Mark Scheme (Results)

Summer 2022

Pearson International Advanced Subsidiary Level In Chemistry (WCH13)

Paper 01: Practical Skills in Chemistry I

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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.

Using the mark scheme

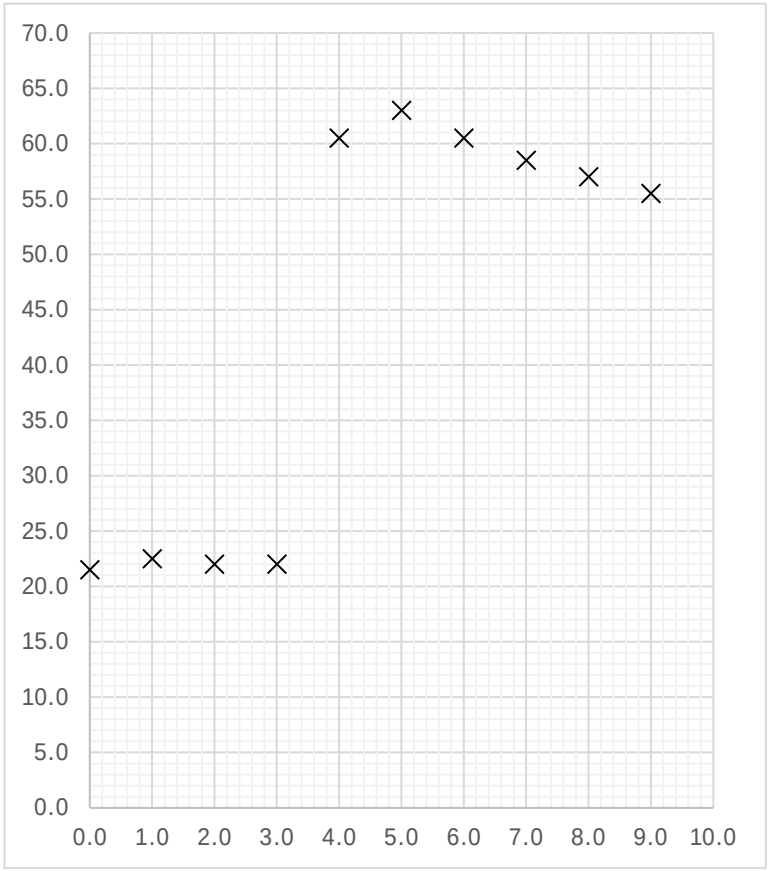
Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read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

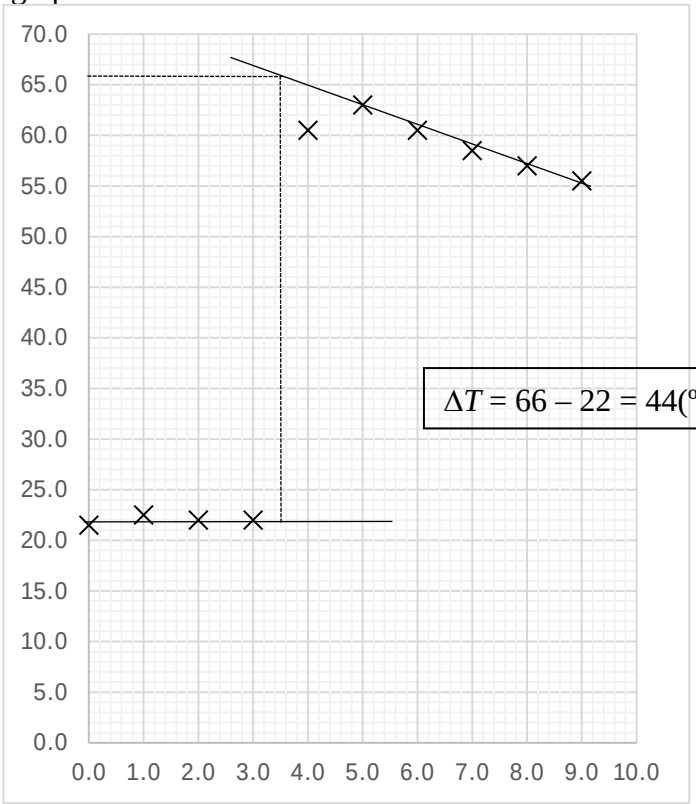
The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ 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)(i)	• All ten points plotted accurately to within half a square	Example of graph  Ignore in this item extension of lines beyond the points or any additional lines (e.g. linking the two lines together)	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(a)(ii)	• straight line of best fit linking the top points **(1)** • use of 3.5 minutes to find ΔT **(1)** • value of ΔT correct from values on a vertical line shown on the graph **(1)**	Example of graph  Allow a best fit line through points at 6, 7 and 8 or through 8, 9 and 10 and anything in between. (6, 7 and 8 gives 67 ºC, 8, 9 and 10 gives 63.5 ºC) Ignore additional lines linking the two lines of best fit other than a vertical line showing where the temperature change is being read.	**(3)**

