PEARSON EDEXCEL IGCSE CHEMISTRY · 4CH1

# CHEMISTRY



## MARK SCHEME

### SECTION 2: INORGANIC CHEMISTRY (PACK 5)

| SCORE | PERCENTAGE |
| --- | --- |
| /222 | % |

STEMUP

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## Mark Scheme

Q1.

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (a) | M1 (put the carbonate in the boiling tube) and the limewater in the test tube<br><br>M2 heat the carbonate and time how long it takes for the limewater to turn cloudy OWTTE<br><br>M3 repeat with the same mass / amount / number of moles of another carbonate<br><br>M4 (the carbonate which decomposes the fastest) will turn the limewater cloudy in the least time | <br><br><br><br>**ACCEPT** repeat with another carbonate using same volume of limewater OWTTE<br><br><br>To score M4 reference to limewater turning cloudy must be mentioned at least once somewhere in answer | 4 |
| (b) (i) | to prevent loss of solid/$XCO_3$/carbonate/XO | **ALLOW** so only carbon dioxide/gas can escape | 1 |
| (ii) | 0.05 | | 1 |
| (iii) | 0.05 | **ALLOW** ECF from (ii) | 1 |
| (iv) | M1 7.40 ÷ 0.05<br><br>M2 148 | correct answer with or without working scores 2<br>**ALLOW** ECF from (iii) | 2 |
| (v) | M1 $A_r$ of metal = 148-60 **OR** 88<br><br>M2 metal is strontium / Sr | If (iv) correct strontium/Sr scores 2 without working<br><br>**ALLOW** ECF from (iv)<br><br>**ALLOW** ECF from M1 as long as answer is nearest Group 2 metal | 2 |
| | | Total for question = 11 marks | |

Q2.

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (a) | (good) conductors of electricity / malleable | **ACCEPT** (good) conductors of heat/ductile/have basic oxides/hydroxides<br><br>**ALLOW** high density/ high melting point/ sonorous/shiny/hard/ strong | 1 |
| (b) | **M1** (in mercury) particles can move/flow OWTTE | **IGNORE** references to spacing/gaps between particles / energy of particles | 2 |
| | **M2** (in solid metal) particles do not move /are in fixed positions | **ACCEPT** particles vibrate (about fixed position) | |
| (c) (i) | (bright) white flame | **ALLOW** white light<br>**ACCEPT** white solid/ash/powder (formed) | 1 |
| (c) (ii) | (product/magnesium oxide is) basic / a base | **ALLOW** (product/magnesium oxide) neutralises acid / dissolves in/reacts with acid /(produces) alkali (when added to water)<br><br>**REJECT** if incorrect product given | 1 |
| (d) (i) | magnesium/sulfur would react with/ burn in oxygen | **ACCEPT** magnesium oxide (not magnesium sulfide) would be formed<br>**ALLOW** sulfur dioxide would be formed | 1 |
| (d) (ii) | **M1** magnesium (atom) loses two electrons<br><br>**M2** sulfur (atom) gains two electrons (from magnesium)<br><br>**M3** charge on magnesium (ion) $2^+/Mg^{2+}$ AND charge on sulfur/sulfide (ion) $2^-/S^{2-}$ | two electrons transferred from magnesium (atom) to sulfur (atom) scores **M1** and **M2** | 3 |

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (d) (iii) | **M1** strong (electrostatic) force of attraction | **ALLOW** strong ionic bonds but<br>No **M1** or **M2** if between atoms/molecules or any reference to intermolecular forces / covalent bonds | 3 |
| | **M2** between magnesium ions/$Mg^{2+}$ and sulfide ions/$S^{2-}$ ions | **ACCEPT** between oppositely charged ions<br><br>**ACCEPT** between positive and negative ions | |
| | **M3** large amount/lot of (heat/thermal) energy needed to overcome forces/attraction | **ACCEPT** large amount/lot of (heat/thermal) energy needed to break the bonds<br>**IGNORE** more energy<br><br>No **M3** if reference to overcoming / breaking intermolecular forces / covalent bonds | |
| (d) (iv) | $MgS + 2HCl \rightarrow MgCl_2 + H_2S$<br><br>**M1** all formulae correct<br><br>**M2** correctly balanced | IGNORE **state symbols**<br><br>**M2 DEP M1**<br><br>**ACCEPT** multiples and fractions | 2 |

Q3.

