



## Mark Scheme (Results)

January 2021

Pearson Edexcel International GCSE  
In Chemistry (4CH1) Paper 1CR and Science  
(Double Award) (4SD0) Paper 1CR

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## General Marking Guidance

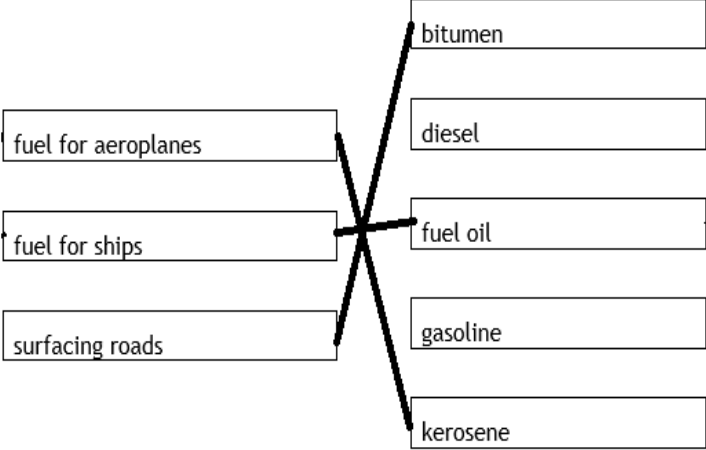
- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

| Question number | Answer                | Notes           | Marks |
|-----------------|-----------------------|-----------------|-------|
| 1               | (a) copper            |                 | 1     |
|                 | (b) glucose/water     |                 | 1     |
|                 | (c) air               |                 | 1     |
|                 | (d) nitrogen/oxygen   |                 | 1     |
|                 | (e) copper            |                 | 1     |
|                 | (f) oxygen and sulfur | in either order | 1     |

**(Total for Question 1 = 6)**

| Question number | Answer   | Notes   | Marks |
|-----------------|--|---|-------|
| 2 (a)           | Any two from the following:<br><br>M1 contains 3 dyes<br>M2 contains (dye) A<br>M3 contains (dye) B<br>M4 does not contain (dye) C / contains an unknown dye OWTTE   |   | 2     |
| (b) (i)         | (Ink 2) is insoluble (in solvent/water)  | ALLOW does not contain (dye) A/B/C  | 1     |
| (b) (ii)        | (repeat) using different solvent   | ALLOW named alternative solvent eg alcohol/ethanol  | 1     |
| (c)             | M1 correct measurement of distance moved by spot<br>AND correct measurement of distance moved by solvent<br><br>M2 use and evaluation of<br><br>$R_f = \frac{\text{distance moved by spot}}{\text{distance moved by solvent front}}$<br><br>M3 answer to 2 sig fig | ALLOW 5.4-5.6<br>ALLOW 7.9-8.1<br><br>Expected:<br>$\frac{5.5}{8.0} = 0.6875$<br>$= 0.69$<br><br>ALLOW ECF from M1<br>M2<br><br>correct answer with no working scores 3 | 3     |

(Total for Question 2 = 7)

| Question number | Answer  | Notes   | Marks |
|-----------------|---|---|-------|
| 3 (a)           | alkanes   |   | 1     |
| (b) (i)         | <p><b>A</b> boiling point is the correct answer because fractional distillation depends on differences in boiling point</p> <p><b>B</b> is not correct because fractional distillation does not depend on differences in density</p> <p><b>C</b> is not correct because fractional distillation does not depend on differences in melting point</p> <p><b>D</b> is not correct because fractional distillation does not depend on differences in solubility</p> |   | 1     |
| (b) (ii)        |  <p>1 mark for each correct line from boxes on left</p>  | <p>If more than one line from a box on left do not award mark for that box</p>                            | 3     |
| (c)             | <p>explanation including the following points:</p> <p>M1 (common impurity in fuels is) sulfur</p> <p>M2 sulfur burns/combusts/reacts (in air/oxygen) to form sulfur dioxide/SO<sub>2</sub></p> <p>M3 sulfur dioxide/SO<sub>2</sub> dissolves in/reacts with rain/water to form acid rain</p>  | <p>If M2 M3 not scored<br/>ALLOW 1 mark for reference to sulphur dioxide/SO<sub>2</sub> and acid rain</p> | 3     |

| Question number | Answer   | Notes   | Marks |
|-----------------|--|---|-------|
| 3 (d) (i)       | cracking   |   | 1     |
| (ii)            | M1 (catalyst) silica/alumina<br><br>M2 (temperature) 600-700 (°C)              | ALLOW silicon dioxide/aluminium oxide<br>ALLOW formulae<br>ALLOW zeolite                        | 2     |
| (iii)           | $C_{13}H_{28} \rightarrow C_8H_{18} +$<br><br>M1 $C_3H_6 +$<br><br>M2 $C_2H_4$ | in either order<br>ALLOW structural formulae<br><br>ALLOW 1 mark for single product $C_5H_{10}$ | 2     |

