



Mark Scheme (Results)

October 2020

Pearson International Advanced Level
In Chemistry (WCH16)
Paper 1: Practical Skills in Chemistry II

Question Number	Answer	Additional Guidance	Mark
1(a)(i)	<ul style="list-style-type: none"> (precipitate B is) copper(II) hydroxide / Cu(OH)_2 / $\text{Cu(OH)}_2(\text{H}_2\text{O})_4$ (1) (complex ion D is) tetraamminediaquacopper(II) ions / $[\text{Cu(NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$ (1) 	<p>In Q1 if name and formula are given both must be correct and ignore state symbols even if incorrect. Penalise omission of copper oxidation state once only</p> <p>In (a)(i) and (a)(ii) Ignore omission of or unnecessary brackets. Ignore copper hydroxide</p> <p>Allow $\text{Cu(NH}_3)_4^{2+}$ / tetraamminecopper((II)) ions Do not award $[\text{Cu(NH}_3)_6]^{2+}$ Ignore spaces in names of complexes</p> <p>If no other mark is awarded in (a) D = $\text{Ni(NH}_3)_6^{2+}$ / $\text{Cr(NH}_3)_6^{2+}$ scores (1)</p>	(2)

Question Number	Answer	Additional Guidance	Mark
1(a)(ii)	<ul style="list-style-type: none"> (black solid) is copper(II) oxide / CuO 	Allow CuO and copper oxide	(1)

Question Number	Answer	Additional Guidance	Mark
1(a)(iii)	<ul style="list-style-type: none"> (yellow solution E contains) tetrachlorocuprate(II) ions / $[\text{CuCl}_4]^{2-}$ 	Allow tetrachlorocuprate tetrachlorocopper((II)) / CuCl_4^{2-}	(1)

Question Number	Answer	Additional Guidance	Mark
1(b)(i)	<ul style="list-style-type: none"> (yellow colour is) chromate(VI) / CrO_4^{2-} (1) (orange colour is) dichromate(VI) / $\text{Cr}_2\text{O}_7^{2-}$ (1) (green colour is) chromium(III) / Cr^{3+} / hexaaquachromium(III) / $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$ (1) 	<p>If oxidation numbers are given they must be correct.</p> <p>Allow chromate</p> <p>Allow dichromate</p> <p>Ignore hexaaquachromium</p>	(3)

Question Number	Answer	Additional Guidance	Mark
1(b)(ii)	<ul style="list-style-type: none"> ethanal / CH_3CHO 	<p>Allow ethanoic acid / CH_3COOH</p> <p>Allow displayed / skeletal formulae</p> <p>Do not award CH_3COH</p> <p>If name and formula are given both must be correct</p>	(1)

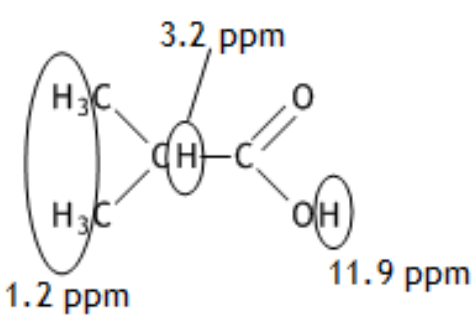
Question Number	Answer	Additional Guidance	Mark
1(c)	<ul style="list-style-type: none"> Copper(II) chromate(VI) / copper(II) chromate / CuCrO_4 	ALLOW copper chromate(VI) / copper chromate	(1)

Question Number	Answer	Additional Guidance	Mark
1(d)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> Copper(II) ions / Cu^{2+} and chromate(VI) ions / CrO_4^{2-} are both coloured and the observed (green) colour is a mixture 	<p>If oxidation numbers are given they must be correct. If name and formula are given both must be correct</p> <p>e.g. copper(II) ions are blue, chromate(VI) ions are yellow and the two colours mix to give green</p> <p>Allow omission of oxidation numbers</p> <p>Allow answers that do not refer to specific ions e.g. compound contains blue ions and yellow ions (so seen as green)</p> <p>Ignore just 'mixing blue and yellow forms green'</p> <p>Ignore explanations for the colours of transition metal ions or the observed colour being due to the absorption of the complementary colour</p> <p>Ignore formula errors e.g. CrO_4^-</p>	(1)

(Total for Question 1= 10 marks)

Question Number	Answer	Additional Guidance	Mark
2(a)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> smell (and formula) (1) volatile product identified as ethanol / $\text{CH}_3\text{CH}_2\text{OH}$ or peak at $m/z = 46$ due to $\text{CH}_3\text{CH}_2\text{OH}^+$ (1) identifies the mass spectrum peak as CH_3CO^+ (1) identifies P as $\text{CH}_3\text{COOCH}_2\text{CH}_3$ (1) 	<p>If names and formulae are give in 2 both must be correct</p> <p>suggest an ester</p> <p>Allow ethanol without stated justification</p> <p>Allow peak at $m/z = 46$ because ethanol present</p> <p>Any structure, and charge on any part of the structure Allow $\text{C}_2\text{H}_3\text{O}^+$ Do not award C_3H_7^+ Do not award if charge omitted</p> <p>Accept displayed or skeletal structure Allow ethyl ethanoate / $\text{CH}_3\text{COOC}_2\text{H}_5$ No TE on incorrect deductions Standalone mark</p>	(4)

