Collins

# AQA

GCSE

# Chemistry

**SET B** – Higher Tier

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# Answers

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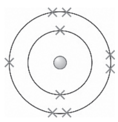
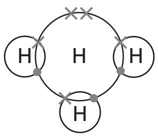
## Paper 1

| Question | Answer(s) | Extra info | Mark(s) | AO/Spec ref. |
|---|---|---|---|---|
| 01.1 | 10 | | 1 | **AO1**<br>4.1.1.5 |
| 01.2 |  | 1 mark for two electrons on inner orbit;<br>1 mark for seven in the outer orbit. | 2 | **AO2**<br>4.1.1.7 |
| 01.3 | (35 × 3) + (37 × 1) ÷ 4<br>= 35.5 | allow 2 marks for correct answer with no workings<br>deduct 1 mark if not to one d.p. | 1<br>1 | **AO2**<br>4.1.1.6 |
| 01.4 | any two from:<br>melting point<br>boiling point<br>relative atomic mass | | 2 | **AO1**<br>4.1.2.6 |
| 02.1 | atoms share electrons…<br>…so that each atom has a full outer shell | | 1<br>1 | **AO1**<br>4.2.1.4 |
| 02.2 |  | | 2 | **AO2**<br>4.2.1.4 |
| 02.3 | They are giant covalent structures. | | 1 | **AO1**<br>4.2.2.6 |
| 02.4 | **Level 3** A detailed and comprehensive answer which includes a description of the structures of both graphite and diamond. The answer must be clear about how the bonding and structure define the conductivity and physical state of each substance. | | 5–6 | **AO3**<br>4.2.3.1<br>4.2.3.2 |
| | **Level 2** An answer which describes the difference in structure between graphite and diamond. It should relate some of the features to the structure or bonding. | | 3–4 | |
| | **Level 1** An answer that appreciates the difference between the structures but does not explain how this affects the properties. | | 1–2 | |
| | **No relevant content** | | 0 | |
| | **Indicative content**<br>• In diamond, each carbon has four covalent bonds. Each atom has a full outer shell.<br>• Diamond has no free electrons or charged particles to conduct electricity.<br>• Covalent bonds are very strong so the atoms in diamond are held firmly together in a very hard structure.<br>• In graphite, each carbon has three covalent bonds in a hexagonal lattice. Each atom has a free electron.<br>• The free electrons allow conduction of electricity.<br>• Covalent bonds create strong layers, which make graphite solid, but there are only weak bonds between layers and this creates the greasy feel. | | | |
| 03.1 | Atoms are arranged in a regular pattern / giant structure<br>surrounded by delocalised electrons.<br>The metallic bonds are created by the strong attraction between the positive nuclei and the delocalised electrons. | | 1<br>1<br>1 | **AO1**<br>4.2.1.5 |
| 03.2 | High malleability<br>High boiling point<br>High electrical conductivity | | 1<br>1<br>1 | **AO1**<br>4.2.2.7<br>4.2.2.8 |
| 03.3 | $2K(s) + 2H_2O(l) \longrightarrow 2KOH(aq) + H_2(g)$ | 1 mark for correct products, 1 for balancing the equation and 1 for state symbols. | 3 | **AO2**<br>4.1.2.5<br>4.2.2.2<br>4.3.1.1 |
| 03.4 | Iron is a transition metal and transition metals are much less reactive than alkali metals. | | 1 | **AO1**<br>4.1.3.1 |
| 03.5 | Pass steam over the iron.<br>Allow a mark for any sensible suggestion such as increasing pressure, temperature or cutting the iron into finer pieces. | | 1 | **AO3**<br>4.5.1.2 |
| 04.1 | Put each piece of metal in (a test tube / beaker of) water.<br>(Use a stopwatch to) measure the time until the effervescence has stopped / metal has disappeared.<br>One mark for any of:<br>wear safety glasses<br>keep hydrogen away from naked flames<br>put the metal into the water using tongs. | | 1<br>1<br>1 | **AO2**<br>4.4.1.2 |
| 04.2 | Put each piece of metal into a test tube / beaker with dilute acid.<br>Judge reactivity by bubble observation / burning splint test. | | 1<br>1 | **AO3**<br>4.4.1.2 |



