Mark Scheme (Results)

January 2023

Pearson Edexcel International Advanced Level in Chemistry (WCH16)
Paper 01 Practical Skills in Chemistry II

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Using the mark scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit. ( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.

Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer. ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Question Number	Answer	Additional Guidance	Mark
1(a)	An answer that makes reference to the following points: • one correct ion **(1)** • two more correct ions **(1)**	 $[Cr(H_2O)_6]^{3+}$ / Cr^{3+}((aq)) $[Fe(H_2O)_6]^{2+}$ / Fe^{2+} ((aq)) $[Ni(H_2O)_6]^{2+}$ / Ni^{2+} ((aq)) $[V(H_2O)_6]^{3+}$ / V^{3+} ((aq)) Allow complex formulae without square brackets Ignore incorrect numbers of water ligands If names are given as well they must be correct Do not award $[Cr(H_2O)_6]^{2+}$ / Cr^{2+}	**(2)**

Question Number	Answer	Additional Guidance	Mark
1(b)(i)	• $Fe(OH)_2$ / $Fe(H_2O)_4(OH)_2$	Allow $[Fe(H_2O)_4(OH)_2]$ Allow $Fe(OH)_2.4H_2O$ Allow ligands in either order Allow iron(II) hydroxide If the name is given as well it must be correct Ignore state symbols, even if incorrect Do not award Fe^{2+}	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(b)(ii)	• $[Cr(OH)_6]^{3-}$	Allow $Cr(OH)_6^{3-}$	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(c)(i)	• redox / oxidation	Do not award just reduction	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(c)(ii)	• $Cr_2O_7^{2-}$ / dichromate(VI) / dichromate	Do not award potassium / sodium dichromate((VI)) / $K_2Cr_2O_7$ / $Na_2Cr_2O_7$ If the oxidation numbers are given they must be correct	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(c)(iii)	• (wear/use) gloves **(1)**	Allow safety / protective gloves Ignore additional precautions such as the use of tongs, carrying out the reaction on a small scale, prevent contact with the skin Ignore nitrile Ignore dilute the acid	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(c)(iv)	A description that makes reference to the following points: • **two** test tube with drops coming from them **(1)** • a hand **and** a piece of metal / wood / description of the rectangle with bits missing **(1)**	Marks may be scored by a drawing of the hazard symbol No mention need be made of the red border or the overall shape of the sign Allow any container e.g. beaker, round bottomed flask The piece of metal / wood could be described in many ways  If no other mark awarded one test tube, with drops, and either a hand or block scores (1)	**(2)**

Question Number	Answer	Additional Guidance	Mark
1(d)(i)	An answer that makes reference to the following points: • chloride (ion) / Cl^- **and** bromide (ion) / Br^-	Allow chlorine ion and bromine ion Allow in either order Ignore state symbols Do not award just chlorine / bromine Do not award iodide / I^- Do not award iodine Do not award HCl / HCl^- / HBr / HBr^-	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(d)(ii)	An answer that makes reference to the following points: • silver chloride is soluble in dilute ammonia **(1)** • silver bromide is insoluble in dilute ammonia OR silver bromide is soluble in concentrated ammonia **(1)**	Penalise use of just chloride / bromide once only Penalise the omission of dilute in M1 only Any reagent other than ammonia will not score Allow precipitate with chloride is soluble in dilute ammonia Do not award just chlorine Allow precipitate with bromide is insoluble in dilute ammonia Allow sparingly soluble for insoluble Do not award just bromine Ignore reference to colours of precipitate even if incorrect	**(2)**

