Level 2: The plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	4-6
Level 1: The plan would not lead to a valid outcome. Some	1-3

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relevant steps are identified, but links are not made clear.	
No relevant content	0
Indicative content  **an ideal plan would be:** • use a rule to measure the length / use a balance to find the mass of the piece of magnesium • put magnesium into conical flask • use measuring cylinder for dilute hydrochloric acid • add dilute hydrochloric acid to conical flask • connect bung (& delivery tube) into conical flask • measuring cylinder is filled with water and inverted / upside down in bowl of water OR uses a gas syringe • hydrogen flows through a delivery / rubber tube into measuring cylinder • wait until all magnesium reacts / use excess dilute hydrochloric acid • record volume when bubbles stop **other things they could mention:** • use accurate / 2 dp balance • to collect gas use measuring cylinder / gas syringe with best resolution • add bung quickly to ensure no gas escapes • gas is collected in graduated apparatus (not test tube) • repeat experiment (with same length / mass of magnesium) • repeat at same temperature since volume of gas will be different	

6

(c) (working)

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$$\frac{\text{change in y-axis}}{\text{change in x-axis}}$$

data from candidate's graph

1

(answer)
0.8 (g of Cu per g of CuO)

1

(d) (working on graph)
extension of straight line and finding y value when x = 7.5

1

factor of ×10

1

(answer) 60 (g)

or

(using gradient)
y = 0.8 x

accept ecf from question part (c)

0.8 × 75

accept part (c) × 75

60

or

(stoichiometric method)

$$\frac{\text{mass of copper oxide}}{\text{Mr of copper oxide}} \times M_r\,(\text{Cu})$$

$$\frac{75}{79.5} \times 63.5$$

= 59.9 (g)

1

[14]

Q11.

(a) silver

1

$Ag^+ + e^- \rightarrow Ag$

1

oxygen

1

$4OH^- \rightarrow O_2 + 2H_2O + 4e^-$

1

(b) 4 ions at start: H^+ OH^- Na^+ Cl^-

1

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H^+ ion discharged at negative electrode

1

Cl^- ion discharged at positive electrode

1

so OH^- and Na^+ remain in solution

1

[8]

Q12.

(a) formulation

1

(b) 1/10

1

(c) make them palatable

1

(d) neutralisation

1

(e) carbon dioxide

1

(f) water has a boiling point of 100 °C

1

water has a melting point lower than room temperature

1

(g) $CaCl_2$

1

(h) crushed

1

melted

must be in this order

1

[10]

Q13.

(a)

Level 2: Scientifically relevant features are identified; the way(s) in which they are similar / different is made clear and (where appropriate) the magnitude of the similarity / difference is noted.	3-4
Level 1: Relevant features are identified and differences noted.	1-2
No relevant content	0
Indicative content	

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• bioleaching is very slow, but although slow, phytomining can be made more efficient by growing quick growing plants • bioleaching extracts copper from quarrying waste, but phytomining extracts copper from contaminated ground • phytomining decontaminates polluted ground, but bioleaching can produce toxic run off which may go into rivers • phytomining takes a long time to stop • bioleaching is a very slow process • plants are burned in phytomining	

4

(b) (plants burned to produce) ash

1

copper compounds in ash dissolved in sulfuric acid

1

(c) $CuSO_4 + Fe$

1

$\rightarrow Cu + FeSO_4$

1

(d) electron transfer

1

(e) delocalised electrons

1

carry charge through the metal

1

(f) turns from white

1

to blue

1

[13]

Q14.

