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

Question number	Answer	Notes	Marks
1 (c)	**D** is correct because a solution with a pH value of 9 is weakly alkaline **A** is incorrect because a solution with a pH value of 9 is not strongly acidic **B** is incorrect because a solution with a pH value of 9 is not strongly alkaline C is incorrect because a solution with a pH value of 9 is not weakly acidic		1
1 (d)	**A** is correct because HNO_3 is the chemical formula of an acid **B** is incorrect because H_2O is not the chemical formula of an acid **C** is incorrect because NaCl is not the chemical formula of an acid **D** is incorrect because NaOH is not the chemical formula of an acid		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)	**M1** (same) solvent **M2** (same type of chromatography) paper	**ALLOW** (same) named solvent eg water **IGNORE** reference to size/length **of paper** **ALLOW** reference to use of pencil (for start line)/spots must start on horizontal line /solvent must start below line or spots **ALLOW** same distance travelled by solvent **IGNORE** distance of line from bottom of paper **IGNORE** amount/volume/concentration of solvent /references to size/volume of dyes or spots /references to temperature/time	2
3 (b) (i)	C is insoluble (in the solvent)		1
(ii)	**M1** Student 2 and dye D/(R_f value) 1.20 **M2** because R_f value must be less than 1 / cannot be greater than 1	 ALLOW spot cannot move further than solvent front OWTTE	2

Question number	Answer	Notes	Marks
3 (c)	**M1** (R_f =) $\frac{9.7}{12}$ **M2** = 0.808(33..) **M3** = 0.81 (to 2 SF)	 0.808(33..) with no working scores **M1** and **M2** **ALLOW M2** ECF if used 10.7 or 13 and R_f < 1 **ALLOW** 1 mark for $\frac{12}{9.7}$ = 1.2(37..) **ALLOW M3** ECF **M2** (must be correct to 2 SF) 0.81 with no working scores 3	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)	**M1** strong (electrostatic) force of attraction **M2** between magnesium ions/Mg^{2+} and sulfide ions/S^{2-} ions **M3** large amount/lot of (heat/thermal) energy needed to overcome forces/attraction	**ALLOW** strong ionic bonds but No **M1** or **M2** if between atoms/molecules or any reference to intermolecular forces / covalent bonds **ACCEPT** between oppositely charged ions **ACCEPT** between positive and negative ions **ACCEPT** large amount/lot of (heat/thermal) energy needed to break the bonds **IGNORE** more energy No **M3** if reference to overcoming / breaking intermolecular forces / covalent bonds	3
5 (d) (iv)	$MgS + 2HCl \rightarrow MgCl_2 + H_2S$ **M1** all formulae correct **M2** correctly balanced	IGNORE **state symbols** **M2 DEP M1** **ACCEPT** multiples and fractions	2

Total for Question 5 = 14 marks

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

Question number	Answer	Notes	Marks
6 (c)	unsaturated hydrocarbon because **M1** contains (carbon to carbon) double bond(s) **M2** contains carbon and hydrogen (atoms) **M3** only	 **REJECT** molecules **M3** DEP on mention of carbon and hydrogen	3
6 (d) (i)	**A** addition B is incorrect because the type of reaction between an alkene and bromine is addition not polymerisation C is incorrect because the type of reaction between an alkene and bromine is addition not precipitation D is incorrect because the type of reaction between an alkene and bromine is addition not substitution		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)	$C_{10}H_{16} + 14\,O_2 \rightarrow 10\,CO_2 + 8\,H_2O$ **M1** $CO_2 + H_2O$ **M2** correctly balanced	 **ACCEPT** in either order **M2 DEP M1** **ACCEPT** multiples or fractions	2
6 (f) (i)	**M1** carbon/C/soot **M2** carbon monoxide/CO	**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)	**M1** breaking up/down of a compound/substance OWTTE **M2** by heat(ing)	**REJECT** elements **REJECT** any references to heat being given out/exothermic	2
(b)	examples of calculation of maximum mass of K_2CO_3 **M1** M_r of $KHCO_3$ = 100 AND M_r of K_2CO_3 = 138 **M2** 200 g $KHCO_3$ produces 138 g K_2CO_3 **M3** 2.50 g $KHCO_3$ produces $\frac{138 \times 2.50}{200}$ = **M4** 1.725 (g K_2CO_3) OR **M1** M_r of $KHCO_3$ = 100 AND M_r of K_2CO_3 = 138 **M2** amount $KHCO_3 = \frac{2.50}{100}$ = 0.025 (mol) **M3** amount $K_2CO_3 = \frac{0.025}{2}$ = 0.0125 (mol) **M4** mass K_2CO_3 (= 0.0125 x 138) = 1.725 (g)	**ALLOW** 2 or more SF **M2 M3 M4 ECF M1** correct answer with or without working scores 4 **ALLOW** 2 or more SF **M2 M3 M4 ECF M1** correct answer with or without working scores 4 3.45/3.46/3.5/6.9 scores 3	4