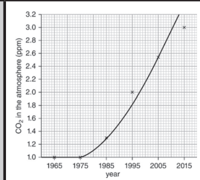
| Question | Answer(s) | Extra info | Mark(s) | AO/Spec ref. |
|---|---|---|---|---|
| 04.3 | magnesium<br>zinc<br>iron<br>copper | 1 mark for magnesium first and copper last;<br>2 marks for all correct | 2 | **AO2**<br>4.4.1.2 |
| 04.4 | The greater a metal's tendency to form positive ions, the greater its reactivity.<br>Free electrons in an outer shell are further from the nucleus and so are easier to lose than those in the inner shells; this is why potassium loses electrons, i.e. is more reactive, than lithium.<br>Single electrons in an outer shell are easier to lose than multiple electrons; this is why magnesium is least reactive. | | 1<br>1<br>1 | **AO2**<br>4.4.1.2 |
| 04.5 | $Mg + Cu^{2+} \longrightarrow Mg^{2+} + Cu$ | | 1 | **AO2**<br>4.4.1.4 |
| 05.1 | $CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$ | | 1 | **AO2**<br>4.3.1.1 |
| 05.2 | The law of conservation of mass | | 1 | **AO1**<br>4.3.1.1 |
| 05.3 | $CaCO_3 = 40 + 12 + (3 \times 16) = 100$<br>$CaCl_2 = 40 + (2 \times 35.5) = 111$ | | 1<br>1 | **AO2**<br>4.3.1.2 |
| 05.4 | = (13.02 + 12.73 + 12.15 + 11.98) ÷ 4<br>= 12.47 g | allow 2 marks for the correct answer without working | 1<br>1 | **AO2**<br>4.3.1.4 |
| 05.5 | = (13.02 – 11.98) ÷ 12.47 × 100%<br>= 8.3% | allow 2 marks for the correct answer without working | 1<br>1 | **AO2**<br>4.3.1.4 |
| 05.6 | The carbon dioxide produced has escaped. | | 1 | **AO2**<br>4.3.1.3 |
| 05.7 | $2Ca + O_2 \longrightarrow 2CaO$ | | 1 | **AO2**<br>4.4.1.1 |
| 05.8 | relative formula mass<br>CaO = 2 × (40 + 16) = 112<br>mass produced = 112 ÷ 80 × 50g<br>= 70g | | 1<br>1 | **AO2**<br>4.3.2.2 |
| 06.1 | $2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$ | | 1 | **AO2**<br>4.4.2.2 |
| 06.2 | **Level 3** A detailed and safe method is given which would produce valid results. A suitable indicator is named and colour change given. | | 5–6 | **AO1/2**<br>4.4.2.4<br>4.4.2.5 |
| | **Level 2** A safe method is described which would produce valid results, but some detail is missing. The method should be aiming to produce more than one set of titration results. | | 3–4 | |
| | **Level 1** A simple method is given which demonstrates some of the required practical procedures needed to produce valid results, but will not produce valid results in its entirety. It should show some understanding of the procedure. | | 1–2 | |
| | **No relevant content** | | 0 | |
| | **Indicative content**<br>• Pipette used to measure 30 $cm^3$ sodium hydroxide solution. Bottom of meniscus lines up with calibration mark. Sodium hydroxide solution is placed in conical flask.<br>• A few drops of indicator are added; litmus, methyl orange, phenolphthalein. Universal indicator is a less good choice but it is used in 4.4.2.4 so allow.<br>• Burette rinsed with sulfuric acid, then filled using small funnel. Funnel is removed. Initial burette reading recorded.<br>• Ensure eyes at meniscus level when taking reading.<br>• Could do rough volume first before accurate trials.<br>• Acid is added from burette, 1 $cm^3$ at a time, until near end point. Acid then added drop by drop until end point is reached.<br>• Indicator changes: litmus: blue to red; methyl orange: yellow to red; phenolphthalein: red to colourless; universal: purple to green<br>• Titration repeated to obtain three results within 0.10 $cm^3$.<br>• Safety glasses worn.<br>• Fill burette with acid below eye level. | | | |
| 06.3 | number of moles NaOH solution = 0.15 × 30 ÷ 1000 = 0.0045 moles<br>number of moles $H_2SO_4$ = 0.0045 ÷ 2 = 0.00225 moles<br>from the graph, 24 $cm^3$ $H_2SO_4$ required.<br>concentration $H_2SO_4$ = 0.00225 ÷ (24 ÷ 1000) = 0.09 mol/$dm^3$ to 2 d.p.<br>Allow error carried forward from 06.1 if balanced incorrectly there | | 1<br>1<br>1<br>1 | **AO2**<br>4.3.4<br>4.4.2.5 |
| 07.1 | anode is positively charged, cathode is negatively charged<br>ions attracted to the anode are negatively charged, ions attracted to the cathode are positively charged | | 1<br>1 | **AO1**<br>4.4.3.1 |
| 07.2 | anions: $Cl^-$ or chloride ion, $OH^-$ or hydroxide ion<br>cations: $Na^+$ or sodium ion, $H^+$ or hydrogen ion | | 1<br>1 | **AO1**<br>4.4.3.4 |
| 07.3 | Hydrogen gas will be produced at the cathode / negatively charged electrode.<br>Chlorine gas will be produced at the anode / positively charged electrode. | | 1<br>1 | **AO2**<br>4.4.3.4 |