(a) **A**

1

(b) covalent

1

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

allow correct multiples

1

(d) reversible (reaction)

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1

(e) nitric acid

1

(f) all points correct

tolerance of ± ½ small square

*allow **1** mark if 4 or 5 of the points are correct*

2

line of best fit

1

(g) 20 °C

1

(h) cold pack to treat injuries

1

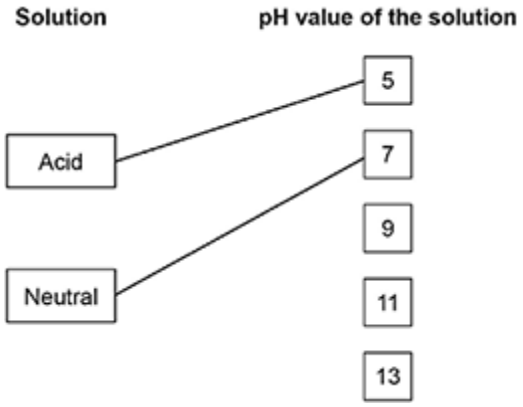
(i) **D**

1

[11]

Q15.

(a)



extra lines from solution negate the mark

2

(b) H^+

1

(c) 3

1

(d) Neutralisation

1

(e) sodium sulfate

1

(f) Add indicator to sodium hydroxide solution

allow add indicator to sulfuric acid

1

Add sulfuric acid (gradually)

allow add sodium hydroxide solution (gradually)

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1

allow pH probe

until indicator just changes (colour)

or until universal indicator turns green or shows pH7

1

[9]

Q16.

Level 3 (5–6 marks):
A coherent method is described with relevant detail, which demonstrates a broad understanding of the relevant scientific techniques, procedures and safety precautions. The
steps in the method are logically ordered with the dependent and control variables correctly identified. The method would lead to the production of valid results.

Level 2 (3–4 marks):
The bulk of a method is described with mostly relevant detail, which demonstrates a reasonable understanding of the relevant scientific techniques, procedures and safety precautions. The method may not be in a completely logical sequence and may be missing
some detail.

Level 1 (1–2 marks):
Simple statements are made which demonstrate some understanding of some of the relevant scientific techniques, procedures and safety precautions. The response may lack a logical structure and would not lead to the production of valid results.

0 marks:
No relevant content

Indicative content

Named chemicals
- copper oxide
- sulfuric acid
- copper sulfate

Correct use of apparatus
- stirring rod
- spatula
- beaker
- filter funnel and filter paper
- evaporating basin
- Bunsen burner
- tripod and gauze
- bench mat
- conical flask

Method
- add (excess) copper oxide to sulfuric acid
- heat the mixture
- filter the mixture
- method to evaporate some of the water from the filtrate eg using a water bath or evaporating to half volume

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- leave solution (to cool and) to form crystals
- remove and dry crystals

Safety

- wearing of safety glasses / goggles
- care with use of sulfuric acid as corrosive
- warming not boiling mixture of copper oxide and sulfuric acid
- hold beaker containing warm mixture with tongs whilst filtering

[6]

Q17.

(a) A base

1

(b) forces

1

(c) calcium loses electrons and oxygen gains electrons

max 3 for incorrect reference to atom / ion or to oxygen / oxide

1

two electrons are transferred

1

calcium has a 2^+ charge

1

oxide has a 2^- charge

1

[6]

Q18.

(a) bonded pair of electrons and

6 non-bonded electrons on chlorine

1

(b) **Level 3 (5–6 marks):**
A detailed and coherent explanation of comparative results of a reaction in terms of concentration and ionisation. The response makes logical links between the points raised and uses sufficient examples to support these links.

Level 2 (3–4 marks):
A description of a reaction with results is given but may miss some details. Links are made but may not be fully articulated and / or precise.

Level 1 (1–2 marks):
Simple statements are made. The response may fail to make logical links between the points raised.

