



Mark Scheme (Results)

January 2022

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)	<p>C red is correct because litmus indicator in an acidic solution is red</p> <p>A is incorrect because litmus indicator in an acidic solution is not blue</p> <p>B is incorrect because litmus indicator in an acidic solution is not orange</p> <p>D is incorrect because litmus indicator in an acidic solution is not yellow</p>		1
1 (b)	<p>C 7 is correct because the pH value of a neutral solution is 7</p> <p>A is incorrect because the pH value of a neutral solution is not 0</p> <p>B is incorrect because the pH value of a neutral solution is not 4</p> <p>D is incorrect because the pH value of a neutral solution is not 14</p>		1

Question number	Answer	Notes	Marks
1 (c)	<p>D is correct because a solution with a pH value of 9 is weakly alkaline</p> <p>A is incorrect because a solution with a pH value of 9 is not strongly acidic</p> <p>B is incorrect because a solution with a pH value of 9 is not strongly alkaline</p> <p>C is incorrect because a solution with a pH value of 9 is not weakly acidic</p>		1
1 (d)	<p>A is correct because HNO_3 is the chemical formula of an acid</p> <p>B is incorrect because H_2O is not the chemical formula of an acid</p> <p>C is incorrect because NaCl is not the chemical formula of an acid</p> <p>D is incorrect because NaOH is not the chemical formula of an acid</p>		1

Question number	Answer	Notes	Marks
1 (e)	neutralisation	ALLOW exothermic	1
1 (f)	M1 potassium chloride M2 water	ACCEPT in either order ALLOW correct chemical formulae	2

Total for Question 1 = 7 marks

Question number	Answer	Notes	Marks
2 (a) (i)	(solute is) the substance/solid that dissolves (in a solvent) OWTTE		1
(ii)	(solvent is) the substance/liquid the solute/solid/substance dissolves in OWTTE		1
(b)	M1 (saturated solution) contains as much dissolved solute/solid/substance as possible OWTTE M2 at a particular temperature		2
(c)	M1 process called diffusion M2 particles spread out (evenly throughout water/solution/liquid)	ALLOW particles move from area of high concentration to area of low concentration	2

Total for Question 2 = 6 marks

Question number	Answer	Notes	Marks
3 (a)	<p>M1 (same) solvent</p> <p>M2 (same type of chromatography) paper</p>	<p>ALLOW (same) named solvent eg water</p> <p>IGNORE reference to size/length of paper</p> <p>ALLOW reference to use of pencil (for start line)/spots must start on horizontal line /solvent must start below line or spots</p> <p>ALLOW same distance travelled by solvent</p> <p>IGNORE distance of line from bottom of paper</p> <p>IGNORE amount/volume/concentration of solvent /references to size/volume of dyes or spots /references to temperature/time</p>	2
3 (b) (i)	C is insoluble (in the solvent)		1
(ii)	<p>M1 Student 2 and dye D/(R_f value) 1.20</p> <p>M2 because R_f value must be less than 1 / cannot be greater than 1</p>	<p>ALLOW spot cannot move further than solvent front</p> <p>OWTTE</p>	2

Question number	Answer	Notes	Marks
3 (c)	<p>M1 (R_f =) $\frac{9.7}{12}$</p> <p>M2 = 0.808(33..)</p> <p>M3 = 0.81 (to 2 SF)</p>	<p>0.808(33..) with no working scores M1 and M2</p> <p>ALLOW M2 ECF if used 10.7 or 13 and R_f < 1</p> <p>ALLOW 1 mark for $\frac{12}{9.7} = 1.2(37..)$</p> <p>ALLOW M3 ECF M2 (must be correct to 2 SF)</p> <p>0.81 with no working scores 3</p>	3

Total for Question 3 = 8 marks

Question number	Answer	Notes	Marks
4 (a)	number of protons (in nucleus of atom)	IGNORE references to electrons	1
4 (b) (i)	D 29 is correct because mass number = total number of protons and neutrons = 14 + 15 = 29 A is incorrect because 14 is the number of protons B is incorrect because 15 is the number of neutrons C is incorrect because 28 is the number of protons + the number of electrons		1
4 (b) (ii)	M1 (group) 4 M2 because 4 electrons in outer shell	ALLOW electronic configuration is 2.8.4	2

Question number	Answer	Notes	Marks
4 (c)	M1 $\frac{(32 \times 95.0) + (33 \times 0.75) + (34 \times 4.25)}{100}$ OR $\frac{(3040) + (24.75) + (144.5)}{100}$ M2 = 32.0925 M3 = 32.1 (1 dp)	32.09(25) with no working scores 2 ALLOW 1 mark for 3209.25 ALLOW M2 ECF M1 if minor error in calculation using all 3 isotopes correct answer to 1 dp with or without working scores 3 ALLOW M3 ECF M2 (must be correct to 1 dp)	3