| Question | Answer(s) | Extra info | Mark(s) | AO/Spec ref. |
|---|---|---|---|---|
| 07.4 | When there are multiple cations and anions in solution, they are discharged preferentially based on the reactivity series.<br>The least reactive ions are discharged as elements. $H^+$ and $Cl^-$ are less reactive than $Na^+$ and $OH^-$.<br>**OR**<br>$Na^+$ is more reactive/tends to lose its electrons more easily than $H^+$ so $H^+$ accepts the electrons at the cathode and discharges as $H_2$.<br>$OH^-$ ions are more reactive/tend to gain electrons more easily than $Cl^-$ so $Cl^-$ loses electrons at the anode and discharges as $Cl_2$. | | 1<br>1<br><br>1<br>1 | **AO2**<br>4.4.3.4 |
| 07.5 | $2H^+ + 2e^- \longrightarrow H_2$ | | 1 | **AO2**<br>4.4.3.5 |
| 07.6 | $4OH^- + 4e^- \longrightarrow 2H_2O + O_2$ | 1 mark for correct products; 1 mark for balanced equation | 2 | **AO2**<br>4.4.3.4 |
| 08.1 | Powdered magnesium will give a faster reaction than the strip because there is a greater surface area for the acid to act on so there will be more collisions. | | 1 | **AO2**<br>4.4.2.1<br>4.6.1.2<br>4.6.1.3 |
| 08.2 | The warm sulfuric acid will give a faster reaction than the room temperature acid because the particles will have higher energy and will collide more. | | 1 | **AO2**<br>4.4.2.1<br>4.6.1.2<br>4.6.1.3 |
| 08.3 | $Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2$ | | 1 | **AO1**<br>4.4.2.1 |
| 08.4 | $M_r$ $Mg + H_2SO_4$ = 24 + (2 × 1) + 32 + (4 × 16) = 122<br>$M_r$ $MgSO_4$ = 24 + 32 + (4 × 16) = 120<br>percentage atom economy = (120 ÷ 122) × 100 = 98.4% | | 1<br>1<br>1 | **AO2**<br>4.3.3.2 |
| 08.5 | The most efficient method based on atom economy only is the one where as few reactant atoms as possible end up as by-products rather than as part of the desired product.<br>Inspection of the two equations shows that the carbonate method has a carbon atom and three oxygen atoms more by-product than the pure magnesium method so the pure magnesium method is the most efficient method. | | 1<br>1 | **AO3**<br>4.3.3.2 |
| 08.6 | Any two sensible suggestions.<br>Indicative content: yield, rate of reaction, uses of by-products, energy required, availability of reactants, safety | | 1 | **AO1**<br>4.3.3.2 |
| 08.7 | theoretical yield = 4 g × (120 ÷ 24)<br>= 20 g | allow 2 marks for correct answer with no workings | 1<br>1 | **AO2**<br>4.3.3.1 |