0 marks:
No relevant content

Indicative content

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Simple statements / descriptions of a reaction

- correct comparative pH, such as, 0–3 (strong) 4–6 (weak)
- named reaction, such as, with a reactive metal or a named carbonate
- comparative results or observations of the named reaction, such as, faster reaction (strong) or greater volume of gas produced in a given time (strong)

Explanations of different results

- weak acids are only partially ionised in aqueous solution
- strong acids are completely ionised in aqueous solution / greater concentration of H^+ ions
- aqueous solutions of acids at the same concentration / same state of division
  of metal / powder, same temperature

6

[7]

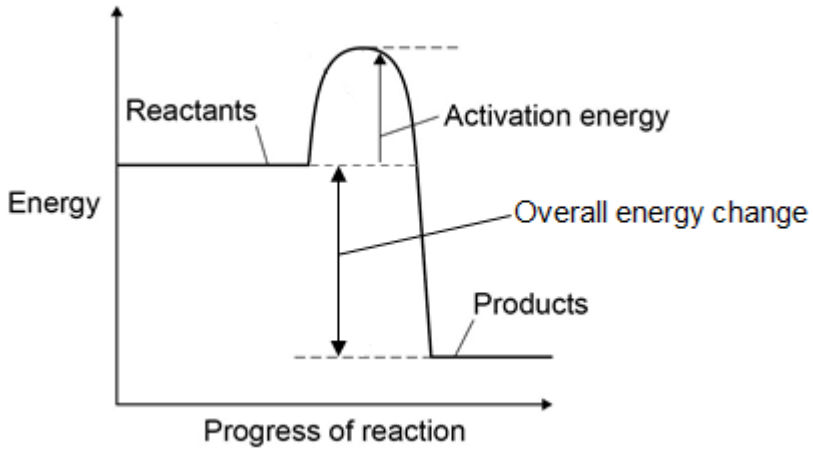
Q19.

(a) the relative energies of the reactants, products and the overall energy change

1

the activation energy

1



(b) (4 × 413) + (2 × 498) = 2 648

1

(2 × 805) + (4 × 464) = 3 466

1

(3466 − 2648 =) 818 (kJ / mol)

1

*allow max **2** marks for one ecf*

(c) **Level 3 (5–6 marks):**
A coherent method is described with relevant detail, which demonstrates a broad understanding of the relevant scientific techniques and procedures. The steps in the method are logically ordered with the dependent and control variables correctly identified. The method would lead to the production of valid results.

Level 2 (3–4 marks):

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The bulk of a method is described with mostly relevant detail, which demonstrates a reasonable understanding of the relevant scientific techniques and procedures. The method may not be in a completely logical sequence and may be missing some detail.

Level 1 (1–2 marks):
Simple statements are made which demonstrate some understanding of some of the relevant scientific techniques and procedures. The response may lack a logical structure and would not lead to the production of valid results.

0 marks:
No relevant content

Indicative content

Named apparatus

- thermometer
- measuring cylinder
- stirring rod
- spatula
- plastic cup (with lid) or beaker
- stopwatch
- filter paper or watch glass
- balance

Method

- weigh the same mass of each metal in each same state of division eg powder
- measure a set volume of sulfuric acid into a plastic cup or beaker
- measure and record the temperature of the sulfuric acid
- add metal W into the plastic cup or beaker
- stir and record the highest temperature or record the temperature after a set time
- calculate the increase in temperature
- repeat the method for metals X, Y and Z
- repeat for each metal at least three times to calculate a mean

Safe use

- comment on safe use should include wearing safety glasses

6

(d) **W**>**Y**>**X**>**Z**

1

reason for position of **W** and **Z**

W *reacts with most solutions whereas* ***Z*** *reacts with none of the solutions*

1

reason for position of **X** and **Y**

Y *is more reactive than* ***X*** *because* ***Y*** *reacts more with sulfuric acid*

1

(e) magnesium is most reactive because not displaced by any metal

1

zinc is second most reactive because displaced by only one metal

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1

copper and hydrogen cannot be placed in order of reactivity or are least reactive because

1

they both are displaced by the most / three metals

1

experiment – add sulfuric acid to copper because copper is less reactive than hydrogen
then copper would not react with sulfuric acid to displace hydrogen

1

[19]

Q20.