(Total for Question 3 = 13)

| Question number                          | Answer  | Notes   | Marks   |                  |      |                |          |  |          |                |   |
|--|---|---|---|------------------|------|----------------|----------|--|----------|----------------|---|
| 4 (a)                                    | (i)   | (hydrated) iron(III) oxide  | REJECT incorrect oxidation states                                   | 1                |      |                |          |  |          |                |   |
|  | (ii)  | M1 (barrier method involves) coating iron in paint/oil/grease/plastic   | ALLOW coating in named metal below iron in reactivity series eg tin | 2                |      |                |          |  |          |                |   |
|  |   | M2 stops oxygen/air/water getting to the iron   | ALLOW stops iron reacting with oxygen/air/water                     |                  |      |                |          |  |          |                |   |
|  | (b) (i)   | <table border="1"> <tr> <td>reading at start</td> <td>20.5</td> </tr> <tr> <td>reading at end</td> <td>33.5 (1)</td> </tr> <tr> <td>volume of oxygen used in cm<sup>3</sup></td> <td>13.0 (1)</td> </tr> </table> |   | reading at start | 20.5 | reading at end | 33.5 (1) | volume of oxygen used in cm <sup>3</sup> | 13.0 (1) | CSQ on reading | 2 |
|  |   | reading at start  | 20.5  |                  |      |                |          |  |          |                |   |
| reading at end                           |   | 33.5 (1)  |   |                  |      |                |          |  |          |                |   |
| volume of oxygen used in cm <sup>3</sup> | 13.0 (1)  |   |   |                  |      |                |          |  |          |                |   |
| (ii)                                     | not all oxygen had reacted / not enough iron (wool)   | ALLOW not left for long enough/ OWTTE   | 1   |                  |      |                |          |  |          |                |   |
| (c)                                      | <p>M1 calculation of volume oxygen used</p> <p>M2 correct expression for percentage of oxygen</p> <p>M3 correct evaluation</p> <p>Example calculation:</p> <p>M1 (35.5 – 20.0 =) 15.5</p> <p>M2 (15.5 ÷ 80.0) x 100</p> <p>M3 19.4(%)</p> | <p>ALLOW ECF from M1</p> <p>ACCEPT 19.375/19.38</p> <p>correct answer with no working scores 3</p>  | 3   |                  |      |                |          |  |          |                |   |

(Total for Question 4 = 9)



| Question number | Answer   | Notes  | Marks |
|-----------------|--|--|-------|
| 5 (a)           | (thermal) decomposition (1)  |  | 1     |
| (b)             | any two of the following:<br>M1 (use the same) amount of metal carbonate<br>M2 (use the same) sized pieces/surface area<br>M3 (use the same) volume of limewater<br>M4 (use same) size flame / distance of flame from boiling tube OWTTE | ALLOW mass<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>M1 (when limewater turns milky/cloudy it) shows carbon dioxide produced<br>M2 showing metal carbonate has reacted/decomposed  | ALLOW carbon dioxide comes from carbonate (reacting/decomposing) | 2     |
| (e) (i)         | M1 (from) green<br>M2 (to) black   | IGNORE qualifiers eg light                                       | 2     |
| (ii)            | $\text{CuCO}_3 \rightarrow \text{CuO} + \text{CO}_2$   | ALLOW products in either order                                   | 1     |

| Question number | Answer  | Notes  | Marks |
|-----------------|---|--|-------|
| 5 (f) (i)       | <p>M1 the lower the metal is (in the reactivity series)</p> <p>M2 the more easily the (metal) carbonate reacts/decomposes</p> | <p>ALLOW the less reactive a metal is</p> <p>ALLOW the more easily the (metal) carbonate produces carbon dioxide</p> <p>ALLOW references to the less time the (metal) carbonate takes to react/decompose</p> <p>ALLOW references to the faster the (metal) carbonate reacts/decomposes</p> <p>ACCEPT reverse arguments</p> | 2     |
| (ii)            | repeat (the investigation) using different / other / more (metal) carbonates  |  | 1     |