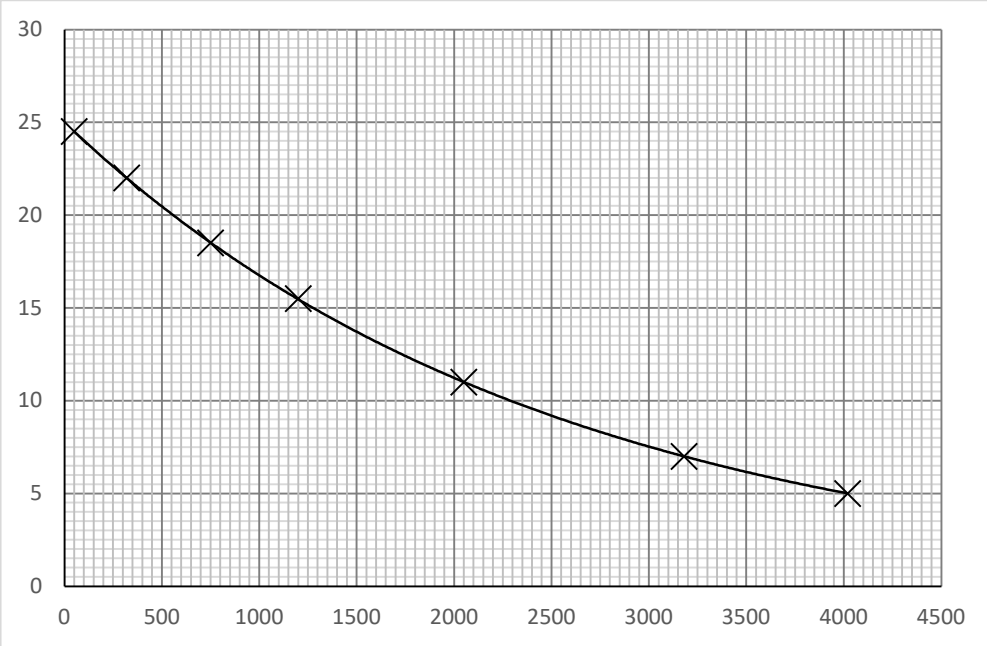
Question Number	Answer	Additional Guidance	Mark
1(d)(iii)	An explanation that makes reference to the following points: • because a green precipitate is formed **(1)** • which does not redissolve in excess ammonia OR and so the dissolving / behaviour of the silver halide precipitate is obscured **(1)**	Ignore the ammonia will react with nitric acid in the solution Allow brown precipitate / ppt / ppte / solid Allow just 'formation of a green precipitate' Allow just 'Fe^{2+} (ions) form a precipitate' Allow $Fe(OH)_2$ / iron(II) hydroxide / $Fe(H_2O)_4(OH)_2$ is formed Ignore incorrect formulae including incorrect metal ions, e.g. Chromium complexes Allow TE on a different coloured precipitate (e.g. white) Allow more than one precipitates makes it hard to see dissolving / identify the anion Ignore just 'interfere with the result' Answer must include a comment regarding dissolving or behaviour of the precipitate, not just 'make it hard to investigate' or 'the results are not clear'	**(2)**

(Total for Question 1 = 14 marks)

Question Number	Answer	Additional Guidance	Mark
2(a)(i)	An answer that makes reference to the following point: • yellow to orange	Do not award yellow to red	**(1)**

Question Number	Answer	Additional Guidance	Mark
2(a)(ii)	An explanation that makes reference to the following points: • because propanone does not completely stop the reaction / the reaction continues (but at a slower rate) **(1)** • the volume of hydrochloric acid will reduce / will decrease / be smaller **(1)**	Ignore reference to temperature Allow no change because propanone stops the reaction for 1 mark	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(a)(iii)	An explanation that makes reference to the following points: • ethanol is a co-solvent / dissolves the 2-chloro-2-methylpropane and the sodium hydroxide / dissolves both reagents **(1)** • so the use of ethanol allows the reactants to mix together (and more collisions to occur) Or so the reactants can only meet at the junction between the layers / cannot mix together in the same solution (and fewer collisions occur) **(1)**	Marks are stand alone Allow 2-chloro-2-methylpropane is immiscible with water Ignore just 'ethanol is a solvent' Do not award ethanol acts as a catalyst Do not award ethanol provides OH^- ions Ignore all reference to intermolecular forces / hydrogen bonds Ignore answers related to increasing rate without justification in terms of improved mixing	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(b)(i) Clip all of 2(b)	ADD LABELS **(1)** **(1)** • 7 points plotted to within ½ square on a graph with sensible scale covering at least 50% in both directions • curved line of best fit should pass through or **very** close to all points	<u>Example of graph</u>  Allow axes with the x axis starting at 50 and the y axis at 5. Should be within a small square of each point if plotted correctly	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(b)(ii) Clip all of 2(b)	An answer that makes reference to the following points • determination of first half-life from the graph either by extrapolation to 0s or by use of points on the curve **(1)** • determination of second half-life from the graph **(1)**	Allow one number if the graphs show the half-life would be the same. 1750 s Allow a value in the range 1650 to 1850(s) NOTE: Accept any value in this range on a reasonable curve on the graph regardless of method Consequential on the graph 3500 – 1750 = 1750 s Allow any value in the range 1650 to 1850 Consequential on the graph Correct answers with no working on the graph scores 1. Values may be shown on the graph	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(b)(iii) Clip all of 2(b)	An answer that makes the following point: • the reaction is first order because the half-lives are the same / similar	Allow a difference in half-lives of ± 150s as similar If the second half-life is roughly double the first (± 150s and in the range 3350 to 3650 s) allow the reaction is first order because half-lives are similar / the same	**(1)**

(Total for Question 2 = 10 marks)

