Mark Scheme (Results)

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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

Question number			Answer	Notes	Marks
4	(a)	(i)		1 mark for each correct formula	3
		(ii)	ammonium nitrate		1
	(b)	(i)	**M1** electrostatic (force of) attraction **M2** between oppositely charged ions	**ALLOW** electrostatic force **ACCEPT** between positive and negative ions **ACCEPT** between cations and anions	2
		(ii)	 **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)	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**	3
					Total 9

The table in 4(a)(i):

	Mg^{2+}	Al^{3+}	NH_4^+
S^{2-}	MgS	Al_2S_3	$(NH_4)_2S$
NO_3^-	$Mg(NO_3)_2$	$Al(NO_3)_3$	NH_4NO_3
CO_3^{2-}	$MgCO_3$	$Al_2(CO_3)_3$	$(NH_4)_2CO_3$

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	**ACCEPT** Br_2 (aq)	
			M2 no change / stays orange	**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	
			M3 (bromine water) decolourised / changes (from orange) to colourless	**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	**ACCEPT** react in similar/same way	
			M5 trend in physical properties (between successive members)	**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 H F $\dfrac{36.36}{12}$ $\dfrac{6.06}{1}$ $\dfrac{57.58}{19}$ **M2** $\dfrac{3.03}{3.03}$ $\dfrac{6.06}{3.03}$ $\dfrac{3.03}{3.03}$ **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** $\dfrac{66}{12 + 2 + 19}$ **OR** $\dfrac{66}{33}$ 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)		If readings are correct but in wrong order award 1 mark for **M1** and **M2**	
			temperature in °C after adding zinc	22.4		
			temperature in °C before adding zinc	17.7		3
			temperature change in °C	4.7		
		M1 22.4		
		M2 17.7		
		M3 (+)4.7		
			ALLOW ECF for **M3** if **M1** and/or **M2** incorrect	
			If answers not given to nearest 0.1°C penalise once only	
	(c) (i)	An explanation that links any **two** of the following points		
		M1 polystyrene is an insulator	**ALLOW** is not a (good) conductor of heat	
			ALLOW is a poor conductor of heat	
		M2 (so) reduces heat loss	**ALLOW** prevents heat loss	
			ALLOW keeps heat in	
		M3 temperature rise/change/reading will be closer to true value OWTTE	**ALLOW** temperature rise/change/reading will be more accurate/valid	2
	(ii)	Any **three** from		
		M1 amount/mass of metal	**ALLOW** size / surface area of metal	
		M2 concentration of acid		
		M3 volume of acid	**ALLOW** amount of acid	
		M4 (speed/time of) stirring		
		M5 external / room temperature	**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	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)		1
			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	

(b)	(i)	**M1** (colourless solution turns) brown		2
		M2 (solution stays) brown / no change	**ALLOW** no reaction	
	(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

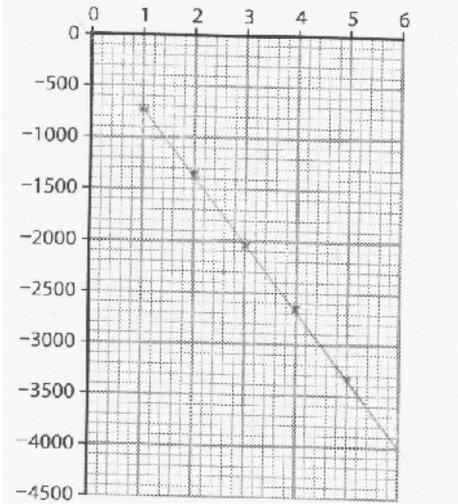| Question number	Answer	Notes	Marks
7 (c)	A description that makes reference to the following 6 points Test for cation **M1** add sodium hydroxide (solution) **M2** if blue precipitate forms solution contains copper(II) ion(s) / contains Cu^{2+} / is a copper compound **M3** if green precipitate forms solution contains iron(II) ion(s) / contains Fe^{2+} / is an iron compound	**ALLOW** ammonia solution **IGNORE q**ualifiers **REJECT** other colours **IGNORE q**ualifiers **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)	**IGNORE** addition of nitric acid **REJECT** addition of hydrochloric acid for **M4**	
		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	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		2
			M2 (limewater) turns cloudy/milky	**ACCEPT** forms white precipitate M2 DEP M1	
	(b)		An explanation that links the following two points		
			M1 weak forces (of attraction) between molecules / weak intermolecular forces (of attraction)	**ALLOW** weak intermolecular bonds **ALLOW** weak intermolecular attractions	
			M2 little energy needed to overcome the (intermolecular) forces	**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		6
	M1 each (carbon) atom is (covalently) bonded to four other (carbon) atoms	**ALLOW** each carbon has four bonds	
	M2 in a (giant) tetrahedral lattice /network / structure	**ALLOW** 3D/rigid in place of tetrahedral	
	M3 the (covalent) bonds are (very) strong	**ALLOW** reference to lot of energy needed to break the (covalent) bonds	
		ALLOW there are lots of/many (covalent) bonds	
	M4 (therefore) diamond is (very) hard (and so good for cutting tools)	**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	
	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	**ALLOW** sheets	
	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** 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

Question number			Answer	Notes	Marks
9	(d)	(i)	**M1** all points plotted correctly **M2** line of best fit drawn with a ruler 	does not need to start at (0,0)	2
		(ii)	**M1** straight line extrapolated up to 6 carbon atoms **M2** value of ΔH read from their graph	**ALLOW** extra point shown at 6 carbon atoms negative sign needed	2
		(iii)	The greater the number of carbon atoms (per molecule) the greater (the magnitude/ value of) ΔH	**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	1
					Total 15

Question number			Answer	Notes	Marks
10	(a)	(i)	$4NH_3 + 5O_2 \rightleftharpoons 4NO + 6H_2O$	**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)		$2NO + O_2 \rightarrow 2NO_2$	**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) = $\dfrac{(0.0816 \times 100)}{(0.100)}$ = 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) = $\dfrac{15.3}{18.75}$ 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