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (a) (i) | neutralisation | ALLOW acid - base | 1 |
| (ii) | acid donates proton(s)/base accepts proton(s) | ALLOW metal oxide for base | 1 |

| | | | |
|---|---|---|---|
| (b) (i) | description including<br><br>M1 appropriate use of at least three named pieces of apparatus<br><br>AND any four of the following points<br><br>M2 add copper(II) carbonate to (dilute sulfuric) acid (a spatula/little at a time and stir after each addition)<br><br>M3 until no more effervescence<br><br>M4 filter (to remove excess copper(II) carbonate/to obtain (copper(II) sulfate) solution)<br><br>M5 heat/warm filtrate/(copper(II) sulfate) solution until crystals start to appear (solution saturated) OWTTE<br><br>M6 filter to obtain (the saturated) solution | <br><br><br><br><br><br>ALLOW until no more reacts/dissolves<br>ALLOW until in excess<br><br><br><br><br>IGNORE if continue and prepare crystals instead of saturated solution | 5 |
| (b) (ii) | M1 calculation of actual mass of crystals obtained<br><br>M2 division by expected mass of crystals (6.4) and multiplication by 100 to convert to percentage<br><br>M3 correct to 1 dp<br><br>Example calculation<br><br>M1 (6.40 – 1.80 = ) 4.6(0)<br><br>M2 (% yield = ) $\frac{4.6}{6.4}$ x100 OR 71.875 (%)<br><br>M3 = 71.9 (%) | <br><br><br><br><br><br><br><br>M2 ECF M1<br><br><br>M3 DEP M2 | 3 |

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (c) (i) | M1 find percentage of water<br><br>M2 divide each percentage by Mr to find number of moles<br><br>M3 divide each answer by smallest to find ratio and value of x<br><br>Expected calculation:<br><br>M1 (79%) $CaSO_4$ 21% $H_2O$<br><br>M2 $\frac{79}{136}$ (= 0.58) $\frac{21}{18}$ (= 1.17)<br><br>M3 $\frac{0.58}{0.58}$ $\frac{1.17}{0.58}$ = 1 : 2<br><br>so x = 2 | correct answer without working scores 3 | 3 |
| (ii) | description including<br><br>M1 do a flame test<br><br>M2 orange-red flame | ALLOW description of flame test | 2 |
| | | **(Total for Question = 15)** | |

Q4.

| Question number | Answer | Additional guidance | Marks |
|---|---|---|---|
| (a) (i) | red | **REJECT** brick-red / orange-red and all other colours | 1 |
| (ii) | $Li^+$ | **IGNORE** name even if incorrect | 1 |
| (iii) | An explanation that links the following two points<br><br>**M1 (**litmus turns) blue<br><br>**M2** (because) hydroxide (ion) / $OH^-$ forms / solution is alkaline / an alkali | **REJECT** purple | 2 |

| | | | |
|---|---|---|---|
| (b) (i) | Any two from:<br><br>**M1** forms a ball<br><br>**M2** disappears / gets smaller<br><br>**M3** forms a white trail<br><br>**M4** bubbles/fizzes/effervescence | **ALLOW** melts<br><br>**ALLOW** dissolves<br><br>**IGNORE** hydrogen or gas given off/evolved/formed/ produced | 2 |
| (ii) | $2Na + 2H_2O \rightarrow 2NaOH + (1)\ H_2$ | **ACCEPT** multiples and fractions<br><br>**IGNORE** state symbols, even if incorrect | 1 |

| Question number | | | |
|---|---|---|---|
| (c) (i) | Any one from:<br><br>**M1** burns / catches fire / (lilac/purple) flame produced<br><br>**M2** moves (around the surface) more quickly | <br><br>**REJECT** any incorrect flame colour<br><br>**ALLOW** reacts more vigorously | <br><br>1 |
| (ii) | Any number or range of numbers between 8 and 14 inclusive | | 1 |
| (d) | An explanation that links together the following two points:<br><br>**M1** rubidium/it is below potassium (in Group 1)<br><br>**M2** and the reactivity (of the elements/metals) increases down the group/as the group is descended/as atomic number/ atomic mass increases | <br><br>**ACCEPT** rubidium/it is lower down in the Periodic Table<br><br>**ACCEPT** rubidium/it has bigger atoms/more shells (of electrons)/more shielding<br><br>**ACCEPT** rubidium (atom)/it loses electrons more easily/readily<br><br>**ACCEPT** correct reverse argument | <br><br>2 |
| | | **Total** | **11** |

Q5.

