



Mark Scheme (Results)

January 2020

Pearson Edexcel International GCSE in
Chemistry (4CH1)
Paper 1C

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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)	(i) argon / helium	ACCEPT Ar / He	1
	(ii) nitrogen	ACCEPT N ₂	1
	(iii) carbon dioxide	ACCEPT CO ₂	1
	(iv) carbon dioxide	ACCEPT CO ₂	1
(b)	(i) $S + O_2 \rightarrow SO_2$		1
	(ii) acid rain	ACCEPT an adverse effect of acid rain e.g. kills fish, damages plants, corrodes limestone/marble buildings/statues etc. IGNORE toxic/pollutant	1
			Total 6

Question number	Answer	Notes	Marks										
2 (a)	<table border="1" data-bbox="419 320 1046 813"> <tr> <td data-bbox="419 320 895 421">name of the part of the atom labelled Z</td> <td data-bbox="895 320 1046 421">nucleus</td> </tr> <tr> <td data-bbox="419 421 895 521">number of protons in this atom</td> <td data-bbox="895 421 1046 521">12</td> </tr> <tr> <td data-bbox="419 521 895 622">number of the group that contains this element</td> <td data-bbox="895 521 1046 622">2</td> </tr> <tr> <td data-bbox="419 622 895 723">number of the period that contains this element</td> <td data-bbox="895 622 1046 723">3</td> </tr> <tr> <td data-bbox="419 723 895 813">charge on the ion formed from this atom</td> <td data-bbox="895 723 1046 813">2+</td> </tr> </table>	name of the part of the atom labelled Z	nucleus	number of protons in this atom	12	number of the group that contains this element	2	number of the period that contains this element	3	charge on the ion formed from this atom	2+	ACCEPT +2 / Mg ²⁺	5
name of the part of the atom labelled Z	nucleus												
number of protons in this atom	12												
number of the group that contains this element	2												
number of the period that contains this element	3												
charge on the ion formed from this atom	2+												
(b)	<ul style="list-style-type: none"> • calculate sum of mass numbers multiplied by percentage abundances • divide answer by 100 • give answer to one decimal place <p>Example calculation</p> <p>M1 $(24 \times 79.2) + (25 \times 10.0) + (26 \times 10.8)$ OR 2431.6</p> <p>M2 $2431.6 \div 100$ OR 24.316</p> <p>M3 24.3</p>	<p>REJECT if correct working given but incorrectly evaluated</p> <p>ALLOW ECF from M1</p> <p>$(24 \times 0.792) + (25 \times 0.100) + (26 \times 0.108)$ OR 24.316 with or without working scores M1 and M2</p> <p>ALLOW ECF from M2 if calculated answer is to 1dp</p>	3										
			Total 8										

Question number	Answer	Notes	Marks
3 (a)	galvanising	ACCEPT galvanisation	1
(b) (i)	rust		1
(ii)	M1 oxygen / air M2 water	ACCEPT O ₂ IGNORE O ACCEPT H ₂ O/moisture ACCEPT in either order	2
(c) (i)	(a reaction which) gives out / produces / releases heat (energy) / thermal energy	IGNORE energy without mention of heat or thermal	1
(ii)	An explanation that links the following two points M1 aluminium/Al is more reactive than iron/Fe	ACCEPT aluminium/Al is higher in reactivity series than iron/Fe ACCEPT reverse argument	2
(iii)	An explanation that links the following three points M1 aluminium is oxidised and iron/iron oxide is reduced M2 aluminium gains oxygen M3 iron oxide/iron loses oxygen	ALLOW replaces/takes place of ALLOW both oxidation and reduction occur ALLOW aluminium/Al loses electrons ALLOW iron <u>ions</u> /Fe ³⁺ gains electrons ALLOW correct references to changes in oxidation number for M2 and M3	3
			Total 10