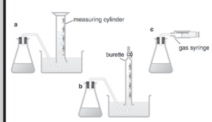
| Question | Answer(s) | Extra info | Mark(s) | AO/Spec ref. |
|---|---|---|---|---|
| 08.8 | Percentage yield = 18.8 ÷ 20 × 100<br>= 94% | allow 2 marks for correct answer with no workings | 1<br>1 | **AO2**<br>4.3.3.1 |
| 09.1 | Zinc / the more reactive metal has a higher tendency than copper / the less reactive metal to lose its outer shell electrons / form positive ions in the electrolyte.<br>Copper / the less reactive metal has a lower tendency to lose electrons and so there is a difference in charge between the two electrodes.<br>The electrons that have been released from zinc are accepted by the less reactive copper electrode, electrons flow and a current is measured. | | 1<br>1<br>1 | **AO1**<br>4.5.2.1<br>4.4.1.2 |
| 09.2 | zinc is oxidised, copper is reduced | both correct for 1 mark | 1 | **AO2**<br>4.5.2.1 |
| 09.3 | Substitute the zinc electrode with a more reactive metal (allow 'more reactive' or K, Na, Li, Ca, Mg or Al)<br>This will create a bigger difference between the reactivities of the metals and the voltage will be higher<br>**OR**<br>Substitute the copper electrode with a less reactive metal (allow "less reactive" or Ag, Au).<br>This will create a bigger difference between the reactivities of the metals and the voltage will be higher. | | 1<br>1<br><br>1<br>1 | **AO3**<br>4.5.2.1 |
| 09.4 | The biggest voltage is between magnesium and lead so they must be the most and least reactive.<br>From the reactivity series, magnesium is highly reactive so it is the most reactive and lead the least reactive.<br>The smallest voltage where one electrode is magnesium is with aluminium so aluminium must be the second most reactive, leaving chromium third **OR** The smallest voltage where one electrode is lead is with chromium so chromium must be the third most reactive, leaving aluminium second.<br>most: magnesium<br>aluminium<br>chromium<br>least: lead | | 1<br>1<br>1 | **AO3**<br>4.5.2.1<br>4.4.1.2 |
| 09.5 | Hydrogen gas is oxidised at the catalyst and releases electrons.<br>$2H_2 \longrightarrow 4H^+ + 4e^-$<br>The electrons move through a wire and reduce the hydrogen ions / protons while reacting with oxygen.<br>$4H^+ + O_2 + 4e^- \longrightarrow 2H_2O$ | | 1<br>1<br>1<br>1 | **AO1**<br>4.5.2.2 |

## Paper 2

| Question | Answer(s) | Extra info | Mark(s) | AO/Spec ref. |
|---|---|---|---|---|
| 01.1 | Manufacturing process<br>Transport requirements<br>Useful lifetime of products | | 1<br>1<br>1 | **AO1**<br>4.10.2.1 |
| 01.2 | **Level 3** A comprehensive answer that uses the properties in the table (raw material, petrol used in transportation of raw material, chemicals used per cup, relative amounts of electricity used and waste water generated) to contrast paper and polystyrene cups. Ideally, at least one additional point will be considered. A conclusion should be reached, backed up with evidence. | | 5–6 | **AO3**<br>4.10.2.1 |
| | **Level 2** An answer that covers some of the main points and draws some conclusions from the information given in the question. Students should reach a conclusion, but some of their evidence may be lacking. | | 3–4 | |
| | **Level 1** An answer that contains some relevant points, but fails to produce a conclusion. | | 1–2 | |
| | **No indicative content** | | 0 | |
| | **Indicative content**<br>**Points from the table**<br>• Paper is made from wood, which is a renewable resource, whilst polystyrene is made from oil, which is a finite resource.<br>• This would suggest that paper is a more sustainable choice until the following points are considered.<br>• Petrol is used in the transportation of wood but it is not required to transport oil.<br>• More chemicals are used per cup made of paper than per polystyrene cup.<br>• More electricity is used per cup made of paper than per polystyrene cup.<br>• More waste water is generated per cup made of paper than per polystyrene cup.<br>**Other points**<br>• Polystyrene can be recycled whilst paper cups cannot because of the glue used / coating.<br>• Paper cups weigh more than polystyrene so more petrol is used in transporting them.<br>• Polystyrene cups can be washed whilst paper cups cannot.<br>**Conclusion**<br>• Polystyrene is more environmentally sustainable. | | | |