Question Number	Answer	Additional Guidance	Mark
1(a)(iii)	An answer that makes reference to the following points: • the reaction is not instantaneous so the best fit line allows for the effect of cooling (during the reaction) OR initial line takes into account changes in temperature of the solution prior to reaction	Allow just deals with the effect of cooling Allow just reaction is not instantaneous Allow takes account of heat loss Allow multiple measurements give a trend of temperature change (over time) Ignore gives a calculation of more accurate final temperature / temperature change Ignore just gives a more accurate / better result Ignore anomaly / anomalous	**(1)**

Question Number	Answer	Additional Guidance	Mark
1 (b)(i)	• calculation of moles of zinc **(1)** • calculation of moles of copper(II) sulfate (so zinc is in excess) **(1)**	Example of calculation = $\frac{4.5}{65.4}$ = 0.068807 / 0.0688 / 6.8807 × 10^{-2} / 6.88 × 10^{-2} / 0.07 (mol) = $\frac{50}{1000}$ × 1.0 = 0.0500 / 5.0 × 10^{-2} (mol) Allow calculations finding required mass of zinc or volume of copper(II) sulfate to match the number of moles of the other substances and showing zinc is therefore in excess Allow use of 65 for Ar of Zn Ignore any justification of excess Ignore SF Correct answers with no working score (2)	**(2)**

Question Number	Answer	Additional Guidance	Mark
1(b)(ii)	• calculation of energy transferred	Example of calculation = 50 × 4.2 × ΔT (from (a)(ii)) = 50 × 4.2 × 44 = 9240 / 9.24 x 10^3 (J) Allow 9.24 kJ but units must be given Allow use of 4.18 for 4.2 Allow TE on answer to (a)(ii) Do not award answers using 54.5/4.5 in place of 50 Do not award incorrect units e.g kJ mol^{-1} Ignore sign Ignore SF except 1 SF Correct answer with no working scores (1)	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(b)(iii)	An answer that makes reference to one of the following points • heat capacity of the metal / zinc / copper / polystyrene cup can be ignored / is zero Or • the density of the solution is 1 g cm^{-3} / the same as water	Allow the metal / thermometer does not absorb heat energy Allow the mass of the metal can be ignored Allow use of specific heat capacity Allow 1g = $1cm^3$ Ignore the mass of solution is the same as the mass of water Ignore no heat loss Do not award just density = 1 (with no unit)	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(b)(iv)	• calculation of value for energy transferred per mole **(1)** • calculation of enthalpy change including sign **(1)**	Example of calculation Allow TE on (b)(i) and (b)(ii) and at each stage = $\frac{\text{answer to (b)(ii)}}{\text{moles of copper(II) sulfate from (b)(i)}}$ = $\frac{9240}{0.0500}$ = 184800 / 185000 (J mol^{-1}) = $-\frac{184800}{1000}$ = –184.8 / 185 (kJ mol^{-1}) Allow answer in J mol^{-1} if unit given Ignore SF except 1SF Correct answer with no working scores 2	**(2)**