Question number	Answer	Notes	Marks
5 (a) (i)	S		1
(ii)	T and U		1
(iii)	U		1
(b)	<p>A description that makes reference to the following three points</p> <p>M1 (add) bromine water</p> <p>M2 no change / stays orange</p> <p>M3 (bromine water) decolourised / changes (from orange) to colourless</p>	<p>ACCEPT Br₂ (aq)</p> <p>ALLOW no reaction</p> <p>If initial colour of bromine water is given in M2 or M3 it must be correct -ALLOW any combination of orange/yellow/brown - but penalise once only</p> <p>If bromine given for M1 then in M2 and M3 allow any combination of red/orange/brown/yellow</p> <p>M2 and M3 dep on bromine water/bromine in M1</p> <p>If no reagent and correct M2 and M3 - score 1</p> <p>if incorrect reagent and correct M2 and M3 score 0</p> <p>IGNORE clear</p> <p>REJECT discoloured</p> <p>ALLOW M1 acidified potassium manganate(VII)</p> <p>M2 no change/stays purple</p> <p>M3 decolourised / goes colourless</p>	3

Question number	Answer	Notes	Marks
5 (c)	<p>Any two of the following points</p> <p>M1 (can be represented by a) general formula</p> <p>M2 each member differs from the next by a CH₂ group OWTTE</p> <p>M3 (each member has) same functional group</p> <p>M4 (each member has) similar/same chemical properties / similar/same (chemical) reactions</p> <p>M5 trend in physical properties (between successive members)</p>	<p>ACCEPT react in similar/same way</p> <p>ACCEPT named physical property, e.g. boiling point</p> <p>REJECT similar/same physical properties</p>	2
(d) (i)	but-1-ene	ALLOW 1-butene	1
(ii)	<p>Either</p> $ \begin{array}{cccc} \text{H} & \text{H} & \text{H} & \text{H} \\ & & & \\ \text{H}-\text{C} & -\text{C} & =\text{C} & -\text{C}-\text{H} \\ & & & \\ \text{H} & & & \text{H} \end{array} $ <p>Or</p> $ \begin{array}{c} \text{H} & & \text{H} \\ & & / \\ \text{H}-\text{C} & -\text{C} & =\text{C} \\ & & \backslash \\ \text{H} & \text{C} & \text{H} \\ & & \\ \text{H}-\text{C} & -\text{H} & \\ & & \\ \text{H} & & \end{array} $	<p>ACCEPT cis or trans isomer</p> <p>REJECT displayed formulae of cyclic alkanes</p>	1

Question number	Answer	Notes	Marks												
5 (e) (i)	<ul style="list-style-type: none"> • Divide percentages by relative atomic masses • Divide results by smallest value to obtain ratio <p>Example calculation</p> <p>M1</p> <table style="margin-left: 40px;"> <tr> <td>C</td> <td>H</td> <td>F</td> </tr> <tr> <td>$\frac{36.36}{12}$</td> <td>$\frac{6.06}{1}$</td> <td>$\frac{57.58}{19}$</td> </tr> </table> <p>M2</p> <table style="margin-left: 40px;"> <tr> <td>$\frac{3.03}{3.03}$</td> <td>$\frac{6.06}{3.03}$</td> <td>$\frac{3.03}{3.03}$</td> </tr> </table> <p>OR</p> <table style="margin-left: 40px;"> <tr> <td>1</td> <td>2</td> <td>1</td> </tr> </table>	C	H	F	$\frac{36.36}{12}$	$\frac{6.06}{1}$	$\frac{57.58}{19}$	$\frac{3.03}{3.03}$	$\frac{6.06}{3.03}$	$\frac{3.03}{3.03}$	1	2	1	0 marks if division by atomic numbers or upside down calculation	2
C	H	F													
$\frac{36.36}{12}$	$\frac{6.06}{1}$	$\frac{57.58}{19}$													
$\frac{3.03}{3.03}$	$\frac{6.06}{3.03}$	$\frac{3.03}{3.03}$													
1	2	1													
(ii)	<ul style="list-style-type: none"> • divide relative molecular mass by empirical formula mass • correct molecular formula <p>Example calculation</p> <p>M1</p> <table style="margin-left: 40px;"> <tr> <td>$\frac{66}{12 + 2 + 19}$</td> <td>OR</td> <td>$\frac{66}{33}$</td> <td>OR</td> <td>2</td> </tr> </table> <p>M2</p> <p>C₂H₄F₂</p>	$\frac{66}{12 + 2 + 19}$	OR	$\frac{66}{33}$	OR	2	<p>ACCEPT symbols in any order</p> <p>correct answer without working scores 2 marks.</p> <p>2CH₂F scores 1</p>	2							
$\frac{66}{12 + 2 + 19}$	OR	$\frac{66}{33}$	OR	2											
			Total 14												