(Total for Question 5 = 12)

| Question number | Answer   | Notes  | Marks |
|-----------------|--|--|-------|
| 6 (a) (i)       | Zn + 2HCl → ZnCl <sub>2</sub> + H <sub>2</sub><br>M1 all symbols and formulae correct<br>M2 correctly balanced   | M2 DEP M1  | 2     |
| (ii)            | lighted splint (produces squeaky) pop  |  | 1     |
| (b) (i)         | 52 (cm <sup>3</sup> )  | ALLOW 51.5-52.5  | 1     |
| (ii)            | M1 vertical line from 15 cm <sup>3</sup> acid to graph line<br>M2 volume hydrogen from graph multiplied by 2<br><br>OR<br>M1 vertical line from 30 cm <sup>3</sup> acid to graph line<br>M2 volume hydrogen from graph | ALLOW extra point drawn at 15 cm <sup>3</sup><br>ALLOW 68-70<br><br>ALLOW extra point drawn at 30 cm <sup>3</sup><br>ALLOW 68-70   | 2     |
| (c)             | explanation linking<br><br>M1 more (acid) particles/(hydrogen) ions/H <sup>+</sup> in same volume<br><br>M2 more (successful) collisions per second/unit time<br><br>M3 rate increases                                 | REJECT molecules once only<br>ALLOW particles are closer together<br><br>ACCEPT more frequent collisions<br>IGNORE more chance/probability of collision<br><br>ALLOW reaction is faster /speeds up<br><br>MAX 1 if refer to particles moving faster/having more energy | 3     |

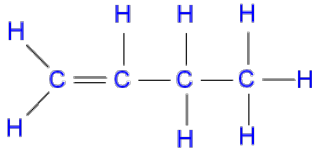
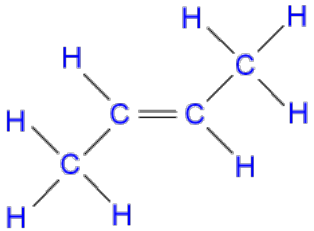
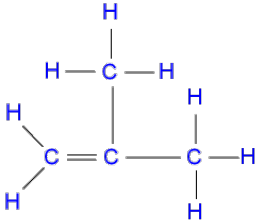
|       |   |   |   |
|-------|---|---|---|
| 6 (d) | <p>explanation including</p> <p>M1 (increase/decrease) surface area</p> <p>M2 increase surface area by using smaller pieces of zinc</p> <p>M3 more (successful) collisions per second/unit time (so rate increases)</p> | <p>ACCEPT more frequent collisions</p> <p>IGNORE more chance/probability of collision</p> <p>M2 M3 ACCEPT reverse arguments</p> | 3 |
|-------|---|---|---|

(Total for Question 6 = 12)

| Question number | Answer   | Notes   | Marks |
|-----------------|--|---|-------|
| 7 (a)           | <p>description including</p> <p>(formation of ions in lithium chloride involves)</p> <p>M1 lithium (atom) losing electron</p> <p>M2 chlorine (atom) gaining an electron</p> <p>(formation of covalent bonds in hydrogen chloride involves)</p> <p>M3 sharing a pair of electrons (one electron from each atom)</p> | <p>ALLOW correct dot-and-cross diagrams for ions for M1 and M2</p> <p>ALLOW correct dot-and-cross diagram showing shared pair in hydrogen chloride for M3</p> | 3     |

|              |  |   |          |
|--------------|--|---|----------|
| <p>7 (b)</p> | <p>explanation including five of the following points:</p> <p>(lithium chloride)</p> <p>M1 giant (ionic) structure</p> <p>M2 strong (electrostatic) forces of attraction</p> <p>M3 between oppositely charged ions</p><br><p>(hydrogen chloride)</p> <p>M4 simple molecular structure</p> <p>M5 weak intermolecular forces of attraction</p> <p>M6 more (heat/thermal) energy needed to overcome forces/break bonds in lithium chloride (than intermolecular forces in hydrogen chloride)</p> <p>OWTTE</p> | <p>ALLOW giant lattice</p> <p>ALLOW strong bonds</p> <p>ACCEPT positive and negative ions</p> <p>If any reference to molecules/atoms/covalent bonds/intermolecular forces/metallic bonds cannot score M2 M3 M6</p><br><p>ALLOW weak bonds between molecules</p><br><p>ACCEPT reverse argument</p><br><p>If description/implication of breaking covalent bonds in hydrogen chloride cannot score M5 M6</p> | <p>5</p> |
|--------------|--|---|----------|

