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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.

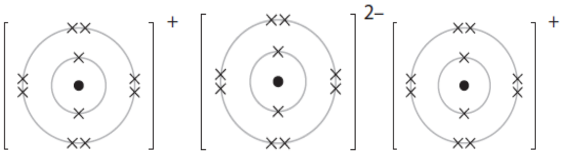
Question number	Answer	Notes	Marks
1 (a) (i)	argon / helium	**ACCEPT** Ar / He	1
(ii)	nitrogen	**ACCEPT** N_2	1
(iii)	carbon dioxide	**ACCEPT** CO_2	1
(iv)	carbon dioxide	**ACCEPT** CO_2	1
(b) (i)	$S + O_2 \rightarrow SO_2$		1
(ii)	acid rain	**ACCEPT** an adverse effect of acid rain e.g. kills fish, damages plants, corrodes limestone/marble buildings/statues etc. **IGNORE** toxic/pollutant	1
			Total 6

Question number	Answer	Notes	Marks
2 (a)	<table><tr><td>name of the part of the atom labelled Z</td><td>nucleus</td></tr><tr><td>number of protons in this atom</td><td>12</td></tr><tr><td>number of the group that contains this element</td><td>2</td></tr><tr><td>number of the period that contains this element</td><td>3</td></tr><tr><td>charge on the ion formed from this atom</td><td>2+</td></tr></table>	**ACCEPT** +2 / Mg^{2+}	5
(b)	• calculate sum of mass numbers multiplied by percentage abundances • divide answer by 100 • give answer to one decimal place Example calculation **M1** (24 x 79.2) + (25 x 10.0) + (26 x 10.8) **OR** 2431.6 **M2** 2431.6 ÷ 100 **OR** 24.316 **M3** 24.3	**REJECT** if correct working given but incorrectly evaluated **ALLOW** ECF from M1 (24 x 0.792) + (25 x 0.100) + (26 x 0.108) **OR** 24.316 with or without working scores **M1** and **M2** **ALLOW** ECF from M2 if calculated answer is to 1dp	3 **Total 8**

Question number	Answer	Notes	Marks
3 (a)	galvanising	**ACCEPT** galvanisation	1
(b) (i)	rust		1
(ii)	**M1** oxygen / air	**ACCEPT** O_2 **IGNORE** O	2
	M2 water	**ACCEPT** H_2O/moisture **ACCEPT** in either order	
(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		2
	M1 aluminium/Al is more reactive than iron/Fe	**ACCEPT** aluminium/Al is higher in reactivity series than iron/Fe **ACCEPT** reverse argument	
	M2 (because) aluminium/Al displaces iron/Fe (from its oxide)	**ALLOW** replaces/takes place of	
(iii)	An explanation that links the following three points		3
	M1 aluminium is oxidised and iron/iron oxide is reduced	**ALLOW** both oxidation and reduction occur	
	M2 aluminium gains oxygen	**ALLOW** aluminium/Al loses electrons	
	M3 iron oxide/iron loses oxygen	**ALLOW** iron <u>ions</u> /Fe^{3+} gains electrons **ALLOW** correct references to changes in oxidation number for **M2** and **M3**	
			Total 10

<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>4 (a) (i)</td><td>
<table>
<tr><th></th><th>Mg^{2+}</th><th>Al^{3+}</th><th>NH_4^+</th></tr>
<tr><td>S^{2-}</td><td>MgS</td><td>Al_2S_3</td><td>$(NH_4)_2S$</td></tr>
<tr><td>NO_3^-</td><td>$Mg(NO_3)_2$</td><td>$Al(NO_3)_3$</td><td>NH_4NO_3</td></tr>
<tr><td>CO_3^{2-}</td><td>$MgCO_3$</td><td>$Al_2(CO_3)_3$</td><td>$(NH_4)_2CO_3$</td></tr>
</table>
</td><td>1 mark for each correct formula</td><td>3</td></tr>
<tr><td>(ii)</td><td>ammonium nitrate</td><td></td><td>1</td></tr>
<tr><td>(b) (i)</td><td>M1 electrostatic (force of) attraction

M2 between oppositely charged ions</td><td>ALLOW electrostatic force

ACCEPT between positive and negative ions
ACCEPT between cations and anions</td><td>2</td></tr>
<tr><td>(ii)</td><td>