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (a) | glowing splint relights | | 1 |
| (b) | M1 filter off the solid<br><br>M2 dry the solid<br><br>M3 same mass of solid / 1 g of solid | ALLOW decant/pour off liquid | 3 |
| (c) | M1 (smooth) curve above original curve<br><br>M2 levels out at 40 $cm^3$ (before 150 sec) | | 2 |
| | | Total for question | = 6 marks |

Q6.

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (a) (i) | water is needed for iron to rust / react | **ALLOW** reaction needs water (and oxygen)<br><br>**ALLOW** increases rate of reaction | 1 |
| (ii) | brown (coating on iron) | **ALLOW** red-brown / orange-brown / orange / orange-red<br>**IGNORE** red alone | 1 |
| (iii) | $Fe_2O_3$ | | 1 |
| (iv) | An explanation that links the following two points<br><br>**M1** (the powder has) a larger surface area<br><br>**M2** so the iron will rust quicker/ the reaction will be faster / the results are (obtained) more quickly | <br><br>**ALLOW** (the powder has) higher surface area:volume<br><br>**IGNORE** references to the collision theory | 2 |
| (b) | syringe reading at start: 81<br>syringe reading at end: 16<br>change in volume in $cm^3$: 65 | **ALLOW** ecf on syringe reading at start if syringe reading at end read incorrectly<br><br>correct volumes the wrong way round scores 1 | 2 |

| | | | |
|---|---|---|---|
| (c) | **M1** (volume of oxygen =) 90 – 22 **OR** 68 ($cm^3$)<br><br>**M2** (total volume at start =) 260 + 90 **OR** 350 ($cm^3$)<br><br>**M3** $\frac{68 \times 100}{350}$ = 19.4 (%) | correct answer without working scores 3<br><br><br><br>**ALLOW** ecf on **M1** and **M2** in **M3** as long as the answer is less than 100%<br><br>**ACCEPT** any number of sig figs except 1<br><br>26.2 (%) scores 2<br>25.7 (%) scores 2<br>75.6 (%) scores 2<br>34.6 (%) scores 1 | 3<br><br><br><br><br><br><br><br><br><br>**Total 10** |

Q7.

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (a) | Example calculation<br><br>M1 (volume of oxygen =) 100 – 25 **OR** 75 ($cm^3$)<br><br>M2 75 ÷ 365 × 100<br><br>M3 20.5 (%) | Correct answer of 20.5 % with or without working scores 3<br><br>**ALLOW** ecf from M1<br><br>**ALLOW** ecf from M2<br><br>**ALLOW** 2 or more significant figures<br><br>**REJECT** incorrect rounding<br>Use of 265 instead of 365 gives an answer of 28.3 and scores 2<br><br>Alternative method<br><br>M1 (volume of air left =) 265 + 25 **OR** 290 ($cm^3$)<br><br>M2 290 ÷ 365 × 100 **OR** 79.5 (%)<br><br>M3 (100 – 79.5 =) 20.5 (%) | 3 |

| | | | | |
|---|---|---|---|---|
| (b) | (i) | M1 paint provides a barrier<br><br>M2 which prevents oxygen / water getting to /reacting with the iron | **ALLOW** paint forms a coating (on the iron) / paint is non-permeable<br><br>**ALLOW** air | 2 |
| | (ii) | M1 zinc is more reactive/higher in the reactivity series (than iron)<br><br>M2 zinc will oxidise / react / corrode instead of /before iron | **ALLOW** zinc is a sacrificial metal<br><br>**IGNORE** references to zinc rusting<br><br>**IGNORE** references to galvanising | 2 |
| | | | | 7 marks |

Q8.