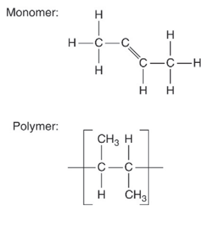
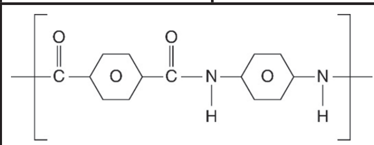
| Question | Answer(s) | Extra info | Mark(s) | AO/Spec ref. |
|---|---|---|---|---|
| 01.3 | thermosoftening…<br>…polymers melt when they are heated so the bottle can be melted and recycled. | | 1<br>1 | **AO2**<br>4.10.3.3 |
| 02.1 | argon — 0.9%<br>carbon dioxide — 0.04%<br>nitrogen — 78%<br>oxygen — 21% | 1 mark for two correct; 2 marks for all correct | 2 | **AO1**<br>4.9.1.1 |
| 02.2 | algae and plants<br>photosynthesis | | 1<br>1 | **AO1**<br>4.9.1.3 |
| 02.3 | $6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$ | | 1 | **AO1**<br>4.1.1.1<br>4.9.1.3 |
| 02.4 | photosynthesis<br>The carbon was incorporated into algae and plants through photosynthesis. When the plants died, they decayed and some were compressed, eventually forming fossil fuels, which acted as a carbon sink. | | 1<br>1 | **AO2**<br>4.9.1.1<br>4.9.1.3 |
| 02.5 |  | 1 mark for accurate plotting; 1 mark for reasonable line of best fit | 2 | **AO2**<br>4.9.2.2 |
| 02.6 | rate = (2.94 – 1.55) ÷ 20 = 0.07 ppm/year per year<br>if line of best fit goes through all points, then values are<br>rate = (2.72 – 1.68) ÷ 20 = 0.05 ppm/year per year<br>(allow ecf from the graph) | 1 mark for reading accurately from their line of best fit;<br>1 mark for calculating the rate to 2 d.p. and including units | 2 | **AO2**<br>4.9.2.2 |
| 02.7 | The rate of growth in the annual increase in carbon dioxide concentration in the atmosphere has increased / the rate of growth has accelerated since 1975.<br>Allow any conclusion which is consistent with the data | | 1 | **AO3**<br>4.9.2.2 |
| 03.1 | $R_f$ red spot = 3.6 ÷ 12.2 = 0.31 (≡ Dye 1)<br>$R_f$ blue spot = 8.5 ÷ 12.2 = 0.70 (≡ Dye 3) | 1 mark for correct formula<br>1 mark for each correct answer | 3 | **AO2**<br>4.8.1.3 |

| Question | Answer(s) | Extra info | Mark(s) | AO/Spec ref. |
|---|---|---|---|---|
| 03.2 | any one from:<br>repeat twice more and take the mean results<br>repeat twice to see if the result is anomalous<br>use larger piece of paper to reduce error in measuring | allow any sensible suggestion | 1 | **AO3**<br>4.8.1.3 |
| 03.3 | A: copper carbonate<br>B: calcium iodide<br>C: sodium sulfate<br>D: lithium chloride | 1 mark for each correctly identified anion and cation | 2<br>2<br>2<br>2 | **AO2**<br>4.8.3.1<br>4.8.3.2<br>4.8.3.3<br>4.8.3.4<br>4.8.3.5 |
| 04.1 | Finite resource<br>A mixture of many compounds of oil<br>Formed from ancient tiny sea creatures | | 1<br>1<br>1 | **AO1**<br>4.7.1.1 |
| 04.2 | **Level 3** A comprehensive answer that explains the full process in a clear and logical way. It should include examples of specific products. | | 5–6 | **AO1**<br>4.7.1.2 |
| | **Level 2** An answer that covers the ideas of evaporation and condensation at different points. It should have some description of the tower but will lack detail. | | 3–4 | |
| | **Level 1** An answer that contains the main ideas of evaporation and condensation but does not explain how the oils are extracted in fractions based on boiling points or vice versa. | | 1–2 | |
| | **No indicative content** | | 0 | |
| | **Indicative content**<br>• Crude oil is fed into the fractional distillation column / tower near the bottom and is heated.<br>• Most of the hydrocarbons contained in crude oil evaporate / boil and the gases rise up the tower.<br>• Bitumen has a very high boiling point, doesn't boil, sinks to the bottom of the tower and is collected.<br>• The tower is kept at precisely graduated temperatures, which get gradually cooler towards the top.<br>• Different hydrocarbons condense at different temperatures.<br>• The ones with higher boiling points condense first and are collected near the bottom of the tower.<br>• The ones with lower boiling points, like liquid petroleum gas, do not condense until they have reached the cold top of the tower.<br>• In this way, the tower separates the oils into fractions based on their boiling points. | | | |