Question Number	Answer	Additional Guidance	Mark
1(c)	An answer that makes reference to two of the following improvements and justifications • place a lid on the polystyrene cup **and** to reduce heat loss **(1)** • measure the temperature more often **and** to give a more precise extrapolation (maximum temperature change) **(1)** • use a pipette / burette (to measure the solution) **and** less uncertainty (in volume measurement) Or use a thermometer with more gradations / more precise thermometer **(1)** **and** to give a more precise temperature change	Ignore just 'better insulation' Ignore read the temperature for longer Allow more accurate extrapolation / line of best fit Ignore just to increase the accuracy Allow to measure the temperature with more precision (i.e with no mention of thermometer). Allow use a digital thermometer Ignore finer zinc powder Ignore use a larger mass / excess of zinc Ignore more concentrated solution If no other mark scored award 1 for two correct improvements of the four given Do not award repeating the experiment Do not award more accurate weighing	**(2)**

(Total for Question 1 = 13 marks)

Question Number	Answer	Additional Guidance	Mark
2(a)	• calculation of moles of hydrochloric acid **(1)** • calculation of moles of $MHCO_3$ in 250 cm^3 **(1)** • calculation of relative formula mass of $MHCO_3$ **(1)** • calculation of A_r of M to 2 decimal places **(1)**	Example of calculation $= \frac{13.35}{1000} \times 0.150 = 0.0020025 / 0.00200 / 2.0025 \times 10^{-3} / 2.00 \times 10^{-3}$ (mol) (ans 1) = ans (1) × 10 = 0.020025 / 0.0200 / 2.0025 × 10^{-2} / 2.00 × 10^{-2} (mol) (ans 2) $= \frac{\text{mass of } MHCO_3}{\text{ans (2)}} = \frac{2.00}{0.020025} = 99.88$ (g mol^{-1}) (ans 3) = ans (3) - 1 - 12 – 48 = 38.88 (g mol^{-1}) Allow for M2 and M3 mass of $MHCO_3$ ÷ 10 and then ÷ (ans 1) Allow TE at each stage Allow use of 25cm^3 giving relative formula mass = 53.33 scores (2) for M2 and M3 as 61 cannot be subtracted from it Correct answer with some working scores 4 Ignore SF except 1SF	**(4)**

Question Number	Answer	Additional Guidance	Mark
2(b)(i)	• calculation of experimental error	Example of calculation = $\frac{39.1 - 37.52}{39.1} \times 100 = 4.04 / 4.0 / 4$ % Allow = 39.1 - 37.52 = 1.58 with no further working Allow 4.04 / 4.0 with no working scores 1 Do not award just 4% with no working Do not award = $\frac{39.1 - 37.52}{37.52} \times 100 = 4.21$ %	**(1)**

Question Number	Answer	Additional Guidance	Mark
2(b)(ii)	An answer that makes reference to the following points: • calculate the experimental difference **(1)** Either • calculation of the range **(1)** • comment on the range in relation to the value of 39.1 **(1)** or • calculation of highest possible value **(1)** • comment on the value 39.1 being between the highest value and the mid-point of the range **(1)**	Example of calculation $37.52 \times 4.50 \div 100 = 1.6884$ $37.52 \pm 1.6884 = 35.832$ to 39.208 / potassium lies within this range $37.52 + 1.6884 = 39.208$ 39.1 lies between 37.52 and 39.208 Use of $39.1 \pm 1.7595 = (40.8595$ to) 37.3405 can score M1 and M2 but cannot score M3. Use of $39.1 - 1.7595 = 37.52$ can score M1 and M2 (similar to 'or') Allow a correct application of uncertainty to an incorrect value can score M2 and M3	**(3)**