Total for Question 4 = 7 marks

Question number	Answer	Notes	Marks
5 (a)	(good) conductors of electricity / malleable	ACCEPT (good) conductors of heat/ductile/have basic oxides/hydroxides ALLOW high density/ high melting point/ sonorous/shiny/hard/ strong	1
5 (b)	M1 (in mercury) particles can move/flow OWTTE M2 (in solid metal) particles do not move /are in fixed positions	IGNORE references to spacing/gaps between particles / energy of particles ACCEPT particles vibrate (about fixed position)	2
5 (c) (i)	(bright) white flame	ALLOW white light ACCEPT white solid/ash/powder (formed)	1
5 (c) (ii)	(product/magnesium oxide is) basic / a base	ALLOW (product/magnesium oxide) neutralises acid / dissolves in/reacts with acid / (produces) alkali (when added to water) REJECT if incorrect product given	1
5 (d) (i)	magnesium/sulfur would react with/ burn in oxygen	ACCEPT magnesium oxide (not magnesium sulfide) would be formed ALLOW sulfur dioxide would be formed	1
5 (d) (ii)	M1 magnesium (atom) loses two electrons M2 sulfur (atom) gains two electrons (from magnesium) M3 charge on magnesium (ion) 2^+ /Mg ²⁺ AND charge on sulfur/sulfide (ion) 2^- / S ²⁻	two electrons transferred from magnesium (atom) to sulfur (atom) scores M1 and M2	3

Question number	Answer	Notes	Marks
5 (d) (iii)	<p>M1 strong (electrostatic) force of attraction</p> <p>M2 between magnesium ions/Mg^{2+} and sulfide ions/S^{2-} ions</p> <p>M3 large amount/lot of (heat/thermal) energy needed to overcome forces/attraction</p>	<p>ALLOW strong ionic bonds but No M1 or M2 if between atoms/molecules or any reference to intermolecular forces / covalent bonds</p> <p>ACCEPT between oppositely charged ions</p> <p>ACCEPT between positive and negative ions</p> <p>ACCEPT large amount/lot of (heat/thermal) energy needed to break the bonds IGNORE more energy</p> <p>No M3 if reference to overcoming / breaking intermolecular forces / covalent bonds</p>	3
5 (d) (iv)	<p>$MgS + 2HCl \rightarrow MgCl_2 + H_2S$</p> <p>M1 all formulae correct</p> <p>M2 correctly balanced</p>	<p>IGNORE state symbols</p> <p>M2 DEP M1</p> <p>ACCEPT multiples and fractions</p>	2

Total for Question 5 = 14 marks

Question number	Answer	Notes	Marks
6 (a)	136		1
6 (b)	<p>M1 simplest (whole number) ratio of atoms present (in a compound)</p> <p>M2 empirical formula (of ocimene/$C_{10}H_{16}$) is C_5H_8</p>	<p>ALLOW elements for atoms</p> <p>ALLOW C : H ratio 5:8</p>	2

Question number	Answer	Notes	Marks
6 (c)	<p>unsaturated hydrocarbon because</p> <p>M1 contains (carbon to carbon) double bond(s)</p> <p>M2 contains carbon and hydrogen (atoms)</p> <p>M3 only</p>	<p>REJECT molecules</p> <p>M3 DEP on mention of carbon and hydrogen</p>	3
6 (d) (i)	<p>A addition</p> <p>B is incorrect because the type of reaction between an alkene and bromine is addition not polymerisation</p> <p>C is incorrect because the type of reaction between an alkene and bromine is addition not precipitation</p> <p>D is incorrect because the type of reaction between an alkene and bromine is addition not substitution</p>		1

Question number	Answer	Notes	Marks
6 (d) (ii)	ocimene contains more than one double bond /three double bonds		1

Question number	Answer	Notes	Marks
6 (e)	$\text{C}_{10}\text{H}_{16} + 14\text{O}_2 \rightarrow 10\text{CO}_2 + 8\text{H}_2\text{O}$ <p>M1 $\text{CO}_2 + \text{H}_2\text{O}$</p> <p>M2 correctly balanced</p>	<p>ACCEPT in either order</p> <p>M2 DEP M1</p> <p>ACCEPT multiples or fractions</p>	2
6 (f) (i)	<p>M1 carbon/C/soot</p> <p>M2 carbon monoxide/CO</p>	ACCEPT M1 M2 in either order	2
(ii)	(carbon monoxide/CO) reduces capacity of blood to carry oxygen OWTTE	ACCEPT correct references to haemoglobin / carboxyhaemoglobin	1