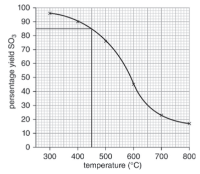
| Question | Answer(s) | Extra info | Mark(s) | AO/Spec ref. |
|---|---|---|---|---|
| 04.3 | A has 3 carbon atoms.<br>B has 22 carbon atoms.<br>C has 16 carbon atoms. | 1 mark for one fuel correctly identified;<br>2 marks for three fuels correctly identified. | 2 | **AO2**<br>4.7.1.3 |
| 04.4 | Longer chains of hydrocarbons (have greater surface area and so) have a larger number of weak intermolecular forces between them.<br>Stronger intermolecular forces (mean it is harder to separate the molecules so this) leads to higher boiling point and viscosity and low flammability. | | 1<br>1 | **AO2**<br>4.7.1.3 |
| 05.1 | Any one of these three diagrams with labels.<br> | 1 mark for any one of the three diagrams;<br>1 mark for correct labels of measuring equipment and reactants (marble chips and dilute HCl) | 2 | **AO2**<br>4.6.1.1<br>4.6.1.2 |
| 05.2 | 0–5 seconds / the first interval | | 1 | **AO2**<br>4.6.1.1 |
| 05.3 | rate = 10.5 $cm^3$ ÷ 5 s = 2.1 $cm^3$/s | 1 mark for correct answer (allow 10.75 ÷ 5 or 11 ÷ 5 = 2.2. Do not allow answers to 2 d.p.);<br>1 mark for correct units | 2 | **AO2**<br>4.6.1.1 |
| 05.4 | any two from:<br>increasing the concentration of the acid<br>increasing the temperature of the acid / system<br>increasing the surface area of the calcium carbonate by cutting it into smaller pieces or using powder | | 2 | **AO1**<br>4.6.1.2 |



| Question | Answer(s) | Extra info | Mark(s) | AO/Spec ref. |
|---|---|---|---|---|
| 05.5 | A reaction takes place when reacting particles collide with each other with sufficient energy.<br>Then either:<br>Increasing the concentration of the acid crowds more reacting particles into the same volume. This means that collisions between reacting particles are more frequent and the speed of reaction increases.<br>Or:<br>Increasing the temperature of the acid / system increases the kinetic energy of the particles. They will move more quickly and so are more likely to collide and the rate of reaction increases.<br>Or:<br>Increasing the surface area of the calcium carbonate means there is a larger reacting surface. Collisions are more likely and the rate of reaction increases. | | 2 | **AO1**<br>4.6.1.3 |
| 06.1 | From the air | | 1 | **AO1**<br>4.10.4.1 |
| 06.2 | Reaction of nitrogen and hydrogen | | 1 | **AO1**<br>4.10.4.1 |
| 06.3 | The reaction is exothermic so more ammonia is produced / the yield is increased at lower temperatures.<br>High temperatures increase the rate of reaction but favour the reverse reaction.<br>A compromise is needed between these two factors. | | 1<br>1 | **AO2**<br>4.10.4.1 |
| 06.4 | A: nitric acid<br>B: phosphate rock<br>C: ammonium phosphate | | 1<br>1<br>1 | **AO2**<br>4.10.4.2 |
| 06.5 | **Level 3** A comprehensive answer that explains the full process in a clear and logical way. It should include reactants, specify an indicator and explain the equipment used in each technique. | | 5–6 | **AO3**<br>4.10.4.2 |
| | **Level 2** An answer that includes the correct reactants and knowledge of the techniques used. | | 3–4 | |
| | **Level 1** An answer that names either the reactants or some of the techniques. | | 1–2 | |
| | **No indicative content** | | 0 | |
| | **Indicative content**<br>• Use a measuring cylinder to pour a known quantity of ammonia solution into a conical flask.<br>• Put an indicator into the ammonia solution.<br>• Use a pipette to put dilute nitric acid into a burette.<br>• Measure the amount of nitric acid required to neutralise the ammonia. (Universal indicator turns green, phenolphthalein turns from pink to colourless, methyl orange turns from yellow to red.)<br>• Repeat with precise measurements and no indicator.<br>• Put the solution into an evaporating dish.<br>• Warm the dish gently to initiate evaporation.<br>• Filter the crystals from the solution using filter paper in a funnel<br>• Wear safety glasses.<br>• Pour ammonia solution and nitric acid below eye level. | | | |
| 07.1 | $C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$ | 1 mark for correct reactants and products;<br>1 mark for balancing the equation | 2 | **AO1**<br>4.1.1.1<br>4.7.2.3 |
| 07.2 | ethanoic acid / $CH_3COOH$ | | 1 | **AO1**<br>4.7.2.3 |
| 07.3 | carboxylic acids do not ionise completely in water / not all of the ethanoic acid molecules ionise at once…<br>…this means the concentration of $H^+$ ions is low and the acid is weak | | 1<br>1 | **AO1**<br>4.7.2.4 |
| 07.4 |  | no marks deducted if methyl groups are on same side or if butene molecule is shown as a straight line | 2 | **AO2**<br>4.7.3.1 |
| 07.5 | <br>other product = water | | 1<br>1 | **AO2**<br>4.7.3.2 |
| 07.6 | both polymerisations occur through condensation of an amine group with a carboxylic acid | | 1 | **AO2**<br>4.7.3.3 |