Question Number	Answer	Additional Guidance	Mark
2(b)(iii)	An explanation that makes reference to the following points: • increasing the mass of $MHCO_3$ / decrease the concentration of HCl **(1)** • gives a larger titration volume (so smaller percentage uncertainty **(1)**	Accept use a larger aliquot / sample / larger volume of $MHCO_3(aq)$ Ignore reading the meniscus at eye level Ignore reading the bottom of the meniscus Dependent on M1 or a near miss	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(b)(iv)	An answer that makes reference to the following points: • use of volumetric flask **(1)** Route 1 • dissolve solid (in a beaker/conical flask) in distilled / deionised water **(1)** • pour (the solution into the volumetric flask using a funnel) **with** washings **(1)** • make (the volumetric flask) up to the mark / 250 cm^3 **and** shake **(1)** Route 2 • transfer solid (to the volumetric flask) **and** dissolve in distilled / deionised water **(1)** • Add washings from the container **(1)** • make (the volumetric flask) up to the mark / 250 cm^3 **and** shake **(1)**	Allow standard flask / graduated flask Volume if stated must be less than 250 cm^3 Allow any indication of swirling, stirring, inverting Volume if stated must be less than 250 cm^3 Allow weigh the container before and after (so mass of solid is known) in place of washing Allow any indication of swirling, stirring, inverting	**(4)**

Question Number	Answer	Additional Guidance	Mark
2(c)(i)	An answer that makes reference to the following points: • flame test **(1)** • lilac flame **(1)**	Ignore descriptions of the flame test Do not award other tests in addition to flame test Do not award pink / purple / mauve Ignore the result of additional tests	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(c)(ii)	An answer that makes reference to the following points: • **dissolve** in deionised / distilled water and add (dilute) nitric acid **(1)** • add silver nitrate (solution) **(1)** • white precipitate **(1)** Or • addition of **concentrated** sulfuric acid **(1)** • formation of (only) steamy fumes **(1)** • damp blue litmus turns red / white smoke with ammonia **(1)**	Accept **dissolve** in (dilute) nitric acid Accept form a solution for dissolve Do not award just water Independent of M1 Dependent on M2 Ignore use of ammonia solution for confirmation Allow white fumes Do not award white smoke	**(3)**

(Total for Question 2 = 19 marks)

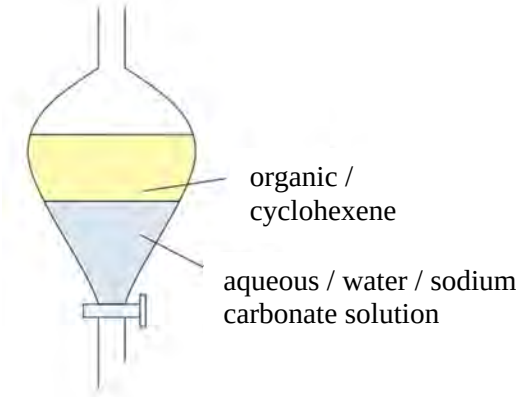
Question Number	Answer	Additional Guidance	Mark
3(a)	An answer that makes reference to the following point • measuring cylinder	Do not award pipette, beaker Ignore burette Ignore numbers or volumes before the measuring cylinder e.g. $10cm^3$ measuring cylinder Do not award measuring cup / jug	**(1)**

Question Number	Answer		Additional Guidance	Mark
3(b)	An answer that makes reference to the following points: • the reaction is exothermic • cyclohexene would be lost because it is volatile / has a low boiling temperature / evaporate	**(1)** **(1)**	Do not award explosive Allow less of the cyclohexene / product produced would be lost / would boil off Allow to prevent / reduce reaction before the distillation experiment takes place Ignore swirling to mix the reactants Ignore prevents evaporation of volatile liquids Ignore too vigorous Ignore references to shifting the position of equilibrium or rate of reaction Ignore increase yield Ignore prevents evaporation / boiling of cyclohexanol / solution	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(c)	An explanation that makes reference to the following points: • so the product is not contaminated by the reaction mixture / cyclohexanol being transferred to the collecting flask	Allow so the reaction mixture / cyclohexanol does not go into the condenser / collecting flask Ignore just to prevent it boiling over Do not award to prevent ignition	**(1)**