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (a) (i) | halogens | **REJECT** halides | 1 |
| (ii) | (pale) green | | 1 |
| (iii) | **M1** test with (damp) litmus paper<br><br>**M2** bleaches | **ALLOW** (damp) universal indicator paper<br><br>**ALLOW** turns white<br>**IGNORE** turns red<br>M2 dep on M1 | 2 |
| (b) | A description that refers to the following three points<br><br>**M1** add (dilute) nitric acid (to the unknown solution)<br><br>**M2** add silver nitrate (solution)<br><br>**M3** (pale) yellow precipitate | **M1** and **M2** can be in either order<br><br>**REJECT** addition of incorrect acid<br><br>**M3** dep on **M2** | 3 |

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| c | An explanation that links the following six points<br><br>chlorine solution and potassium bromide solution<br><br>**M1** (solution) turns orange | <br><br><br><br>**ACCEPT** yellow<br>**REJECT** brown/red | 6 |
| | **M2** (because) chlorine displaces bromine | **ACCEPT** correct word equation, balanced chemical equation or ionic equation. | |
| | **M3** (so) chlorine is more reactive than bromine | | |
| | bromine solution and potassium iodide solution<br><br>**M4** (solution) turns brown | | |
| | **M5** (because) bromine displaces iodine | **ACCEPT** correct word equation, balanced chemical equation or ionic equation | |
| | **M6** (so) bromine is more reactive than iodine | If incorrect use of chloride, bromide or iodide in any marking point deduct 1 mark.<br><br>**ALLOW** 1 mark for correct order of reactivity given if **M3** and **M6** not scored | |
| | | | **Total 13** |

Q9.

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (a) | $Zn\ (s) + H_2SO_4\ (aq) \rightarrow ZnSO_4\ (aq) + H_2\ (g)$<br><br>all state symbols correct | | 1 |
| all clip with graph (b) (i) | all points correctly plotted (within +/- half a square) | | 1 |
| (ii) | circle around point at 6 min | | 1 |
| (iii) | smooth curve of best fit | | 1 |
| (iv) | student took reading too soon/before 6 min | | 1 |
| (v) | mass from graph at 6 min | IGNORE UNITS | 1 |
| (c) (i) | **M1** curve becomes less steep /gradient decreases (as time increases)<br><br>**M2** so rate of reaction decreases | <br><br>M2 DEP M1 | 2 |
| (ii) | the (sulfuric) acid was in excess OWTTE | **ALLOW** not all (sulfuric) acid reacted<br>**ALLOW** zinc was limiting reagent<br>**ALLOW** zinc was not in excess | 1 |

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (d) | **M1** magnesium (more reactive than zinc so) would make reaction faster/increase the rate<br><br>**M2** less concentrated acid would make reaction slower/decrease the rate<br><br>**M3** (so) difficult/impossible to know whether rate will increase or decrease overall OWTTE | **REJECT** reference to different surface area<br><br>**REJECT** references to differences in energy/speed of particles<br><br>**ALLOW** difficult/impossible to know which change has greater effect OWTTE<br><br>**ALLOW** idea of difficult/impossible to predict (overall) effect of changing two factors at same time OWTTE<br><br>**ALLOW** idea of difficult/impossible to know if changes cancel each other out OWTTE | 3 |
| (e) | **M1** at higher temperature particles have more (kinetic) energy<br><br>**M2** more (successful) collisions per unit time<br><br>**M3** rate of reaction increases | **ACCEPT** more particles have the required activation energy<br>**ALLOW** particles move faster<br><br>**ALLOW** more frequent (successful) collisions | 3 |

Q10.

| Question number | | Answer | Notes | Marks |
|---|---|---|---|---|
| (a) | (i) | $Mg + 2HCl \rightarrow MgCl_2 + H_2$ | **IGNORE** state symbols even if incorrect | 1 |
| | (ii) | (squeaky) pop with lighted splint | | 1 |
| | (iii) | **M1** amount of magnesium = 0.090 ÷ 24 **OR** 0.00375 (mol)<br><br>**M2** amount of HCl needed = 2 × 0.00375 = 0.0075 (mol) (which is less than 0.025)<br><br>**OR**<br><br>**M1** amount of magnesium needed = 0.025÷2 **OR** 0.0125 (mol)<br><br>**M2** mass of magnesium needed = 0.0125 × 24 = 0.3(g) (there is less magnesium than needed) | **ALLOW** any number of significant figures | 2 |