M1 correct electron arrangement of both sodium ions

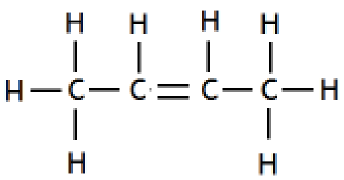
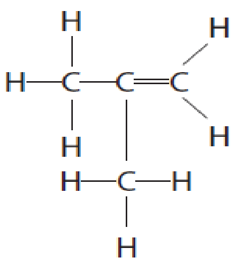
M2 correct electron arrangement of the oxide ion

M3 correct charges on all ions (with or without brackets)</td><td>If only outer shells shown correctly scores 1 mark

ACCEPT dots in place of crosses or any combination of dots and crosses for M1 and M2</td><td>3

Total 9</td></tr>
</table>

Question number	Answer	Notes	Marks
5 (a) (i)	S		1
(ii)	T and U		1
(iii)	U		1
(b)	A description that makes reference to the following three points **M1** (add) bromine water **M2** no change / stays orange **M3** (bromine water) decolourised / changes (from orange) to colourless	**ACCEPT** Br_2 (aq) **ALLOW** no reaction 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 If bromine given for M1 then in M2 and M3 allow any combination of red/orange/brown/yellow **M2** and **M3** dep on bromine water/bromine in **M1** If no reagent and correct M2 and M3 - score 1 if incorrect reagent and correct M2 and M3 score 0 **IGNORE** clear **REJECT** discoloured **ALLOW M1** acidified potassium manganate(VII) **M2** no change/stays purple **M3** decolourised / goes colourless	3

Question number	Answer	Notes	Marks
5 (c)	Any **two** of the following points **M1** (can be represented by a) general formula **M2** each member differs from the next by a CH_2 group OWTTE **M3** (each member has) same functional group **M4** (each member has) similar/same chemical properties / similar/same (chemical) reactions **M5** trend in physical properties (between successive members)	**ACCEPT** react in similar/same way **ACCEPT** named physical property, e.g. boiling point **REJECT** similar/same physical properties	2
(d) (i)	but-1-ene	**ALLOW** 1-butene	1
(ii)	**Either**  **Or** 	**ACCEPT** cis or trans isomer **REJECT** displayed formulae of cyclic alkanes	1

Question number	Answer	Notes	Marks
5 (e) (i)	• Divide percentages by relative atomic masses • Divide results by smallest value to obtain ratio Example calculation **M1** C: $\frac{36.36}{12}$ H: $\frac{6.06}{1}$ F: $\frac{57.58}{19}$ **M2** $\frac{3.03}{3.03}$ $\frac{6.06}{3.03}$ $\frac{3.03}{3.03}$ **OR** 1 2 1	0 marks if division by atomic numbers or upside down calculation	2
(ii)	• divide relative molecular mass by empirical formula mass • correct molecular formula Example calculation **M1** $\frac{66}{12 + 2 + 19}$ **OR** $\frac{66}{33}$ OR 2 **M2** $C_2H_4F_2$	**ACCEPT** symbols in any order correct answer without working scores 2 marks. $2CH_2F$ scores 1	2
			Total 14

Question number			Answer	Notes	Marks
6	(a)		zinc + hydrochloric acid → zinc chloride + hydrogen	**ACCEPT** fully correct chemical equation	1
	(b)		<table><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> **M1** 22.4 **M2** 17.7 **M3** (+)4.7	If readings are correct but in wrong order award 1 mark for **M1** and **M2** **ALLOW** ECF for **M3** if **M1** and/or **M2** incorrect If answers not given to nearest 0.1˚C penalise once only	3
	(c)	(i)	An explanation that links any **two** of the following points **M1** polystyrene is an insulator **M2** (so) reduces heat loss **M3** temperature rise/change/reading will be closer to true value OWTTE	**ALLOW** is not a (good) conductor of heat **ALLOW** is a poor conductor of heat **ALLOW** prevents heat loss **ALLOW** keeps heat in **ALLOW** temperature rise/change/reading will be more accurate/valid	2
		(ii)	Any **three** from **M1** amount/mass of metal **M2** concentration of acid **M3** volume of acid **M4** (speed/time of) stirring **M5** external / room temperature	**ALLOW** size / surface area of metal **ALLOW** amount of acid **ALLOW** initial /starting temperature	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 ºC inclusive		1
(iii)	most reactive magnesium zinc iron tin copper	**ACCEPT** symbols	1
			Total 12