Question number	Answer	Notes	Marks						
6 (a)	zinc + hydrochloric acid → zinc chloride + hydrogen	ACCEPT fully correct chemical equation	1						
(b)	<table border="1"> <tr> <td>temperature in °C after adding zinc</td> <td>22.4</td> </tr> <tr> <td>temperature in °C before adding zinc</td> <td>17.7</td> </tr> <tr> <td>temperature change in °C</td> <td>4.7</td> </tr> </table> <p>M1 22.4 M2 17.7 M3 (+)4.7</p>	temperature in °C after adding zinc	22.4	temperature in °C before adding zinc	17.7	temperature change in °C	4.7	<p>If readings are correct but in wrong order award 1 mark for M1 and M2</p> <p>ALLOW ECF for M3 if M1 and/or M2 incorrect If answers not given to nearest 0.1°C penalise once only</p>	3
temperature in °C after adding zinc	22.4								
temperature in °C before adding zinc	17.7								
temperature change in °C	4.7								
(c) (i)	<p>An explanation that links any two of the following points</p> <p>M1 polystyrene is an insulator</p> <p>M2 (so) reduces heat loss</p> <p>M3 temperature rise/change/reading will be closer to true value OWTTE</p>	<p>ALLOW is not a (good) conductor of heat ALLOW is a poor conductor of heat</p> <p>ALLOW prevents heat loss ALLOW keeps heat in</p> <p>ALLOW temperature rise/change/reading will be more accurate/valid</p>	2						
(ii)	<p>Any three from</p> <p>M1 amount/mass of metal</p> <p>M2 concentration of acid</p> <p>M3 volume of acid</p> <p>M4 (speed/time of) stirring</p> <p>M5 external / room temperature</p>	<p>ALLOW size / surface area of metal</p> <p>ALLOW amount of acid</p> <p>ALLOW initial /starting temperature</p>	3						

Question number	Answer	Notes	Marks
6 (d)	(i) no reaction (occurred between copper and hydrochloric acid)	IGNORE copper is unreactive ALLOW copper is less reactive than hydrogen	1
	(ii) Any value between 1.5 and 5.0 °C inclusive		1
	(iii) most reactive magnesium zinc iron tin copper	ACCEPT symbols	1
			Total 12

Question number	Answer	Marks
7 (a)	(i) B bromine	1
	(ii) A is incorrect as astatine is a solid C is incorrect as chlorine is a gas D is incorrect as iodine is a solid	1
	(iii) C chlorine (as it is pale green) A is incorrect as astatine is black B is incorrect as bromine is brown C is incorrect as iodine is dark grey A astatine B is incorrect as bromine is more reactive than astatine C is incorrect as chlorine is more reactive than astatine D is incorrect as iodine is more reactive than astatine	1