| | | | | |
|---|---|---|---|---|
| (b) | (i) | all points plotted correctly to the nearest grid line | | 1 |
| | (ii) | best fit curve starting at 0 and levelling off at 88 $cm^3$ | | 1 |
| | (iii) | **M1** vertical line on grid from 10 seconds to curve | **ALLOW** any mark at correct position on curve / either axis | 2 |
| | | **M2** volume correctly read from their graph to the nearest grid line | expected value 25 to 30 $cm^3$ | |
| | (iv) | An explanation that links the following two points | | 2 |
| | | **M1** concentration (of HCl) is greatest (at the start) | **REJECT** incorrect references to energy<br>**ALLOW** more particles (of HCl / more $H^+$ ions)<br>**ALLOW** more HCl molecules / greater surface area of Mg<br>**IGNORE** greater mass /more Mg<br>**IGNORE** references to the graph | |
| | | **M2** more collisions per unit time / more frequent collisions | | |

| | | | | |
|---|---|---|---|---|
| (c) | (i) | M1 curve starting at 0 and steeper than original curve | **ALLOW** a curve starting within 1 small square of the original | 2 |
| | | **M2** curve levelling off at same volume as original curve | | |
| | (ii) | An explanation that links the following three points | | 3 |
| | | M1 particles gain more (kinetic) energy | **ALLOW** particles move faster | |
| | | **M2** more collisions have energy greater than the activation energy | **ACCEPT** more collisions are successful | |
| | | **M3** collision frequency increases **OR** rate of reaction increases | **ACCEPT** more (successful) collisions per unit time | |
| | | | | **Total 15** |

Q11.

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (a) (i) | $Zn + 2HCl \rightarrow ZnCl_2 + H_2$ | | 2 |
| | M1 all symbols and formulae correct | | |
| | M2 correctly balanced | M2 DEP M1 | |
| (ii) | lighted splint (produces squeaky) pop | | 1 |
| (b) (i) | 52 ($cm^3$) | ALLOW 51.5-52.5 | 1 |
| (ii) | M1 vertical line from 15 $cm^3$ acid to graph line | ALLOW extra point drawn at 15 $cm^3$ | 2 |
| | M2 volume hydrogen from graph multiplied by 2 | ALLOW 68-70 | |
| | OR | | |
| | M1 vertical line from 30 $cm^3$ acid to graph line | ALLOW extra point drawn at 30 $cm^3$ | |
| | M2 volume hydrogen from graph | ALLOW 68-70 | |
| (c) | explanation linking | | 3 |
| | M1 more (acid) particles/(hydrogen) ions/$H^+$ in same volume | REJECT molecules once only<br>ALLOW particles are closer together | |
| | M2 more (successful) collisions per second/unit time | ACCEPT more frequent collisions<br>IGNORE more chance/probability of collision | |
| | M3 rate increases | ALLOW reaction is faster /speeds up<br>MAX 1 if refer to particles moving faster/having more energy | |

| | | | |
|---|---|---|---|
| (d) | explanation including<br><br>M1 (increase/decrease) surface area<br><br>M2 increase surface area by using smaller pieces of zinc<br><br>M3 more (successful) collisions per second/unit time (so rate increases) | <br><br><br><br><br>ACCEPT more frequent collisions<br>IGNORE more chance/probability of collision<br><br>M2 M3 ACCEPT reverse arguments | 3 |
| | | **(Total for Question = 12)** | |

Q12.

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (a) | (thermal) decomposition (1) | | 1 |
| (b) | any two of the following:<br><br>M1 (use the same) amount of metal carbonate<br><br>M2 (use the same) sized pieces/surface area<br><br>M3 (use the same) volume of limewater<br><br>M4 (use same) size flame / distance of flame from boiling tube OWTTE | <br><br>ALLOW mass<br><br><br>ALLOW amount | 2 |
| (c) | bubbles are air (from tube) / caused by air (expanding on heating) | ALLOW gas in tube expands (on heating) | 1 |

| | | | | |
|---|---|---|---|---|
| (d) | | explanation including<br><br>M1 (when limewater turns milky/cloudy it) shows carbon dioxide produced<br><br>M2 showing metal carbonate has reacted/decomposed | <br><br><br>ALLOW carbon dioxide comes from carbonate (reacting/decomposing) | <br><br>2 |
| (e) | (i) | M1 (from) green<br><br>M2 (to) black | IGNORE qualifiers eg light | 2 |
| | (ii) | $CuCO_3 \rightarrow CuO + CO_2$ | ALLOW products in either order | 1 |

| Question number | | Answer | Notes | Marks |
|---|---|---|---|---|
| (f) | (i) | M1 the lower the metal is (in the reactivity series)<br><br>M2 the more easily the (metal) carbonate reacts/decomposes | ALLOW the less reactive a metal is<br><br>ALLOW the more easily the (metal) carbonate produces carbon dioxide<br><br>ALLOW references to the less time the (metal) carbonate takes to react/decompose<br><br>ALLOW references to the faster the (metal) carbonate reacts/decomposes<br><br>ACCEPT reverse arguments | 2 |
| | (ii) | repeat (the investigation) using different / other / more (metal) carbonates | | 1 |
| | | | **(Total for Question = 12)** | |

Q13.