(a) it goes up / increases

1

because the reaction is exothermic **or** transfers energy to the surroundings
allow gives out thermal / heat energy

1

(b) $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

1

(c) copper sulfate

1

(d) **X** bubbles of gas

1

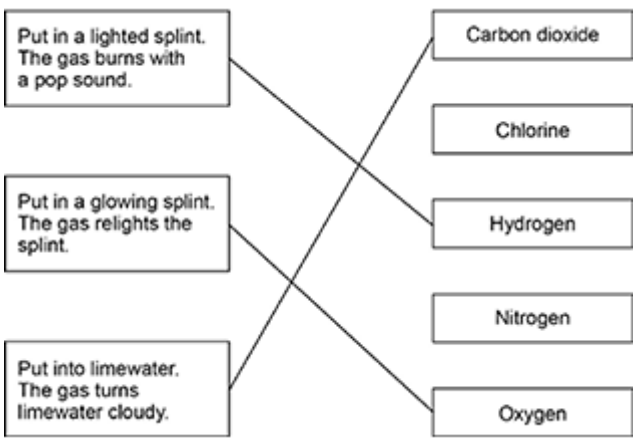
Y no bubbles of gas

1

(e) calcium>magnesium>zinc>copper
*if not all correct allow **1** mark for at least two metals in the correct position*

2

(f)

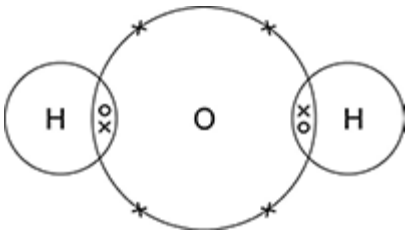


extra lines from a test negate the mark

3

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(g)



two pairs of shared electrons

1

oxygen has four other electrons not bonded

1

[13]

Q21.

(a) **Level 3 (5–6 marks):**
A full, detailed and coherent plan covering all the major steps is provided, which outlines
the apparatus required and sets out the steps needed in a logical manner that could be followed by another person to produce a pure, dry sample of copper nitrate.

Level 2 (3–4 marks):
The substantive content of a plan is present but may be missing some steps. The plan
may not be in a completely logical sequence but leads towards the production of a pure,
dry sample of copper nitrate.

Level 1 (1–2 marks):
Simple statements relating to relevant apparatus or steps are made but they may not be
in a logical order. The plan would not allow another person to produce the sample.

0 marks:
No relevant content

Indicative content

- pour a suitable volume of nitric acid into a suitable container
- add a small amount of copper carbonate to the acid and stir until the effervescence stops
- continue to add small amounts of copper carbonate to the acid and each time stir until any effervescence stops
- eventually when there is no reaction / effervescence when the copper carbonate is added filter the mixture to remove the excess copper carbonate
- pour the filtrate (copper nitrate solution) into an evaporating basin and heat to evaporate a small amount of the water
- leave the copper nitrate solution to crystallise
- remove the crystals from the solution remaining and dry the crystals

6

(b) 1 mole carbon dioxide = 14 + (16 × 2) = 46 g

1

14 g is 0.30 mole

1

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1 mole is 6.02×10^{23} molecules

1

so 14 g has 1.81×10^{23} molecules

*allow 1.81×10^{23} with no working shown for **4** marks*

1

*answer not given in standard form max. **3** marks*

[10]

Q98.

(a) (acids) <u>react</u> with calcium carbonate / shells

1

(so) shells will be (chemically) eroded

*do **not** allow melts*

allow dissolved / are thinner / worn away / corroded

ignore weakened / break down

1

(b) (i) calcium carbonate → calcium oxide (+ carbon dioxide)

ignore numbers and symbols

1

(ii) 22 (g)

mark answer line and ignore working

1

(iii) calcium hydroxide / limewater

ignore solution

1

[5]

Q99.