**(Total for Question 7 = 8)**

| Question number | Answer   | Notes   | Marks |
|-----------------|--|---|-------|
| 8 (a) (i)       | <p>explanation linking</p> <p>M1 (molecules/compounds) having same molecular formulae</p> <p>M2 but different structural/displayed formulae</p>  | <p>ALLOW different structures</p> <p>ALLOW different arrangement of atoms</p>   | 2     |
| (ii)            | <p>M1 displayed formula of but-1-ene</p>  <p>M2 displayed formula of but-2-ene</p>  | <p>IGNORE bond angles</p> <p>ALLOW displayed formula of methylpropene</p>  | 2     |

| Question number | Answer  | Notes  | Marks |   |   |
|-----------------|---|--|-------|---|---|
| 8 (b) (i)       | <p>explanation linking</p> <p>M1 molecule is unsaturated as contains (carbon to carbon) double bond</p> <p>M2 molecule not a hydrocarbon as contains oxygen</p>   | ACCEPT does not contain hydrogen and carbon only | 2     |   |   |
| (ii)            | addition  |  |       |   | 1 |
| (iii)           | <div data-bbox="367 790 837 1059" data-label="Chemical-Block"> <math display="block">\left[ \begin{array}{c} \text{H} &amp; \text{CH}_3 \\   &amp; / \\ \text{---C} &amp; \text{---C---} \\   &amp; \backslash \\ \text{H} &amp; \text{COOCH}_3 \end{array} \right]_n</math> </div> <p>M1 correct repeat unit structure</p> <p>M2 extension bonds, brackets and n</p> |  |       | n can be anywhere after bracket<br>extension bonds do not have to go through brackets<br>M2 DEP M1 or near miss | 2 |

| Question number | Answer  | Notes   | Marks |
|-----------------|---|---|-------|
| 8 (c) (i)       | <p>M1 calculation of mass of octane</p> <p>M2 calculation of Mr of C<sub>8</sub>H<sub>18</sub> and CO<sub>2</sub></p> <p>M3 link between mass/mol C<sub>8</sub>H<sub>18</sub> and mass/mol CO<sub>2</sub></p> <p>M4 calculation of mass CO<sub>2</sub> in g</p> <p>M5 calculation of mass CO<sub>2</sub> in kg</p> <p>Example calculation:</p> <p>M1 50 x 700 = 35000 (g)</p> <p>M2 M<sub>r</sub> of C<sub>8</sub>H<sub>18</sub> = 114 and M<sub>r</sub> CO<sub>2</sub> = 44</p> <p>M3 114g C<sub>8</sub>H<sub>18</sub> produces (8 x 44 =) 352 (g) CO<sub>2</sub></p> <p>M4 35000 g C<sub>8</sub>H<sub>18</sub> produces <math>\frac{35000 \times 352}{114}</math><br/>= 108070.2 (g) CO<sub>2</sub></p> <p>M5 = 108 (kg)</p> <p>Alternative method using mol:</p> <p>M1 50 x 700 = 35000 (g)</p> <p>M2 M<sub>r</sub> of C<sub>8</sub>H<sub>18</sub> = 114 and M<sub>r</sub> CO<sub>2</sub> = 44</p> <p>M3 n (C<sub>8</sub>H<sub>18</sub>) = <math>\frac{35000}{114}</math> = 307.0175 mol<br/>so n (CO<sub>2</sub>) = 8 x 307.0175 = 2456.14 mol</p> <p>M4 mass CO<sub>2</sub> = 2456.14 x 44 = 108070.2 (g)</p> <p>M5 = 108 (kg)</p> | <p>ALLOW 2 sig fig or more in M4 and M5</p> <p>ALLOW 2 sig fig or more in M3 M4 and M5</p> <p>MARK CSQ in both methods</p> <p>correct answer without working scores 5</p> | 5     |



|      |                               |                          |   |
|------|-------------------------------|--------------------------|---|
| (ii) | global warming/climate change | IGNORE greenhouse effect | 1 |
|------|-------------------------------|--------------------------|---|

(Total for Question 8 = 15)

| Question number | Answer   | Notes  | Marks |
|-----------------|--|--|-------|
| 9 (a)           | to keep out of contact/prevent reaction with air/oxygen/water/moisture   | ALLOW they react with air/oxygen/water/moisture  | 1     |
| (b) (i)         | similarity: both fizz/move on surface/ produce flame<br><br>difference caesium: faster/more violent reaction   | ALLOW both melt/form a ball/produce a gas/<br>produce hydrogen/form an alkaline solution<br><br>ACCEPT reverse argument for potassium<br>ALLOW caesium explodes  | 2     |
| (ii)            | $2\text{Cs} + 2\text{H}_2\text{O} \rightarrow 2\text{CsOH} + \text{H}_2$<br><br>M1 all symbols/formulae correct<br><br>M2 correctly balanced   | ACCEPT fractions and multiples<br><br>M2 DEP M1  | 2     |
| (c) (i)         | a lid/cover  |  | 1     |
| (ii)            | explanation linking either<br><br>M1 stir solution<br><br>M2 to obtain more accurate (maximum) temperature<br><br>OR<br><br>M1 measure temperature of sodium hydroxide<br><br>M2 to check if different to/same as temperature of (hydrochloric) acid | ALLOW reference to even temperature throughout/<br>heat evenly distributed<br>OWTTE<br><br>ALLOW take an average of temperature of sodium hydroxide and temperature of (hydrochloric) acid for 2 marks | 2     |