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (a) (i) | **M1** white flame/light | | 2 |
| | **M2** white powder/solid (formed) | **ALLOW** white smoke<br>**ALLOW** white ash<br>**REJECT** white precipitate | |
| (ii) | magnesium gains oxygen | **ACCEPT** magnesium loses electrons/ oxidation state (of Mg) increases / goes from / changes from 0 to +2 | 1 |
| (b) (i) | gives out/releases heat (energy)/thermal energy | **IGNORE** energy alone | 1 |
| (ii) | $2Mg + CO_2 \rightarrow 2MgO + C$ | **ALLOW** multiples and fractions | 1 |
| (iii) | Any one from | | 1 |
| | the fire would keep burning<br>OR<br>the carbon dioxide would not put out the fire<br>OR<br>a large amount of heat/thermal energy would be released | **ALLOW** Any other sensible suggestion | |

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (c) | An explanation giving two linked changes<br><br>M1 (the student should) lift and replace the lid<br><br>M2 (to allow) oxygen/air to enter the crucible (to react with the magnesium)<br><br>AND<br><br>M3 reheat and reweigh / heat to constant mass<br><br>M4 to make sure that all the magnesium has reacted | | 4<br><br>Total 10 |

Q14.

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (a) (i) | glowing splint relights | **REJECT** burning splint | 1 |
| (ii) | A description that refers to the following three points<br><br>M1 filter out manganese(IV) oxide / solid<br><br>M2 leave to dry<br><br>M3 same mass/ 1g of manganese(IV) oxide / solid | | 3 |
| (b) (i) | M1 280 ÷ 120<br><br>M2 2.33 | <br><br>**ALLOW** ecf from M1<br><br>**ALLOW** any number of significant figures except 1 | 2 |
| (ii) | An explanation that links the following three points<br><br>M1 the concentration of hydrochloric acid is greatest<br><br>M2 therefore there are more collisions<br><br>M3 per unit time | <br><br>**ALLOW** the surface area of zinc is greatest<br><br>**ALLOW** greatest number of/more particles (of hydrochloric acid/ zinc)<br><br>More frequent collisions scores M2 and M3<br><br>Max 1 if incorrect reference to energy | 3<br><br>2 |
| (iii) | M1 curve above original and starts at 0<br><br>M2 curve goes flat at same volume (410cm$^3$) | | |
| (iv) | M1 greater surface area<br><br>M2 more collisions per unit time / more frequent collisions | | 2 |
| (c) | M1 8.46 × $10^{-3}$ mol of zinc<br><br>M2 therefore 1.69 × $10^{-2}$ mol hydrochloric acid needed (which is less than 2.50 × $10^{-2}$ mol)<br><br>**OR**<br><br>M1 1.25 × $10^{-2}$ mol of zinc are needed<br><br>M2 therefore 0.8(13) g of zinc is needed (and there is only 0.55g) | **ALLOW** any number of sig figs including one e.g. 0.008 moles of zinc, therefore 0.016 moles of acid needed scores M1 and M2 | 2 |
| | | | 15 marks |

Q15.

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (a) (i) | M1 oxygen / air<br><br>M2 water | | 2 |
| (ii) | (hydrated) iron(III) oxide | REJECT (hydrated) iron (II) oxide | 1 |
| (iii) | C<br>C is the correct answer because rusting involves the oxidation of iron.<br>A is not the correct answer because the rusting of iron is not combustion.<br>B is not the correct answer because the rusting of iron is not neutralisation.<br>D is not the correct answer because the rusting of iron is not thermal decomposition. | | 1 |
| (b) (i) | galvanising | ALLOW galvanisation<br>IGNORE sacrificial protection | 1 |
| (ii) | M1 zinc is more reactive (than iron)<br><br>M2 zinc reacts / oxidises / corrodes before / instead of iron | ALLOW zinc is higher in the reactivity series (than iron)<br><br>REJECT references to zinc rusting | 2 |
| (iii) | Any two from:<br><br>painting<br><br>plastic coating<br><br>oiling / greasing<br><br>chromium plating<br><br>sacrificial protection<br><br>cathodic protection | <br><br>ALLOW powder coating | 2 |
| | | | Total for question = 9 marks |

Q16.