(b) (i)	M1 (colourless solution turns) brown M2 (solution stays) brown / no change	ALLOW no reaction	2
(ii)	bromine would not react with (sodium) bromide / bromine cannot displace itself OWTTE	ALLOW bromine cannot react with itself ALLOW both contain bromine/same element/same halogen ALLOW because no reaction would occur REJECT bromine cannot displace bromide	1
(iii)	$\text{Br}_2 + 2\text{NaI} \rightarrow 2\text{NaBr} + \text{I}_2$	ACCEPT correct ionic equation $\text{Br}_2 + 2\text{I}^- \rightarrow 2\text{Br}^- + \text{I}_2$ ALLOW multiples and fractions	1

Question number	Answer	Notes	Marks
7 (c)	<p>A description that makes reference to the following 6 points</p> <p>Test for cation</p> <p>M1 add sodium hydroxide (solution)</p> <p>M2 if blue precipitate forms solution contains copper(II) ion(s) / contains Cu^{2+} / is a copper compound</p> <p>M3 if green precipitate forms solution contains iron(II) ion(s) / contains Fe^{2+} / is an iron compound</p>	<p>ALLOW ammonia solution</p> <p>IGNORE qualifiers REJECT other colours</p> <p>IGNORE qualifiers REJECT other colours</p> <p>If no reagent or incorrect reagent but correct M2 and M3 score 1</p> <p>ALLOW M1 flame test or description of flame test</p> <p>M2 if blue-green (flame) solution contains copper(II) ion(s) / contains Cu^{2+} / is a copper compound</p> <p>No M3 for this test</p> <p>ALLOW M1 addition of suitable metal above Cu in reactivity series</p> <p>M2 brown/pink/pink-brown solid forms</p> <p>No M3 for this test</p>	6

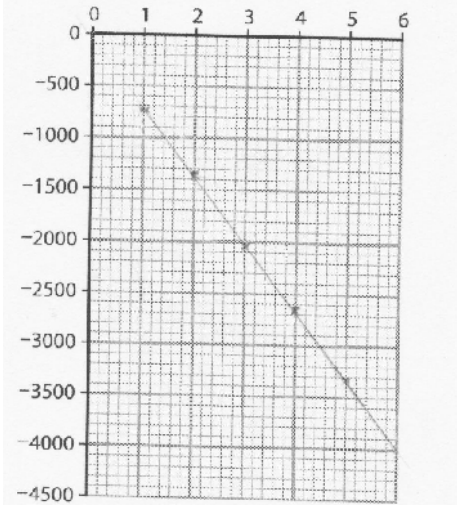
	<p>Test for anion</p> <p>M4 add silver nitrate (solution)</p> <p>M5 if white precipitate forms solution contains chloride ion(s) / contains Cl^- / is a chloride</p> <p>M6 if cream precipitate forms solution contains bromide ion(s) / contains Br^- / is a bromide</p>	<p>IGNORE addition of nitric acid</p> <p>REJECT addition of hydrochloric acid for M4</p> <p>If no reagent or incorrect reagent but correct M5 and M6 score 1</p> <p>ALLOW M4 add chlorine water (to solution)</p> <p>M5 if turns orange/yellow/brown solution contains bromide ion(s) / contains Br^- / is a bromide</p> <p>No M6 for this test</p>	<p>Total 13</p>
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Question number	Answer	Notes	Marks
8 (a) (i)	sublimation / subliming		1
(ii)	<p>M1 (add to/bubble into) limewater</p> <p>M2 (limewater) turns cloudy/milky</p>	<p>ACCEPT forms white precipitate M2 DEP M1</p>	2
(b)	<p>An explanation that links the following two points</p> <p>M1 weak forces (of attraction) between molecules / weak intermolecular forces (of attraction)</p> <p>M2 little energy needed to overcome the (intermolecular) forces</p>	<p>ALLOW weak intermolecular bonds ALLOW weak intermolecular attractions</p> <p>IGNORE less energy</p> <p>ALLOW little energy needed to separate the molecules</p> <p>M2 DEP M1 correct or missing</p>	2