Question number	Answer	Marks
7 (a) (i)	**B** bromine 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
(ii)	**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	1
(iii)	**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)	$Br_2 + 2NaI \rightarrow 2NaBr + I_2$	**ACCEPT** correct ionic equation $Br_2 + 2I^- \rightarrow 2Br^- + I_2$ **ALLOW** multiples and fractions	1

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

	Test for anion **M4** add silver nitrate (solution) **M5** if white precipitate forms solution contains chloride ion(s) / contains Cl^- / is a chloride **M6** if cream precipitate forms solution contains bromide ion(s) / contains Br^- / is a bromide	**IGNORE** addition of nitric acid **REJECT** addition of hydrochloric acid for **M4** If no reagent or incorrect reagent but correct M5 and M6 score 1 **ALLOW** **M4** add chlorine water (to solution) **M5** if turns orange/yellow/brown solution contains bromide ion(s) / contains Br^- / is a bromide No **M6** for this test	**Total 13**

Question number	Answer	Notes	Marks
8 (a) (i)	sublimation / subliming		1
(ii)	**M1 (**add to/bubble into) limewater **M2** (limewater) turns cloudy/milky	 **ACCEPT** forms white precipitate M2 DEP M1	2
(b)	An explanation that links the following two points **M1** weak forces (of attraction) between molecules / weak intermolecular forces (of attraction) **M2** little energy needed to overcome the (intermolecular) forces	 **ALLOW** weak intermolecular bonds **ALLOW** weak intermolecular attractions **IGNORE** less energy **ALLOW** little energy needed to separate the molecules **M2** DEP **M1** correct or missing	2

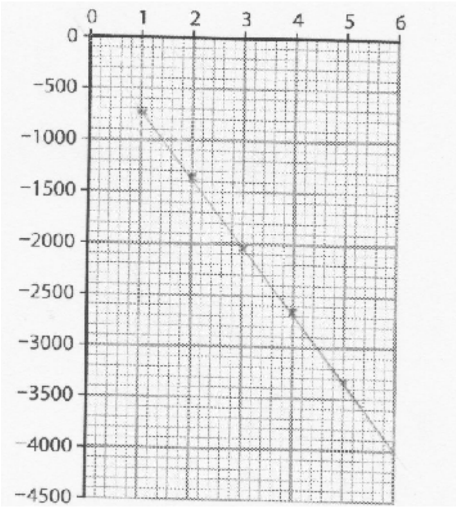
(c)	Any explanation that links any **three** of the following points for diamond **M1** each (carbon) atom is (covalently) bonded to four other (carbon) atoms **M2** in a (giant) tetrahedral lattice /network / structure **M3** the (covalent) bonds are (very) strong **M4** (therefore) diamond is (very) hard (and so good for cutting tools)	**ALLOW** each carbon has four bonds **ALLOW** 3D/rigid in place of tetrahedral **ALLOW** reference to lot of energy needed to break the (covalent) bonds **ALLOW** there are lots of/many (covalent) bonds **ALLOW** diamond is (very) strong If mention of intermolecular forces in diamond MAX 2 for diamond If mention of ions in diamond only M4 can be scored	6
	Any explanation that links any **three** of the following points for graphite **M5** each (carbon) atom is (covalently) bonded to three other (carbon) atoms **M6** (the structure is) in layers **M7** weak forces (between layers) **M8** (the layers can) slide over each other/ rub off **M9** this makes graphite soft (so it can make marks on paper)	**ALLOW** sheets **ALLOW** slippery If mention of intermolecular forces in graphite MAX 2 for graphite If mention of ions in graphite only M9 can be scored	
			Total 11