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (a) (i) | fractional distillation | **ALLOW** distillation<br><br>**REJECT** simple distillation | 1 |
| (ii) | evaporation | **ALLOW** evaporating /boiling | 1 |
| (iii) | condensation | **ALLOW** condensing | 1 |

| | | | | |
|---|---|---|---|---|
| (b) | (i) | **M1** (mass ethanol $15.50 \times 0.79$ =) 12.245 (g) | | 2 |
| | | **M2** (moles ethanol = $12.245 \div 46$ =) 0.266 (mol) | **ALLOW** any number of significant figures except 1<br><br>**ALLOW** ecf from M1 | |
| | | **OR** | | |
| | | **M1** (1 $cm^3$ ethanol = $0.79 \div 46$ =) 0.0172 mol | | |
| | | **M2** (15.5 $cm^3$ ethanol = $0.0172 \times 15.5$ =) 0.267 (mol) | **ALLOW** any number of significant figures except 1<br><br>**ALLOW** ecf from M1<br><br>correct answer with or without working scores 2. | |
| | (ii) | answer from (b)(i) $\times 6 \times 10^{23}$<br>e.g. ($0.266 \times 6.0 \times 10^{23}$ =) $1.60 \times 10^{23}$ | **ALLOW** any number of significant figures except 1<br><br>**ALLOW** answer in ordinary form | 1 |

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (c) (i) | M1 add anhydrous copper sulfate<br><br>M2 turns blue | **ALLOW** add white copper sulfate<br><br>M2 dependent on M1<br><br>**ALLOW**<br><br>M1 add anhydrous cobalt chloride/ cobalt chloride paper<br><br>M2 turns pink<br><br>M2 dependent on M1 | 2 |
| (ii) | M1 measure boiling point<br><br>M2 is 100°C | <br><br>**ALLOW** melting/freezing point is 0°C for both marks | 2 |

| | | | |
|---|---|---|---|
| (d) (i) | M1 $\Delta T = 49.5°C$<br><br>M2 $Q = mc\Delta T$ **OR** $100 \times 4.2 \times 49.5$<br><br>M3 20 790 J | correct answer with or without working scores 3<br><br>**ALLOW** ecf from M1<br><br>**ALLOW** 20 800 | 3 |
| (ii) | M1 20.790 kJ<br><br>M2 (20.790 ÷ 0.0200 =) -1039.5 (kJ/mol) | **ALLOW** answer to 10(c)(i) ÷ 1 000<br><br>**ALLOW** any number of significant figures from 3<br><br>**ALLOW** M1 ÷ 0.0200 as long as answer is negative.<br><br>**REJECT** incorrect rounding.<br><br>**REJECT** positive answer. | 2 |
| | | | 15 |

Q17.

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (a) | Test for sodium ions<br><br>M1 do a flame test<br><br>M2 yellow flame<br><br>Test for carbonate ions<br><br>M3 add acid<br><br>M4 (bubble the) gas/carbon dioxide into limewater<br><br>M5 which turns cloudy | <br><br>**ALLOW** any description of a flame test<br><br>**ALLOW** orange or yellow-orange<br><br><br><br>**ALLOW** any named acid<br><br>**ALLOW** aqueous calcium hydroxide<br><br>M4 dep on M3<br><br>**ALLOW** milky / white precipitate<br><br>M5 dep on mention of limewater | 5 |
| (b) | M1 giant (ionic structure/lattice)<br><br>M2 strong forces/attraction between (oppositely charged) ions<br><br>M3 large amount of (thermal/heat) energy to overcome the forces/attraction | <br><br>**ALLOW** strong ionic bonds but **REJECT** if between atoms/molecules<br><br>**ACCEPT** large amount of (thermal/heat) energy required to break the bonds **IGNORE** more energy<br><br>No **M3** if reference to overcoming / breaking intermolecular forces /covalent bonds | 3 |
| | | Total for question | = 8 marks |

Q18.