Question Number	Answer	Additional Guidance	Mark
3(d)	An explanation that makes reference to the following points: • the range starts below the boiling temperature of cyclohexene and finishes below that of water / cyclohexanol **(1)** • a minimum amount of cyclohexanol / water / phosphoric acid / impurities are distilled across Or so cyclohexene vaporising below the boiling temperature is collected **(1)**	Allow only cyclohexene boils within this range / between 80ºC and 90ºC Ignore statements of the range and boiling temperatures without explanation Allow above this range (more) water (and cyclohexanol) would distil across / would be collected Allow cyclohexanol / water will remain in the flask / will not be vapourised	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(e)(i)	An answer that makes reference to the following points: • phosphoric((V)) acid / H_3PO_4 **(1)** • equation **(1)**	Allow (excess) acid Ignore (excess) H^+ ions $2H^+ + CO_3^{2-} \rightarrow CO_2 + H_2O$ Allow $2H^+ + CO_3^{2-} \rightarrow H_2CO_3$ Allow multiples Ignore state symbols, even if incorrect	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(e)(ii)	An answer that makes reference to the following points • diagram of separating funnel including a tap and a stopper or capable of being stoppered **(1)** • two labelled layers **(1)**	 Top layer labelled organic layer, bottom layer labelled aqueous layer Ignore cyclohexanol in cyclohexene layer Do not award bottom layer labelled as cyclohexanol but allow labelled as aqueous layer containing cyclohexanol / water and cyclohexanol	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(e)(iii)	An answer that makes reference to the following point • ionic compounds / cyclohexanol / sodium phosphate((V))	Allow (excess) sodium carbonate Allow sodium ions / phosphate((V)) ions / carbonate ions Ignore water Ignore just 'impurities' Do not award phosphoric((V)) acid Do not award HCl / hydrochloric acid	**(1)**

Question Number	Answer	Additional Guidance	Mark
3(f)	An answer that makes reference to the following points: • $MgSO_4$ **(1)** • it is an anhydrous (salt) (and doesn't react) **(1)**	Allow contains no water / not hydrated Allow reasons why the other five are not suitable M2 depends on M1	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(g)(i)	An answer that makes reference to the following points: • bromine water / $Br_2(aq)$ / bromine solution **(1)** • orange to colourless **(1)** Or • potassium manganate(VII) / $KMnO_4$ and sulfuric acid • purple to colourless	M2 dependent on M1 or near miss Allow bromine / $Br_2(l)$ / Br_2 Do not award bromide Allow decolourises bromine / bromine water Allow brown to colourless Allow yellow to colourless If bromine is used do not award yellow / orange to colourless. M2 must be brown/red-brown to colourless Allow potassium permanganate Allow acidified potassium manganate(VII) Do not award hydrochloric acid Allow purple to brown Allow decolourises	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(g)(ii)	An answer that makes reference to the following points: • (addition of) phosphorus pentachloride / phosphorus(V) chloride / PCl_5 **(1)** • misty / steamy fumes (of HCl) **(1)** Or • (addition of) sodium **(1)** • effervescence / bubbles **(1)**	M2 dependent on M1 or near miss Do not award potassium dichromate((VI)) Do not award phosphorus chloride but count as near miss Allow white fumes Ignore litmus paper test on fumes Do not award white gas Allow white solid formed Allow ester formation addition of a carboxylic acid / named carboxylic acid **and** a strong acid / mineral acid / named strong acid / formula of strong acid (1) sweet / fruity smell (of ester) (1)	**(2)**

Question Number	Answer	Additional Guidanc2e	Mark
3(g)(iii)	An answer that makes reference to the following points: • (no because) PCl_5 / Na reacts with water (so would potentially give a false positive test) **(1)**	Allow yes with or without justification if ester formation is used in 3(g)(ii)	**(1)**

(Total for Question 3 = 18 marks)

(Total for Paper = 50 marks)

Pearson Education Limited. Registered company number 872828
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