Question Number	Answer	Additional Guidance	Mark
3(a)(i)	An answer that makes reference to the following point: • (if the mixture was not acidified) manganate(VII) ions would only be partially reduced OR (if the mixture was not acidified brown) MnO_2 / brown precipitate would be formed	Ignore manganate(VII) ions cannot be reduced Allow will form MnO_4^{2-}	**(1)**

Question Number	Answer	Additional Guidance	Mark
3(a)(ii)	An answer that makes reference to the following points: • hydrochloric acid / Cl^- (ions) would be oxidised by manganate(VII) (ions) **(1)** • nitric acid would oxidise iron(II) (ions to iron(III) ions) / would be reduced by the iron(II) (ions) **(1)**	Allow reacts (with manganate(VII) (ions)) to from chlorine If no other mark is awarded allow HCl will react with manganate(VII) (ion) and HNO_3 will react with iron(II) (ions) scores (1) Ignore comments which do not link the acid to what they would react with such as 'these acids could react with Fe^{2+}'	**(2)**

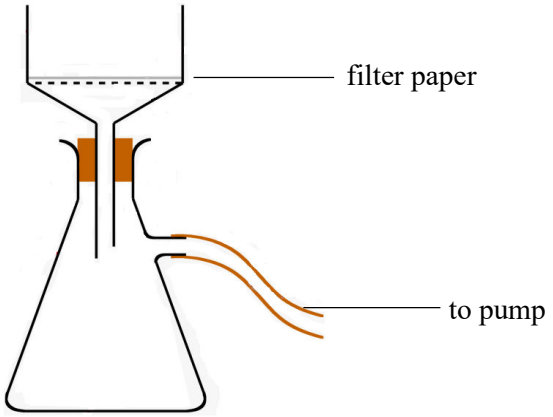
Question Number	Answer		Additional Guidance	Mark
3(b)			Example of calculation	**(4)**
	• calculation of moles of $KMnO_4$	**(1)**	$\frac{40.35}{1000} \times 0.0200 = 0.000807 / 8.07 \times 10^{-4}$ (mol)	
	• calculation of moles of Fe^{2+}	**(1)**	$0.000807 \times 5 = 0.004035 / 4.035 \times 10^{-3}$ (mol)	
	• calculation of mass of Fe^{2+}	**(1)**	$0.004035 \times 55.8 = 0.22515 / 0.225$ (g)	
	• calculation of percentage by mass	**(1)**	$\frac{0.225}{4.50} \times 100 = 5.0034 / 5.00$ (%)	
			Ignore SF throughout Final answer with some working scores (4)	

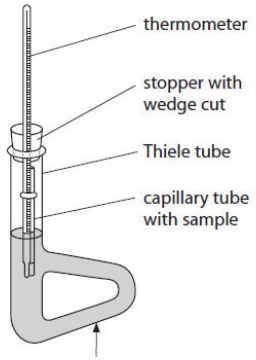
Question Number	Answer	Additional Guidance	Mark
3(c)	An answer that makes reference to **three** of the following points: • add (potassium manganate(VII)) drop by drop (close to the end-point) **(1)** • swirl / shake / stir the conical flask or mix the reagents in the conical flask **(1)** • place a white tile (underneath the conical flask to help see the colour change) **(1)** • place paper / card behind the burette (to help read the volume of solution in the burette) **(1)** • rinse the conical flask / the tip of the burette with deionised water (to wash in all reactants) **(1)**	Ignore additional practical points even if incorrect Allow any shake etc. continuous or occasional e.g near the end-point, or once the first permanent pink is seen. Allow any use of white background (e.g. white walls)	**(3)**

(Total for Question 3 = 10 marks)

Question Number	Answer	Additional Guidance	Mark
4(a)	An answer that makes reference to the following points: • (heating is required) to increase the rate of the reaction / or (without heating) the reaction is too slow / does not have a reasonable rate **(1)** • (a condenser is used to) prevent the **escape** of (volatile / low boiling / flammable) compounds **(1)**	Allow to give complete reaction Ignore comments about yield without link to complete reaction Ignore without heat the reaction cannot happen Allow gaseous Allow other specific hazards e.g toxic Allow prevent the evaporation of Allow reactants / products / any single reactant / any single product / mixture / chemicals / solvent instead of compounds Ignore so the solutions / reactions does not come out of the flask / spill / leak Ignore to prevent burning unless linked to loss of flammable substances	**(2)**