| Question | Answer(s) | Extra info | Mark(s) | AO/Spec ref. |
|---|---|---|---|---|
| 08.1 | arable farm:<br>(2 ÷ 5.5) × 40 = 14.54 ≡ 15<br>livestock farm:<br>(2.5 ÷ 5.5) × 40 = 18.2 ≡ 18<br>detergent plant:<br>(1 ÷ 5.5) × 40 = 7.3 ≡ 7 | 1 mark for one correct;<br>2 marks for all correct;<br>0 marks if answers have decimal places | 2 | **AO2**<br>4.10.1.2 |
| 08.2 | concentrate all sampling in the river running past the arable farm…<br>…as this part of the river won't be polluted with either effluent from the livestock farm or chemicals from the detergent plant | | 1<br>1 | **AO3**<br>4.10.1.2 |
| 08.3 | acceptable reading for North America in the range (16.5–16.8)<br>acceptable reading for Sub-Saharan Africa in the range (1.5–1.8)<br>this gives answers in the range 9%–12% | 1 mark for reasonable approxima-tions;<br>1 mark for correct calculation | 1<br>1 | **AO2**<br>4.10.1.2 |
| 08.4 | bacteria | | 1 | **AO2**<br>4.10.1.4 |
| 08.5 | bioleaching is much slower than traditional methods and this makes it more expensive<br>the median cost in the table is 39.9 US cent/lb Cu and two of the three bioleaching projects are 25% and 50% higher than this<br>the average cost of bioleaching projects is 47.0 US cent/lb Cu, which compares poorly with the average cost of traditional projects at 35.0 US cent/lb Cu<br>the range of bioleaching projects is 30.1–60.8 US cent/lb Cu, which compares poorly to the range of traditional projects at 29.5-40.2 US cent/lb Cu | three clear points for 3 marks, at least one of which should be derived from data in the table | 3 | **AO3**<br>4.10.1.4 |

| Question | Answer(s) | Extra info | Mark(s) | AO/Spec ref. |
|---|---|---|---|---|
| 09.1 |  | 1 mark for accurate plotting;<br>1 mark for appropriate line of best fit | 2 | **AO2**<br>4.6.2.1<br>4.6.2.6 |
| 09.2 | approximately 85%<br>allow ecf from previous answer | | 1 | **AO2**<br>4.6.2.5 |
| 09.3 | exothermic<br>from Le Chatelier's principle, if the temperature is increased the system will act to counteract the change, that is, it will favour the endothermic reaction<br>as temperature increases, the yield decreases and so the reverse reaction must be endothermic | | 1<br>1<br>1 | **AO3**<br>4.6.2.4<br>4.6.2.6 |
| 09.4 | from Le Chatelier's principle, if the pressure is increased the system will act to counteract the change. It will go in the direction that produces the lower number of moles of gas.<br>for every 3 moles of gas reactants there are 2 moles of gas products so the equilibrium would move to the right. | | 1<br>1 | **AO3**<br>4.6.2.7 |
| 09.5 | no<br>a catalyst affects the rate of reaction by lowering activation energy but does not affect the yield since the catalyst increases the rates of the forward and backward reaction equally | | 1<br>1 | **AO3**<br>4.6.2.4 |