Total for Question 7 = 6 marks

Question number	Answer	Notes	Marks
8 (a)	$Zn\ (s) + H_2SO_4\ (aq) \rightarrow ZnSO_4\ (aq) + H_2\ (g)$ all state symbols correct		1
8 all clip with graph (b) (i)	all points correctly plotted (within +/- half a square)		1
(ii)	circle around point at 6 min		1
(iii)	smooth curve of best fit		1
(iv)	student took reading too soon/before 6 min		1
(v)	mass from graph at 6 min	IGNORE UNITS	1
8 (c) (i)	**M1** curve becomes less steep /gradient decreases (as time increases) **M2** so rate of reaction decreases	 **M2** DEP **M1**	2
(ii)	the (sulfuric) acid was in excess OWTTE	**ALLOW** not all (sulfuric) acid reacted **ALLOW** zinc was limiting reagent **ALLOW** zinc was not in excess	1

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

Total for Question 8 = 15 marks

Question number	Answer	Notes	Marks
9 (a)	**M1** copper(II) carbonate is green **M2** copper(II) carbonate is insoluble/cannot form a solution OWTTE	**IGNORE** is not white/is a different colour	2
9 (b)	Description including six of following points (Test for potassium ions) **M1** flame test **M2** lilac flame (Test for carbonate ions) **M3** add acid (to mixture of solids/solution) **M4** (pass/bubble) gas/carbon dioxide into limewater **M5** which goes cloudy/milky / white ppt forms (Test for iodide ions) **M6** (add dilute nitric acid followed by) silver nitrate (solution) **M7** yellow ppt/solid	 **ALLOW** description of flame test **ALLOW** any named acid **IGNORE** references to concentration **M4** DEP on **M3** **M5** DEP on mention of limewater **M7** DEP on mention of silver nitrate	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)	calculation with following steps **M1** calculate moles of Na_2CO_3 **M2** calculate moles of H_2O **M3** divide each by smaller to obtain ratio 1 : 7 example calculation: **M1** $\frac{3.18}{106} = 0.03$ **M2** $\frac{3.78}{18} = 0.21$ **M3** $\frac{0.03}{0.03} : \frac{0.21}{0.03} = 1 : 7$ Alternative method: **M1** (If formula is $Na_2CO_3.7H_2O$ products will form in ratio) 106 g Na_2CO_3 : 126 g H_2O **M2** so mass of water that forms with 3.18 g Na_2CO_3 should = $\frac{(126 \times 3.18)}{106}$ **M3** = 3.78 g so formula is correct	**ALLOW** ECF from (i) **ALLOW** ECF from (ii)	3
(c) (i)	explanation including **M1** not heated crystals (for long) enough **M2** so not all water removed/evaporated OWTTE		2
(ii)	**M1** repeat heating (and cooling) **M2** until constant mass OWTTE	**ALLOW** heat for longer	2

Total for Question 10 = 10 marks

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

11 (b)	**M1** 0.025 mol $CuSO_4$ reacts with 0.025 mol Zn **M2** mass Zn needed = 0.025 x 65 = 1.625 g (3g > 1.625g so having 3g Zn is excess) OR **M1** 0.025 mol $CuSO_4$ reacts with 0.025 mol Zn **M2** 3g Zn = $\frac{3}{65}$ = 0.046 mol (0.046 > 0.025 so having 3g Zn is excess)	**ALLOW** reference to 1:1 molar ratio or (only) 0.025 mol Zn needed **M2** subsumes **M1** **ALLOW** reference to 1:1 molar ratio or (only) 0.025 mol Zn needed	2

Question number	Answer	Notes	Marks
11 (c) (i)	**M1** calculation of temperature rise **M2** correct substitution into Q = m x 4.2 x temp rise **M3** correct evaluation of Q Example calculation **M1** (40.6 – 21.1) OR 19.5 **M2** Q = 50 x 4.2 x 19.5 **M3** = 4100 (J)	ALLOW 4095 IGNORE sign	3
(ii)	**M1** answer to (i) ÷ 0.025 **M2** correct evaluation in J **M3** correct conversion to kJ and minus sign Example calculation **M1** 4095 ÷ 0.025 **M2** = 163 800 (J) **M3** = −160 kJ	**ACCEPT** use of 4000 **ACCEPT** 160 000/ 164 000 **ACCEPT** −163.8/−164 160/163.8/164 scores 2	3
11 (d)	**M1** Zn/zinc is oxidised because loses electrons **M2** Cu^{2+}/copper ions reduced because gains electrons		2

Total for Question 11 = 16 marks

Total for paper = 110 marks

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