Question Number	Answer	Additional Guidance	Mark
2(b)(i)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> • meaning of carbon dioxide evolved (and molecular formula) (1) • structures of Q and R (1) 	<p>e.g. React with NaHCO_3 / form CO_2 so Q and R are carboxylic acids / $\text{C}_3\text{H}_7\text{COOH}$ Allow acids for carboxylic acids</p> <p>$(\text{CH}_3)_2\text{CHCOOH}$ and $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$ Allow any type of structure</p> <p>Allow names 2-methylpropanoic acid / methylpropanoic acid and butanoic acid</p>	(2)

Question Number	Answer	Additional Guidance	Mark
2(b)(ii)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> three peaks indicates three proton environments (1) peak areas indicate one proton environment with six protons (1) doublet (at 1.2 ppm) indicates (six) protons adjacent to a proton environment with only one proton OR Heptuplet (at 3.2 ppm) indicated a proton adjacent to a proton environment with six protons (1) identification of Q as $(\text{CH}_3)_2\text{CHCOOH}$ (1) 	<p>Allow three types of proton</p> <p>Allow non-standard terminology e.g. 'two splits' If no other mark is scored correct description of n+1 rule on given structure scores (1)</p> <p>Structure of Q with the proton environments labelled and linked to the spectrum scores M1, M2 and M4 e.g.</p> 	(4)

(Total for Question 2 = 10 marks)

Question Number	Answer	Additional Guidance	Mark
3(a)	<ul style="list-style-type: none"> phenol is corrosive and wearing gloves 	Allow caustic Allow phenol is toxic by skin absorption so wear gloves Ignore irritates the skin Ignore use of fume cupboard Do not award toxic so use fume cupboard and corrosive so use gloves	(1)

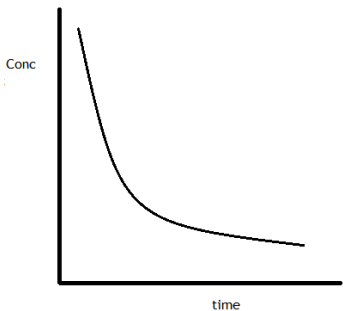
Question Number	Answer	Additional Guidance	Mark
3(b)	An answer that makes reference to the following points: <ul style="list-style-type: none"> phenol reacts (rapidly) with the bromine (formed in the reaction) (1) when all the phenol is used up the (excess)bromine bleaches the methyl red indicator (marking a fixed point in the progress of the reaction) (1) 	Ignore reference to white precipitate (of 2,4,6-tribromophenol) Allow phenol removes the bromine Do not award phenol is a solvent Allow indicator decolourises when all the phenol has reacted / is used up	(2)

Question Number	Answer	Additional Guidance	Mark
3(c)	<ul style="list-style-type: none"> use a white card / white background 	Allow any position of the white card (etc) Ignore adding more indicator / increased conc Do not award use of a cross (on white card) Do not award use of a colorimeter	(1)

Question Number	Answer	Additional Guidance	Mark
3(d)(i)	<ul style="list-style-type: none"> so the volume (of $\text{BrO}_3^-(\text{aq})$) is proportional to concentration 	Allow equal / equivalent to for proportional Ignore fair test	(1)

Question Number	Answer	Additional Guidance	Mark
3(d)(ii)	<ul style="list-style-type: none"> • suitable choice of scale and correct choice of axes (1) • axes labelled, with units (1) • all six points plotted correctly and best fit line (through the origin) (1) <p>COMMENT Mark the plotting and BFL by impression but points 1,2 5 and 6 should be on the line with 3 slightly above the line and 4 slightly below.</p> <p>If the scale is non-linear only M2 is available</p>	<p>Points plotted together with the origin (if included but not required) must cover at least 50% of the graph in both directions 1/t on vertical axis</p> <p>Ignore punctuation errors e.g. (cm³) instead of / cm³</p>	(3)

Question Number	Answer	Additional Guidance	Mark
3(d)(iii)	<ul style="list-style-type: none"> first order (with respect to bromate(V) ions) and because the graph ((of $1/t \propto \text{rate}$) v volume of BrO_3^- (\propto concentration)) is a straight line (through the origin) 	<p>Allow first order (with respect to bromate(V) ions) and because as the concentration / volume (of BrO_3^-) doubles, the rate doubles. Or because as the concentration / volume (of BrO_3^-) doubles, the time halves.</p> <p>Ignore rate increases as concentration of BrO_3^- increases because rate proportional to concentration of BrO_3^-</p>	(1)

Question Number	Answer	Additional Guidance	Mark
3(d)(iv)	<ul style="list-style-type: none"> the methyl red is decolourised early in the reaction when the concentration of reactant vs time graph is (almost) linear so the gradient of the tangent is the same as the (change in) concentration / time <p>Example of possible graph</p> 	<p>Accept this shown on a sketch graph</p> <p>Allow assumes that the reaction rate is constant for a particular run using conc v time graph as shown on left</p> <p>do not award just 'concentration is proportional to time'</p>	(1)