(c)	<p>Any explanation that links any three of the following points for diamond</p> <p>M1 each (carbon) atom is (covalently) bonded to four other (carbon) atoms</p> <p>M2 in a (giant) tetrahedral lattice /network / structure</p> <p>M3 the (covalent) bonds are (very) strong</p> <p>M4 (therefore) diamond is (very) hard (and so good for cutting tools)</p> <p>Any explanation that links any three of the following points for graphite</p> <p>M5 each (carbon) atom is (covalently) bonded to three other (carbon) atoms</p> <p>M6 (the structure is) in layers</p> <p>M7 weak forces (between layers)</p> <p>M8 (the layers can) slide over each other/ rub off</p> <p>M9 this makes graphite soft (so it can make marks on paper)</p>	<p>ALLOW each carbon has four bonds</p> <p>ALLOW 3D/rigid in place of tetrahedral</p> <p>ALLOW reference to lot of energy needed to break the (covalent) bonds</p> <p>ALLOW there are lots of/many (covalent) bonds</p> <p>ALLOW diamond is (very) strong</p> <p>If mention of intermolecular forces in diamond MAX 2 for diamond</p> <p>If mention of ions in diamond only M4 can be scored</p> <p>ALLOW sheets</p> <p>ALLOW slippery</p> <p>If mention of intermolecular forces in graphite MAX 2 for graphite</p> <p>If mention of ions in graphite only M9 can be scored</p>	<p>6</p> <p>Total 11</p>
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Question number	Answer	Notes	Marks
9 (a)	to minimise/prevent (mass loss by) evaporation of the (liquid) fuel OWTTE	ALLOW to find mass of fuel used/burned	1
(b) (i)	soot/carbon	REJECT copper oxide	1
(ii)	<p>An explanation that links the following two points.</p> <p>M1 incomplete combustion (occurs)</p> <p>M2 (because) the air/oxygen supply is limited OWTTE</p>	<p>ALLOW mark for soot/carbon if not seen in (i), unless copper oxide is mentioned in (i)</p> <p>If copper oxide in (i) ALLOW 1 mark for (because) copper reacts with oxygen (in air)</p>	2
(c) (i)	<ul style="list-style-type: none"> • substitution into $Q = mc\Delta T$ • calculation of heat energy in Joules • conversion to kJ <p>Example calculation</p> <p>M1 $Q = 100 \times 4.2 \times 30$</p> <p>M2 = 12600 (J)</p> <p>M3 = 12.6 kJ</p>	<p>12600 (J) with no working scores M1 and M2</p> <p>M2 ECF M1</p> <p>ALLOW approximately = 13 kJ</p> <p>12.6 kJ with no working scores 3</p>	3

(ii)	<ul style="list-style-type: none">• calculate the amount, in moles, of methanol• divide Q by the amount in moles• give the answer with the correct sign <p>Example calculation</p> <p>M1 $0.96 \div 32$ OR 0.03</p> <p>M2 $12.6 \div 0.03$ OR 420 (kJ/mol)</p> <p>M3 $- 420$ (kJ/mol)</p>	<p>ACCEPT $13 \div 0.03$ OR $430/433$ for M2</p> <p>AND $- 430 / - 433$ for M3</p>	3
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Question number	Answer	Notes	Marks
9 (d) (i)	<p>M1 all points plotted correctly</p> <p>M2 line of best fit drawn with a ruler</p> 	does not need to start at (0,0)	2
(ii)	<p>M1 straight line extrapolated up to 6 carbon atoms</p> <p>M2 value of ΔH read from their graph</p>	<p>ALLOW extra point shown at 6 carbon atoms</p> <p>negative sign needed</p>	2
(iii)	The greater the number of carbon atoms (per molecule) the greater (the magnitude/ value of) ΔH	<p>ALLOW ΔH is (directly) proportional to the number of carbon atoms per molecule</p> <p>ALLOW The greater the number of carbon atoms (per molecule) the more exothermic the ΔH value</p>	1
			Total 15