(a) (acids) <u>react</u> with calcium carbonate / shells

1

(so) shells will be (chemically) eroded

*do **not** allow melts*

allow dissolved / are thinner / worn away / corroded

ignore weakened / break down

1

(b) (i) mass of products should equal mass of reactants

allow loss in mass

or

4.4 g lost

1

(there is a difference because the) gas <u>escapes</u>

ignore gas produced / evaporated

1

[4]

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Q1.

No reportable questions.

Q2.

Foundation

Students found this 'extended response' question, based around Required Practical Activity 8, difficult to answer. Most of the correct responses (33%) were at level 1. Those students that just repeated the stem of the question gained no marks.

The question stated that the method contains several errors and does not produce copper sulfate crystals. Most students missed that the wrong two chemicals were being used in the stem of the question. Common improvements that gained no credit included quoting volume or masses, while some responses just changed the apparatus, expanded the method or included safety issues.

In a few cases students mentioned a correct improvement but failed to explain the reason for the change. For example, students:

- mentioned the need to filter but failed to state that filtering removed the excess solid
- stated add more solid but did not justify that this was to ensure all of the acid reacts.

42% of students gained no credit for an answer, while a further 18% of students did not make an attempt to answer at all.

Higher

This was an 'extended response question' that was based around Required Practical Activity 8. The quality of responses ranged from near perfect plans that achieved six marks to those which merely repeated the stem of the question and gained zero.

The question stated that the method contains several errors and does not produce copper sulfate crystals. It was quite common for students to miss that the wrong two chemicals were being used in the question stem. And although some students could see that a copper compound needed to be used, they didn't recognise that sulfuric acid would be needed to produce a sulfate.

Common improvements that gained no credit included quoting volume and masses, while some responses just changed the apparatus, or expanded the method and still included the errors.

In many cases students mentioned an improvement but failed to explain the reason for the change. For example, many students:

- mentioned the need to filter but failed to state that filtering removed the excess copper carbonate
- stated that excess base was added but did not justify that this was to ensure all the acid was neutralised.

This question discriminated between students well with 31% of students achieving a level

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2 or 3 mark. Students generally found it tough, with 2% achieved full marks, and 22% of gaining no credit.

Q3.

(a) In this 'extended response' question many students used the information effectively and gave very good explanations. 73% of students were able to achieve at least one mark, while 18% of students gave answers sufficient enough to meet the demands of the level 3 descriptor.

Some misunderstood the solubility data and gave SiO_2 as the most soluble. Many understood how pH related to acid, alkali and neutral. Although a common error was the confusion between whether sodium oxide was alkaline or acidic so many gave C and D correct from the solubility data but A and B incorrect.

In long descriptions, students would often contradict chemical identification or properties due to a lack of organisation within their response. A number gave the identity of the substances as elements instead of oxides. Some did not link the letters with any of the four substances listed in the question, choosing other compounds.

(b) Students struggled with the concept that is if an acid is diluted by a factor of 10 then the pH increases by 1. Very few showed any attempt at the correct method, with 12% of students achieving one or two marks. Most students simply multiplied the 3 by 100 to give an answer of 300.

Q4.

(a) 66% of students answered this question correctly. The most common incorrect answer was water.

(b) 47% of students appreciated the need for filtration or the use of a magnet. The most common incorrect responses were electrolysis, distillation, heating / evaporation or displacement using carbon.

Students need to understand the list principle. If they give two answers (one correct and one incorrect) when only one is required, no mark can be awarded. This was the case with those students who gave filter and another method that was incorrect e.g. simple distillation.

(c) Students found this question tough, but it discriminated well with higher-attaining students being able to achieve four or five marks (10%). 74% of students scored zero marks.

The most common mistake found in correct calculation methods was the absence of a conversion from g to mg. Some got to 0.185 g and then stopped or converted g to mg incorrectly. Common errors were dividing by 1000 rather than multiplying by 1000 or using a factor of 10 or 100 to convert g to mg.