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (a) | C<br><br>C is the correct answer because a precipitate of calcium sulfate will form in tube 1, no precipitate will form in tube 2 as both products are soluble in water and a precipitate of copper(II) carbonate will form in tube 3.<br>A, B and D are not the correct answers as no precipitate will form in tube 2. | | 1 |

| | | | | |
|---|---|---|---|---|
| (b) | (i) | white | | 1 |
| (b) | (ii) | Any five from:<br><br>M1 filter<br><br>M2 heat/boil (the solution)<br><br>M3 to evaporate some of the water<br><br>M4 leave / cool (to crystallise)<br><br>M5 pour off excess liquid **OR** filter (to obtain crystals)<br><br>M6 suitable method of drying the crystals | <br><br><br><br>ALLOW until crystals form on the end of a glass rod<br>ALLOW until crystals first start to form<br>ALLOW until the solution is saturated<br><br>M4 dep on M2<br><br>M5 dep on crystals having been formed<br><br>IGNORE references to washing<br><br>e.g. place in (warm) oven / leave to dry (in warm place) / use filter paper / kitchen towel / / desiccator<br><br>If solution heated to dryness or left to evaporate all of the water only M1 and M2 can be awarded.<br><br>If method produces silver chloride only M1 and M6 can be awarded | 5 |
| | (iii) | any one from: | | 1 |

| | | | |
|---|---|---|---|
| | to make sure the silver nitrate and sodium chloride fully reacted<br><br>to make sure the products only contained silver chloride and sodium nitrate<br><br>to ensure the highest possible yield | ALLOW so all the reactants react OR so nothing left unreacted OR so neither reagent is in excess<br><br>ALLOW to make sure the sodium nitrate (crystals) would be pure<br>ALLOW If either solution were in excess, it would contaminate the sodium nitrate OWTTE | |
| | | | Total for question = 8 marks |

Q19.

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| (a) | <table><tr><td>precipitate of barium carbonate</td><td>precipitate of barium sulfate</td></tr><tr><td>no precipitate</td><td>no precipitate</td></tr><tr><td>precipitate of calcium carbonate</td><td>precipitate of calcium sulfate</td></tr></table> | if barium sulfate and calcium carbonate correct but without including 'precipitate of' scores 1 out of 2<br><br>**ALLOW** correct formulae | 3 |
| (b) | A description that refers to any six of the following points<br><br>M1 do a flame test<br><br>M2 sodium chloride produces a yellow flame<br><br>M3 add acid<br><br>M4 potassium carbonate effervesces / bubbles<br><br>M5 add dilute nitric acid<br><br>M6 add silver nitrate (solution)<br><br>M7 potassium chloride gives a white precipitate<br><br>M8 potassium iodide gives a yellow precipitate | **ACCEPT** any description of a flame test<br><br>**ACCEPT** yellow-orange or orange<br><br>**IGNORE** any flame colour given for the potassium compounds<br><br>**ALLOW** any named acid<br><br>**ACCEPT** carbon dioxide/gas given off which turns limewater cloudy for M4<br><br>M4 is dep on M3<br><br>M7 and M8 are dep on M6<br><br>**ALLOW** addition of chlorine/bromine solution as an alternative to M6<br><br>M7 no colour change with potassium chloride<br><br>M8 solution turns brown with potassium iodide<br><br>If this alternative given no M5 | 6 |
| | | | 9 marks |

Q20.

<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>(a)</td><td>
<table>
<tr><th>Information</th><th>Substance</th></tr>
<tr><td>a good conductor of electricity</td><td>copper</td></tr>
<tr><td>an element that has a basic oxide</td><td>copper</td></tr>
<tr><td>a substance used as a fuel</td><td>methane</td></tr>
<tr><td>a major cause of acid rain</td><td>sulfur dioxide</td></tr>
<tr><td>a non-metallic element that is a solid at room temperature</td><td>iodine</td></tr>
</table>
</td><td>ALLOW correct formulae</td><td>5</td></tr>
<tr><td>(b)</td><td>A description which refers to the following points<br><br>M1 bubble/add (the gas/carbon dioxide) into limewater<br><br>M2 (limewater) turns cloudy/milky</td><td>ACCEPT calcium hydroxide<br><br>ACCEPT white precipitate<br><br>M2 dep on use of limewater/calcium hydroxide in M1</td><td>2<br><br>Total 7</td></tr>
</table>