Question number	Answer	Notes	Marks
10 (a) (i)	$4\text{NH}_3 + 5\text{O}_2 \rightleftharpoons 4\text{NO} + 6\text{H}_2\text{O}$	ACCEPT multiples and fractions	1
(ii)	reversible (reaction)	ACCEPT reaction that goes both ways / both forwards and backwards reactions occur IGNORE references to equilibrium	1
(iii)	to increase the rate of the reaction / to speed up the reaction OWTTE	IGNORE references to lowering the activation energy	1
(b)	$2\text{NO} + \text{O}_2 \rightarrow 2\text{NO}_2$	ACCEPT multiples and fractions	1
(c) (i)	<ul style="list-style-type: none"> calculate M_r of NO_2 and HNO_3 calculate the amount, in moles, of NO_2 calculate the amount, in moles, of HNO_3 calculate the mass in tonnes of HNO_3 <p>Example calculation</p> <p>M1 M_r of $\text{NO}_2 = 46$ M_r of $\text{HNO}_3 = 63$</p> <p>M2 $n(\text{NO}_2) = 11.5 \times 10^6 \div 46$ OR 250 000 (mol)</p> <p>M3 $n(\text{HNO}_3) = \frac{2 \times 25\,0000}{3}$ OR 167 000 / 170 000</p> <p>M4 $(167\,000 \times 63 \text{ g}) = 10.5$ (tonnes)</p>	<p>ALLOW working in megamoles i.e. $11.5 \div 46$ OR 0.25</p> <p>ALLOW ECF from incorrect M_r of NO_2</p> <p>calculator answer 166666.66 ALLOW working in megamoles i.e. $\frac{2 \times 0.25}{3}$ OR 0.167 / 0.17</p> <p>ALLOW ECF from M2</p> <p>10.5 (tonnes) with no working scores 4</p> <p>ACCEPT 10.7 (if 170 000 used)</p> <p>ALLOW ECF from M3 ALLOW ECF from incorrect M_r of HNO_3</p>	4
(ii)	can be (re)used in stage 2 / to make more nitrogen dioxide (in stage 2) / can be used to make more nitric acid	IGNORE can be recycled/reused unless qualified	1

Question number	Answer	Notes	Marks
10 (d)	<ul style="list-style-type: none"> • calculate the amount, in moles, of copper(II) nitrate • calculate the theoretical yield, in moles, of copper(II) nitrate • calculate the percentage yield <p>Example calculation</p> <p>M1 $n\text{Cu}(\text{NO}_3)_2$ formed = $15.3 \div 187.5$ OR 0.0816</p> <p>M2 theoretical $n\text{Cu}(\text{NO}_3)_2 = 0.200 \div 2$ OR 0.100</p> <p>M3 (% yield) = $\frac{(0.0816 \times 100)}{(0.100)} = 81.6$ (%)</p> <p>Alternative method</p> <ul style="list-style-type: none"> • calculate the theoretical yield, in moles, of copper(II) nitrate • calculate the theoretical mass of copper nitrate that should be formed • calculate the percentage yield <p>Example calculation</p> <p>M1 theoretical $n\text{Cu}(\text{NO}_3)_2 = 0.200 \div 2$ OR 0.100</p> <p>M2 theoretical mass of copper nitrate = $0.1 \times 187.5 = 18.75$</p> <p>M3 (% yield) = $\frac{15.3}{18.75} \times 100 = 81.6$ (%)</p>	<p>ALLOW 0.082</p> <p>ACCEPT 82 (%)</p> <p>Mark M3 CSQ on M1 and M2</p> <p>40.8 scores 2</p> <p>ALLOW 18.8</p> <p>ACCEPT 82 (%)</p> <p>Mark M3 CSQ on M1 and M2</p> <p>40.8 scores 2</p> <p>81.6(%) with no working scores 3 marks</p>	<p>3</p> <p>Total 12</p>