Stoichiometry was not well understood which resulted in students obtaining an answers of:

- 280 mg or 0.280 g due to the omission of the stoichiometric ratio (× 2/3) or
- 124 mg or 0.124 g where they had divided by 72 and multiplied by 112, and had multiplied by 2/3 as well, so they had taken the ratio into account twice.

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Some students got as far as 0.12/24 or 0.12/72 and then no further. Others tried to calculate RFMs for the compounds involved and got no further and gained no marks.

(d) The most common mark achieved was for stating that reduction was the gaining of electrons. Many students quoted OILRIG but gave an incomplete answer of 'reduction was gain', without stating what it was that was being gained.

Few students specifically identified the 'reduced species' being reduced. Some did identify iron was reduced but didn't say which ion of iron, others gave magnesium or iron chloride.

Only a small number of students correctly wrote the half equation. 1% of students achieved two or three marks.

Q5.

(a) Nearly all students were able to identify the thermometer as the equipment needed to measure temperature but a number answered in terms of a beaker rather than a measuring cylinder as being the most suitable piece of equipment to measure volume. 71% of students achieved both marks.

(b) 41% of students successfully identified the anomalous result and went on to calculate the correct value for the mean.

A significant number of students added all four values together and divided by four, the answer obtained by this method, 6.6, was credited with one mark for being able to calculate a mean. A significant minority of students gave the mode value rather than the mean.

(c) 44% of students answered correctly, with most popular distractor to use a thermometer with a resolution of 1 °C.

(d) 6% of students were able to name both products in this neutralisation reaction, with a significant number of students answering salt or sodium oxide instead of sodium chloride and hydrogen instead of water. There was often no link to the reactants and it was difficult to see where students had obtained their answer from.

(e) 36% of students were able to identify the colour of universal indicator at both the pHs given. Others were not able to link the colours of universal indicator at different pHs to the relative strength of acids and alkalis.

Q6.

Foundation

(a) 38% of students made no attempt at answering the question. Of those who did, most used a lit splint or added universal indicator with 8% of students knowing the correct test for carbon dioxide.

(b) 43% of students did not attempt this 'extended response' question on a Required Practical Activity. It was expected that students would have knowledge of the methods of preparing a soluble salt.

Key steps in the process were: using the correct reagents, mixing in a suitable container; adding the magnesium carbonate in excess then filtering; a crystallisation method (not just evaporation to dryness).

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Very few students realised that magnesium carbonate should be added to excess or the mixture should be filtered. Most responses that were creditworthy included some or all of the following points: heating the reactants, evaporating the solution (often to dryness), leaving until crystals formed. A suitable container for the addition of magnesium carbonate to the acid was often not given, with the reagents being heated in a plastic bowl or petri dish.

Approximately half the students who attempted the question obtained at least two marks, usually either for a good description of the crystallisation process or for a partial description of the first and last stages.

A significant number of students started with the product itself which made it difficult to access level 2. As the question was asking for the procedure, not for observations, any colour changes given were ignored.

Higher

(a) Of the 31% of students able to recall the test for carbon dioxide, usually also knew the result of the test. A few students answered in terms of using a straw to blow through limewater.

A large number of incorrect responses referred to the hydrogen ‘pop’ test, or to extinguishing a lit splint

(b) This ‘extended response’ question was centred around a Required Practical Activity, so it was expected that students would have knowledge of the methods of preparing a soluble salt.

Key steps in the process were: using the correct reagents, mixing in a suitable container; adding the magnesium carbonate in excess then filtering; a crystallisation method (not just evaporation to dryness).

Approximately half the students who attempted the question achieved three marks, usually for descriptions of the first and last stages. Few students referred to the filtration stage or realised that magnesium carbonate should be added to excess. Those who did usually described this in terms of excess magnesium carbonate being visible rather than the absence of effervescence when magnesium carbonate was added.

Many students evaporated to dryness rather than describing a method to determine the crystallisation point. Often having evaporated all the water, students then left the substances to cool and crystallise.