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)	An explanation that links the following two points. **M1** incomplete combustion (occurs) **M2** (because) the air/oxygen supply is limited OWTTE	**ALLOW** mark for soot/carbon if not seen in (i), unless copper oxide is mentioned in (i) If copper oxide in (i) ALLOW 1 mark for (because) copper reacts with oxygen (in air)	2
(c) (i)	• substitution into $Q = mc\Delta T$ • calculation of heat energy in Joules • conversion to kJ Example calculation **M1** Q = 100 x 4.2 x 30 **M2** = 12600 (J) **M3** = 12.6 kJ	12600 (J) with no working scores M1 and M2 M2 ECF M1 **ALLOW** approximately = 13 kJ 12.6 kJ with no working scores 3	3

	(ii)	• calculate the amount, in moles, of methanol • divide Q by the amount in moles • give the answer with the correct sign Example calculation **M1** 0.96 ÷ 32 **OR** 0.03 **M2** 12.6 ÷ 0.03 **OR** 420 (kJ/mol) **M3** – 420 (kJ/mol)	**ACCEPT** 13 ÷ 0.03 **OR** 430/433 for **M2** **AND** – 430 / – 433 for **M3**	3

<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>9 (d) (i)</td><td>M1 all points plotted correctly

M2 line of best fit drawn with a ruler


</td><td>does not need to start at (0,0)</td><td>2</td></tr>
<tr><td>(ii)</td><td>M1 straight line extrapolated up to 6 carbon atoms

M2 value of ΔH read from their graph</td><td>ALLOW extra point shown at 6 carbon atoms

negative sign needed</td><td>2</td></tr>
<tr><td>(iii)</td><td>The greater the number of carbon atoms (per molecule) the greater (the magnitude/ value of) ΔH</td><td>ALLOW ΔH is (directly) proportional to the number of carbon atoms per molecule

ALLOW The greater the number of carbon atoms (per molecule) the more exothermic the ΔH value</td><td>1

Total 15</td></tr>
</table>

Question number	Answer	Notes	Marks
10 (a) (i)	**4**NH_3 + **5**O_2 $\rightleftharpoons$ **4**NO + **6**H_2O	**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)	2NO + O_2 → $2NO_2$	**ACCEPT** multiples and fractions	1
(c) (i)	• 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 Example calculation **M1** M_r of NO_2 = 46 M_r of HNO_3 = 63 **M2** $n(NO_2)$ = 11.5 x 10^6 ÷ 46 **OR** 250 000 (mol) **M3** $n(HNO_3) = \frac{2 \times 25\,0000}{3}$ **OR** 167 000 / 170 000 **M4** (167 000 x 63 g) = 10.5 (tonnes)	**ALLOW** working in megamoles i.e. 11.5 ÷ 46 **OR** 0.25 **ALLOW** ECF from incorrect Mr of NO_2 calculator answer 166666.66 **ALLOW** working in megamoles i.e. $\frac{2 \times 0.25}{3}$ **OR** 0.167 / 0.17 **ALLOW** ECF from M2 10.5 (tonnes) with no working scores 4 **ACCEPT** 10.7 (if 170 000 used) **ALLOW** ECF from M3 **ALLOW** ECF from incorrect M_r of HNO_3	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)	• calculate the amount, in moles, of copper(**II**) nitrate • calculate the theoretical yield, in moles, of copper(**II**) nitrate • calculate the percentage yield Example calculation **M1** nCu$(NO_3)_2$ formed = 15.3 ÷ 187.5 **OR** 0.0816 **M2** theoretical nCu$(NO_3)_2$ = 0.200 ÷ 2 **OR** 0.100 **M3** (% yield) = $\frac{(0.0816 \times 100)}{(0.100)}$ = 81.6 (%) Alternative method • 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 Example calculation **M1** theoretical nCu$(NO_3)_2$ = 0.200 ÷ 2 **OR** 0.100 **M2** theoretical mass of copper nitrate = 0.1 x 187.5 = 18.75 **M3** (% yield) = $\frac{15.3}{18.75}$ x 100 = 81.6 (%)	**ALLOW** 0.082 **ACCEPT** 82 (%) Mark M3 CSQ on M1 and M2 40.8 scores 2 **ALLOW** 18.8 **ACCEPT** 82 (%) Mark M3 CSQ on M1 and M2 40.8 scores 2 81.6(%) with no working scores 3 marks	3 **Total 12**

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