Question Number	Answer	Additional Guidance	Mark
4 (b)	An explanation that makes reference to the following points: • because the reaction between ethanoyl chloride and water is vigorous **(1)** • this prevents rapid evolution of (toxic) HCl gas / loss of volatile substances **(1)**	Allow the reaction is (very) exothermic Allow the reaction is violent Allow dissolving of HCl is (very) exothermic Allow this prevents rapid / uncontrolled production of bubbles / effervescence Ignore to avoid spitting Ignore causing an explosion Ignore cracking of glassware	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(c)	• Büchner flask with a side arm connected to a **labelled** pump / aspirator **(1)** • Büchner funnel with porous base **(1)** • **labelled** flat filter paper and apparatus which is sealed except for (the pump and) the funnel **(1)**	<u>Example of diagram</u>  pump or aspirator should be shown and labelled or the connecting tube labelled (as above). Allow an arrow labelled 'pump' or 'to vacuum pump' pointing either way Allow vacuum No label required for flask Do not award other glassware e.g. round-bottomed flask with side arm attached Allow just 'filter' or just 'paper'?	**(3)**

Question Number	Answer	Additional Guidance	Mark
4(d)(i)	• crystals in a labelled capillary tube sealed at one end **(1)** • tube (strapped to) labelled thermometer with the crystals at the bulb in a boiling tube or Thiele tube containing oil / a liquid with level at the top of or above the sample but below the top of the capillary tube **(1)**	<u>Example of diagram</u>  Allow a description of a capillary tube, e.g. thin bore glass tube Allow an unlabelled tube that is up to a similar diameter to the thermometer Allow 'melting point tube' Allow tube Do not award test tube Allow the crystals at the same height as the thermometer bulb. Allow thermometer and capillary tube with sample in a piece of apparatus labelled as melting point apparatus Allow any heating bath Allow water as the liquid Allow any suitable container (e.g beaker) for the oil Do not award equipment which will not hold the mineral oil	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(d)(ii)	An answer that makes reference to the following points: • it's pure if the melting temperature range is narrow / sharp **(1)** • the melting temperature (range) should match the melting temperature of the compound in a table of data **(1)**	Allow arguments about melting point of impure samples References to only boiling temperature score 0. Allow 'close to the book value' Allow melting temperature is the same as a pure sample	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(e)	Either • calculation of number of moles of 2-aminobenzoic acid **(1)** • calculation of number of moles of ethanoyl chloride Or • calculation of number of moles of 2-aminobenzoic acid **(1)** • calculation of required volume of ethanoyl chloride	<u>Example of calculation</u> $\frac{5.00}{137}$ = 0.0365 / 0.036496 / 3.65×10^{-2} / 3.6496×10^{-2} / 0.036 (mol) (ans 1) Do not award 0.037 (mol) $\frac{10 \times 1.1}{78.5}$ = 0.140 / 0.14013 (mol) (ans 2) $\frac{5.00}{137}$ = (0.0365 / 0.036496 / 3.65×10^{-2} / 3.6496×10^{-2} / 0.036) (mol) (ans 1) (0.0365 x 78.5) ÷ 1.1 = 2.6048 / 2.60 cm^3 N.B. Using this method it is not necessary to see the value for moles of 2-aminobenzoic acid since the final comparison is in volume, not moles. Ignore any statement relating to the excess Ignore SF except 1 SF	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(f)	• calculation of M_r of 2-ethanoylaminobenzoic acid **(1)** Either • calculation moles of 2-ethanoylaminobenzoic acid obtained **(1)** • calculation of mass of 2-ethanoylaminobenzoic acid **(1)** Or • calculation of maximum mass of 2-ethanoylaminobenzoic acid **(1)** • calculation of actual mass obtained **(1)**	<u>Example of calculation</u> M1 is stand alone. Other methods may be possible. $(12 \times 9) + (1 \times 9) + 14 + (16 \times 3) = 179$ (g mol^{-1}) OR 137 + 78.5 – 36.5 = 179 (ans 1) ((4(e)(ans 1)) × 56.7) ÷ 100 = (0.0365 × 56.7) ÷ 100 = 0.0207 / 0.020693 / 2.07×10^{-2} / 2.0693×10^{-2} (mol) (ans 2) (ans 1) × (ans 2) = 0.0207 × 179 = 3.7041 (g) 179 × (4(e)(ans 1)) = 179 × 0.0365 = 6.5335 (g) (ans 3) 56.7 × (ans 3) ÷ 100 = 56.7 × 6.5335 ÷ 100 = 3.7045 / 3.70 (g) If the moles of ethanoyl chloride is used instead of 2-aminobenzoic acid this gives a final mass of 14.2g scores 2 Correct answer with some working scores 3 Allow TE throughout including on answer to 4(e) Ignore SF except 1 SF	**(3)**

(Total for Question 4 = 16 marks)

Total for Paper = 50 marks)

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