| Question number | Answer   | Notes  | Marks |
|-----------------|--|--|-------|
| 9 (d) (i)       | <p>M1 correct temperature change/<math>\Delta T</math></p> <p>M2 correct substitution into <math>Q = m \times c \times \Delta T</math></p> <p>M3 correct evaluation</p> <p>Example calculation:</p> <p>M1 <math>\Delta T = (26.5 - 19.9)</math> OR 6.6</p> <p>M2 <math>Q = 100 \times 4.2 \times 6.6</math></p> <p>M3 = 2800 (J)</p> | <p>M2 ECF M1</p> <p>M3 ECF M2</p> <p>IGNORE any sign<br/>ALLOW 2770, 2772</p> <p>correct answer without working scores 3</p>   | 3     |
| (ii)            | <p>M1 answer to M3 from (i) <math>\div 0.05</math></p> <p>M2 correct evaluation in kJ/mol with negative sign</p> <p>expected answer</p> <p>M1 <math>2800 \div 0.05</math> OR 56000 (J)</p> <p>M2 - 56 (kJ/mol)</p>   | <p>2770 gives 55400<br/>2772 gives 55440</p> <p>negative sign required</p> <p>ACCEPT -55.4<br/>ACCEPT -55.44<br/>ACCEPT -55</p> <p>correct answer without working scores 2</p> | 2     |

(Total for Question 9 = 13)

| Question number | Answer   | Notes   | Marks |
|-----------------|--|---|-------|
| 10 (a) (i)      | neutralisation   | ALLOW acid - base   | 1     |
| (ii)            | acid donates proton(s)/base accepts proton(s)  | ALLOW metal oxide for base  | 1     |
| (b) (i)         | <p>description including</p> <p>M1 appropriate use of at least three named pieces of apparatus</p> <p>AND any four of the following points</p> <p>M2 add copper(II) carbonate to (dilute sulfuric acid (a spatula/little at a time and stir after each addition)</p> <p>M3 until no more effervescence</p> <p>M4 filter (to remove excess copper(II) carbonate/to obtain (copper(II) sulfate) solution)</p> <p>M5 heat/warm filtrate/(copper(II) sulfate) solution until crystals start to appear (solution saturated) OWTTE</p> <p>M6 filter to obtain (the saturated) solution</p> | <p>ALLOW until no more reacts/dissolves</p> <p>ALLOW until in excess</p> <p>IGNORE if continue and prepare crystals instead of saturated solution</p> | 5     |
| (b) (ii)        | <p>M1 calculation of actual mass of crystals obtained</p> <p>M2 division by expected mass of crystals (6.4) and multiplication by 100 to convert to percentage</p> <p>M3 correct to 1 dp</p> <p>Example calculation</p> <p>M1 (6.40 - 1.80 = ) 4.6(0)</p> <p>M2 (% yield = ) <math>\frac{4.6}{6.4} \times 100</math> OR 71.875 (%)</p> <p>M3 = 71.9 (%)</p>  | <p>M2 ECF M1</p> <p>M3 DEP M2</p>   | 3     |

| Question number | Answer   | Notes   | Marks |
|-----------------|--|---|-------|
| 10 (c) (i)      | <p>M1 find percentage of water</p> <p>M2 divide each percentage by Mr to find number of moles</p> <p>M3 divide each answer by smallest to find ratio and value of x</p> <p>Expected calculation:</p> <p>M1 (79%) CaSO<sub>4</sub>                      21% H<sub>2</sub>O</p> <p>M2 <math>\frac{79}{136}</math> (= 0.58)                      <math>\frac{21}{18}</math> (= 1.17)</p> <p>M3 <math>\frac{0.58}{0.58}</math>                      <math>\frac{1.17}{0.58}</math> = 1 : 2</p> <p>so x = 2</p> |   | 3     |
| (ii)            | <p>description including</p> <p>M1 do a flame test</p> <p>M2 orange-red flame</p>  | <p>correct answer without working scores 3</p> <p>ALLOW description of flame test</p> | 2     |

(Total for Question 10 = 15)

Total for paper = 110 marks