Question Number	Answer	Additional Guidance	Mark
3(d)(v)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> the portion need not be discarded and as the data is plotted on a graph, the actual volume of the BrO_3^- solution is not important (provided the (accurate) volume is known) (1) but the volume of water added must change from 7.0 cm^3 to 6.5 cm^3 (1) 	<p>Ignore references to experimental uncertainty</p> <p>Allow the portion need not be discarded and if the volume is known</p> <p>or the total volume of the solution must still be kept at 40 cm^3</p> <p>If no other mark is scored, 'portion should be discarded and because the total volume will have changed' scores (1)</p>	(2)

Question Number	Answer	Additional Guidance	Mark
3(e)(i)	<ul style="list-style-type: none"> the burette would transfer the liquid too slowly (so the start time would be inaccurate) 	<p>Accept reverse arguments</p> <p>Accept if a burette is used the reaction will start before all the KBrO_3 is added.</p> <p>Allow if a burette is used the reaction will start immediately so difficult to measure the time</p>	(1)

Question Number	Answer	Additional Guidance	Mark
4(a)	<ul style="list-style-type: none"> when the reagents are mixed an exothermic reaction occurs 	Allow just 'exothermic reaction' Ignore violent / vigorous Ignore 'to keep the mixture cool' Ignore 'to prevent evaporation' Ignore 'to slow the reaction' Ignore 'reference to equilibrium' Do not award explosive Do not award to prevent decomposition Do not award to quench the reaction	(1)

Question Number	Answer	Additional Guidance	Mark
4(b)	An answer that makes reference to the following points: <ul style="list-style-type: none"> concentrated sulfuric acid acting as a catalyst 	Allow speeds up the reaction / lowers the activation energy Ignore increases yield of ester / shifts equilibrium to the right / provides H ⁺ Do not award to initiate the reaction	(1)

Question Number	Answer	Additional Guidance	Mark
4(c)	<ul style="list-style-type: none"> calculation of mass of 5.0 cm³ of ethanoic anhydride (1) calculation of amount of ethanoic anhydride (1) calculation of amount of 2.00 g of 2-hydroxybenzoic acid and comparison (1) 	<p>Example of calculation:</p> <p>mass = 5.0 x 1.082 = 5.41 g</p> <p>mol ethanoic anhydride = 5.41 / 102 = 0.05304 / 5.304 x 10⁻² (mol)</p> <p>mol 2-hydroxybenzoic acid = 2 / 138 = 0.01449 / 1.449 x 10⁻² (mol)</p> <p>and 0.01449 < 0.05304</p> <p>Ignore SF</p> <p>Penalise incorrect rounding once only</p> <p>TE at each stage</p> <p>Allow alternative methods e.g.</p> <p>mol 2-hydroxybenzoic acid = 2 / 138 = 0.01449 (mol) (1)</p> <p>mass of min mol ethanoic anhydride = 0.01449 x 102 = 1.4783 g (1)</p> <p>vol of min mol ethanoic anhydride = 1.4783 ÷ 1.082 = 1.3662 cm³</p> <p>and 5 > 1.3662 (so ethanoic anhydride in excess) (1)</p>	(3)

Question Number	Answer	Additional Guidance	Mark
4(d)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> reflux condenser sealed (1) direction of water flow in condenser is incorrect (1) conical flask should not be used (1) 	<p>If additional errors are listed, mark these first</p> <p>Allow reflux condenser should be open (at top)</p> <p>Allow water should flow in through the bottom (and out through the top)</p> <p>Allow pear-shaped / round-bottom flask should be used</p> <p>Allow the answers as annotations on the diagram</p> <p>Do not award use of a thermometer</p>	(3)

Question Number	Answer	Additional Guidance	Mark
4(e)	<ul style="list-style-type: none"> to react with / remove excess ethanoic anhydride 	<p>Allow</p> <p>to dissolve excess ethanoic anhydride</p> <p>to dissolve / remove ethanoic acid</p> <p>to precipitate / crystallise the aspirin</p> <p>to improve yield of crystals</p> <p>Do not award quenches / stops the reaction</p> <p>Ignore just 'to cool the mixture'</p>	(1)

Question Number	Answer	Additional Guidance	Mark
4(f)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> • speed of filtration (1) • removal of water (1) 	<p>Example of answers</p> <p>faster</p> <p>drier product Allow dries product Allow removes more filtrate Ignore more efficient Do not award removes more impurity</p>	(2)

Question Number	Answer	Additional Guidance	Mark
4(g)	<p>A description that makes reference to the following points</p> <ul style="list-style-type: none"> • melting temperature determination (1) • melting temperature sharp and close to book value / 136°C (1) 	<p>M1 may be inferred from M2</p> <p>Allow melting point</p> <p>Do not award boiling temperature determination measurement of percentage yield. heat to constant mass</p> <p>Allow melting temperature sharp and compare to literature value</p> <p>Ignore descriptions of experimental method</p>	(2)

(Total for Question 4 = 13 marks)
Total for paper = 50 marks