Total for Question 6 = 13 marks

Question number	Answer	Notes	Marks
7 (a)	<p>M1 breaking up/down of a compound/substance OWTTE</p> <p>M2 by heat(ing)</p>	<p>REJECT elements</p> <p>REJECT any references to heat being given out/exothermic</p>	2
(b)	<p>examples of calculation of maximum mass of K_2CO_3</p> <p>M1 M_r of $KHCO_3 = 100$ AND M_r of $K_2CO_3 = 138$</p> <p>M2 200 g $KHCO_3$ produces 138 g K_2CO_3</p> <p>M3 2.50 g $KHCO_3$ produces $\frac{138 \times 2.50}{200} =$</p> <p>M4 1.725 (g K_2CO_3)</p> <p>OR</p> <p>M1 M_r of $KHCO_3 = 100$ AND M_r of $K_2CO_3 = 138$</p> <p>M2 amount $KHCO_3 = \frac{2.50}{100} = 0.025$ (mol)</p> <p>M3 amount $K_2CO_3 = \frac{0.025}{2} = 0.0125$ (mol)</p> <p>M4 mass $K_2CO_3 (= 0.0125 \times 138) = 1.725$ (g)</p>	<p>ALLOW 2 or more SF</p> <p>M2 M3 M4 ECF M1</p> <p>correct answer with or without working scores 4</p> <p>ALLOW 2 or more SF</p> <p>M2 M3 M4 ECF M1</p> <p>correct answer with or without working scores 4</p> <p>3.45/3.46/3.5/6.9 scores 3</p>	4

Total for Question 7 = 6 marks

Question number	Answer	Notes	Marks
8 (a)	$\text{Zn (s)} + \text{H}_2\text{SO}_4 \text{ (aq)} \rightarrow \text{ZnSO}_4 \text{ (aq)} + \text{H}_2 \text{ (g)}$ <p>all state symbols correct</p>		1
8 all clip with graph	<p>(b) all points correctly plotted (within +/- half a square)</p> <p>(i)</p> <p>(ii) circle around point at 6 min</p> <p>(iii) smooth curve of best fit</p> <p>(iv) student took reading too soon/before 6 min</p> <p>(v) mass from graph at 6 min</p>	IGNORE UNITS	1 1 1 1 1
8 (c)	<p>(i) M1 curve becomes less steep /gradient decreases (as time increases)</p> <p>M2 so rate of reaction decreases</p> <p>(ii) the (sulfuric) acid was in excess OWTTE</p>	<p>M2 DEP M1</p> <p>ALLOW not all (sulfuric) acid reacted</p> <p>ALLOW zinc was limiting reagent</p> <p>ALLOW zinc was not in excess</p>	2 1

Question number	Answer	Notes	Marks
8 (d)	<p>M1 magnesium (more reactive than zinc so) would make reaction faster/increase the rate</p> <p>M2 less concentrated acid would make reaction slower/decrease the rate</p> <p>M3 (so) difficult/impossible to know whether rate will increase or decrease overall OWTTE</p>	<p>REJECT reference to different surface area</p> <p>REJECT references to differences in energy/speed of particles</p> <p>ALLOW difficult/impossible to know which change has greater effect OWTTE</p> <p>ALLOW idea of difficult/impossible to predict (overall) effect of changing two factors at same time OWTTE</p> <p>ALLOW idea of difficult/impossible to know if changes cancel each other out OWTTE</p>	3
8 (e)	<p>M1 at higher temperature particles have more (kinetic) energy</p> <p>M2 more (successful) collisions per unit time</p> <p>M3 rate of reaction increases</p>	<p>ACCEPT more particles have the required activation energy</p> <p>ALLOW particles move faster</p> <p>ALLOW more frequent (successful) collisions</p>	3

Total for Question 8 = 15 marks

Question number	Answer	Notes	Marks
9 (a)	<p>M1 copper(II) carbonate is green</p> <p>M2 copper(II) carbonate is insoluble/cannot form a solution OWTTE</p>	IGNORE is not white/is a different colour	2
9 (b)	<p>Description including six of following points</p> <p>(Test for potassium ions)</p> <p>M1 flame test</p> <p>M2 lilac flame</p> <p>(Test for carbonate ions)</p> <p>M3 add acid (to mixture of solids/solution)</p> <p>M4 (pass/bubble) gas/carbon dioxide into limewater</p> <p>M5 which goes cloudy/milky / white ppt forms</p> <p>(Test for iodide ions)</p> <p>M6 (add dilute nitric acid followed by) silver nitrate (solution)</p> <p>M7 yellow ppt/solid</p>	<p>ALLOW description of flame test</p> <p>ALLOW any named acid IGNORE references to concentration</p> <p>M4 DEP on M3</p> <p>M5 DEP on mention of limewater</p> <p>M7 DEP on mention of silver nitrate</p>	6