As this was an ‘extended response question’ a student who used reactants which would not lead to the production of magnesium chloride was unlikely to access level 3, as the plan would not lead to a valid outcome.

A significant number of students started with the product itself which made it difficult to access level 2. As the question was asking for the procedure, not for observations, any colour changes given were ignored.

Q7.

(a) 42% of students were able to achieve two marks for the correct plotting of the points. However they were often then unable to draw a correct line of best fit. Some students drew a straight line in spite of the obviously curved trend. The ability of others to plot a smooth curve was limited, with most lines being very poorly drawn

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displaying errors such as using a ruler to draw dot to dot, drawing multiple or very thick lines.

The fourth marking point required students to extrapolate the lines by following the instructions to continue both lines until they met. Many changed the direction of the lines after the last plotted point and ended with a 'hump' or added a straight line to the already drawn line of best fit.

(b) 69% of students were able to use the graph correctly to give the maximum temperature. Often the answer was to the same resolution as the temperature values given in the table, e.g. 27.85 °C.

(c) 52% of students were able to give the correct temperature resolution.

(d) Many students concentrated on improving the temperature measurement or gave vague statements concerning the resolution, which weren't credited. Others repeated the experiment, but without going on to calculate a mean. A significant number realised that smaller intervals of adding hydrochloric acid was required, but not all were able to express themselves clearly often just stating more volume was needed. 5% of students achieved both marks.

(e) 49% of students achieved some credit for this question, with 5% achieving five or six marks.

There were eight available marking points in this question:

- three of these dealt with pH changes
- four dealt with the ions in the solution
- one was for recognition that this was a neutralisation reaction.

Addressing the answer in terms of ions was rarely seen, especially relating changes in pH to factors of 10 changes in H^+ concentration. In the answers dealing with pH, some had the pH numbers the wrong way round, with the alkali being at low pH, with the pH then increasing as acid was added. Some related pH to the colour of universal indicator, which was ignored, rather than a numerical value.

(f) 10% of students appeared to know how to calculate concentration. Few students:

- realised that a conversion was required
- were able to correctly convert dm^3 into cm^3 with 1000 cm^3 being omitted completely or the use of 100 instead of 1000.

0.056 g/dm^3 was the most common response where no conversion was attempted, followed by 5.6 g/dm^3 where 100 cm^3 rather than 1000 cm^3 was used.

Q98.

(a) This was a standard demand question, which was also on the higher paper. There were many confused responses with poor terminology. 1 mark was for stating that acids react with calcium carbonate or shells. Only a few students used the word react. The second mark was for saying the shells would be eroded, but words such as cracked, rotted, destroyed, broken or weakened were insufficient.

(b) (i) The word equation was well attempted, but as it was only worth 1 mark, both chemicals had to be named correctly. Incorrect names given included

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calcium cobalt and calcium dioxide. Some students listed the names of the elements in the two compounds, calcium carbon oxygen and calcium oxygen, instead of naming the substances. Students should be made aware of the names of ions given on the Data Sheet, which might have been helpful to some.

(ii) Less than half of the students understood the concept of conservation of mass, and so did not attempt to subtract one number from the other. Many added the two numbers together.

(iii) Less than a third of the students realised that the liquid that turned cloudy with carbon dioxide was limewater.

Q99.

(a) This question was standard demand. There were many confused responses with poor terminology. 1 mark was for stating that acids react with calcium carbonate or shells. A lot of students thought the acid reacted with calcium and surprisingly few students used the word react. The second mark was for saying the shells would be eroded, but words such as cracked, rotted, destroyed or broken were insufficient.

(b) Only a few students said that the mass of products should equal the mass of reactants, but still gained the first marking point if they said that there was a decrease in mass. To gain the second mark it had to be clear that the gas would escape from the test tube, which could be phrased in several ways. Most simply stated that a gas was produced, which was in the stem of the question so was insufficient for the mark. Others said the calcium carbonate or the gas evaporated, which was incorrect. Once again poor scientific terminology let a lot of students down.

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