Total for Question 9 = 8 marks

Question number	Answer	Notes	Marks
10 (a)	contain water of crystallisation /are hydrated		1
10 (b) (i)	3.18g		1
(ii)	3.78g		1
(iii)	<p>calculation with following steps</p> <p>M1 calculate moles of Na₂CO₃</p> <p>M2 calculate moles of H₂O</p> <p>M3 divide each by smaller to obtain ratio 1 : 7</p> <p>example calculation:</p> <p>M1 $\frac{3.18}{106} = 0.03$</p> <p>M2 $\frac{3.78}{18} = 0.21$</p> <p>M3 $\frac{0.03}{0.03} : \frac{0.21}{0.03} = 1 : 7$</p> <p>Alternative method:</p> <p>M1 (If formula is Na₂CO₃.7H₂O products will form in ratio) 106 g Na₂CO₃ : 126 g H₂O</p> <p>M2 so mass of water that forms with 3.18 g Na₂CO₃ should = $\frac{(126 \times 3.18)}{106}$</p> <p>M3 = 3.78 g so formula is correct</p>	<p>ALLOW ECF from (i)</p> <p>ALLOW ECF from (ii)</p>	3
(c) (i)	<p>explanation including</p> <p>M1 not heated crystals (for long) enough</p> <p>M2 so not all water removed/evaporated OWTTE</p>		2
(ii)	<p>M1 repeat heating (and cooling)</p> <p>M2 until constant mass OWTTE</p>	ALLOW heat for longer	2

Total for Question 10 = 10 marks

Question number	Answer	Notes	Marks
11 (a)	<p>Award 1 mark each for any six of the following:</p> <p>Method 1</p> <p>M1 polystyrene (insulator so) reduces/prevents heat loss (to atmosphere) OWTTE</p> <p>M2 no lid so heat/thermal energy will be lost (to atmosphere)</p> <p>M3 stirring will ensure even temperature / more accurate (highest) temperature OWTTE</p> <p>M4 no lid so possibility of spillage OR polystyrene cup (containing thermometer) unstable/may fall over OWTTE</p> <p>Method 2</p> <p>M5 glass bottle poor insulator so heat/thermal energy loss occurs OWTTE</p> <p>M6 bung helps reduce/prevent heat/thermal energy loss (to atmosphere)</p> <p>M7 bung so no spillage</p> <p>M8 cannot stir so cannot ensure even temperature / cannot ensure accurate (highest) temperature OWTTE</p>	<p>ALLOW references to heat/thermal energy evenly spread (throughout solution) OWTTE</p> <p>IGNORE references to increases rate of reaction</p> <p>ALLOW references to heat /thermal energy not evenly spread (throughout solution) OWTTE</p>	6

11 (b)	<p>M1 0.025 mol CuSO₄ reacts with 0.025 mol Zn</p> <p>M2 mass Zn needed = 0.025 x 65 = 1.625 g (3g > 1.625g so having 3g Zn is excess)</p> <p>OR</p> <p>M1 0.025 mol CuSO₄ reacts with 0.025 mol Zn</p> <p>M2 3g Zn = $\frac{3}{65}$ = 0.046 mol (0.046 > 0.025 so having 3g Zn is excess)</p>	<p>ALLOW reference to 1:1 molar ratio or (only) 0.025 mol Zn needed</p> <p>M2 subsumes M1</p> <p>ALLOW reference to 1:1 molar ratio or (only) 0.025 mol Zn needed</p>	2
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Question number	Answer	Notes	Marks
11 (c) (i)	<p>M1 calculation of temperature rise</p> <p>M2 correct substitution into $Q = m \times 4.2 \times \text{temp rise}$</p> <p>M3 correct evaluation of Q</p> <p>Example calculation</p> <p>M1 (40.6 - 21.1) OR 19.5</p> <p>M2 $Q = 50 \times 4.2 \times 19.5$</p> <p>M3 = 4100 (J)</p>	<p>ALLOW 4095</p> <p>IGNORE sign</p>	3
(ii)	<p>M1 answer to (i) $\div 0.025$</p> <p>M2 correct evaluation in J</p> <p>M3 correct conversion to kJ and minus sign</p> <p>Example calculation</p> <p>M1 $4095 \div 0.025$</p> <p>M2 = 163 800 (J)</p> <p>M3 = -160 kJ</p>	<p>ACCEPT use of 4000</p> <p>ACCEPT 160 000/ 164 000</p> <p>ACCEPT -163.8/-164</p> <p>160/163.8/164 scores 2</p>	3
11 (d)	<p>M1 Zn/zinc is oxidised because loses electrons</p> <p>M2 Cu^{2+}/copper ions reduced because gains electrons</p>		2

Total for Question 11 = 16 marks

Total for paper = 110 marks

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