

Question 4 (Answer: B)

- Moles: $\text{CH}_4 = 0.80/16.0 = 0.050$; $\text{H}_2\text{O} = 1.35/18.0 = 0.075$.
- 0.050 mol of methane would need 0.100 mol of steam, so the steam is the limiting reagent.
- 0.075 mol H_2O gives $0.075 \times 4/2 = 0.15$ mol H_2 , which is $0.15 \times 24 = 3.6 \text{ dm}^3$.

Question 4 (Answer: B)

- NaOH: $0.0250 \times 2.0 = 0.050$ mol, and with one COOH group the acid is 0.050 mol too.
- $M_r = 4.4/0.050 = 88$, which matches the *molecular* formula $\text{C}_4\text{H}_8\text{O}_2$.
- But the question asks for the *empirical* formula, so divide through by 2: $\text{C}_2\text{H}_4\text{O}$.

1(a)	I The following data are recorded: • two burette readings AND titre for the rough titration • initial and final burette readings for two (or more) accurate titrations
	II Titre values recorded for accurate titrations, AND Correct headings and units in the accurate titration table • initial / start AND (burette) reading / volume • final / end AND (burette) reading / volume • titre OR volume used/added/ OR FA 2 used/added • unit: / cm^3 OR (cm^3) OR in cm^3 (for each heading) OR cm^3 unit given for each volume recorded.
	III All accurate burette readings recorded to 0.05 cm^3
	IV The final accurate titre recorded must be within 0.10 cm^3 of any other accurate titre
	Accuracy (Q) marks Round burette readings to the nearest 0.05 cm^3 . Check and correct titre subtractions where necessary. Examiner selects the best mean titre, using the following hierarchy: • two (or more) accurate identical titres (ignoring any that are labelled 'rough'), <i>then</i> • two (or more) accurate titres within 0.05 cm^3, <i>then</i> • two(or more) accurate titres within 0.10 cm^3, <i>etc.</i> Calculate the candidate's mean titre value Calculate the supervisor's mean titre value Calculate the difference (δ) between the candidate's mean titre and the supervisor's mean titre

Award accuracy Q marks as follows:	
V	Award if $\delta \leq 0.50 \text{ cm}^3$
VI	Award if $\delta \leq 0.30 \text{ cm}^3$
VII	Award if $\delta \leq 0.20 \text{ cm}^3$

1(b)	Correctly calculates mean titre to 2 dp • Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm^3. • Working/explanation must be shown OR ticks must be put next to the two (or more) accurate readings selected. • The mean should be quoted to 2 dp and be rounded to nearest 0.01 cm^3. (e.g. 26.675 cm^3 must be rounded to 26.68 cm^3)
1(c)(i)	All answers to (c)(ii), (c)(iii) and (c)(iv) to 3 – 4 sf
1(c)(ii)	Correctly calculates amount of manganate(VII) = $0.02 \times \text{volume in (b)} / 1000 \text{ mol}$
1(c)(iii)	Correctly uses M1 Amount of ethanedioic acid = (c)(ii) $\times 5 / 2 \text{ mol}$ M2 Concentration of FA 1 = (c)(ii) $\times 5 / 2 \times 1000 / 25 \text{ mol dm}^{-3}$
1(c)(iv)	Correctly uses $M_r = 6.2(0) / \text{(c)(iii)}$
1(c)(v)	$(M_r - 90) / 18$ AND correctly calculates answer as integer
1(d)	H^+ needed in the reaction / H^+ used in / appears in the equation

2(a)	I Six correct headings with units in results space • (Mass) crucible + lid / g • (Mass) crucible + lid + FA 4 / g • (Mass) crucible + lid + residue / contents after first heating / g • (Mass) crucible + lid + residue after second heating / g • (Mass) FA 4 (used) / g • (Mass) residue / g Display of units: / g, (g), in g, in gram(me)s or in (column) heading covering all entries
	II Four readings in space provided • All four weighings recorded to same decimal places (either to two or to three) • Reading after 2nd heating within + 0.02 and – 0.05 of reading after 1st heating
	II Correct subtractions • Correct calculations of mass FA 4 and residue AND • Mass of FA 4 is between 2.90 and 3.40 g.
	IV and V Accuracy Theoretical value = 1.78 Calculate and record candidate's mass ratio = mass FA 4 / mass of residue. Award IV if $1.51 \leq \text{candidate's mass ratio} \leq 2.05$ Award V if $1.60 \leq \text{candidates mass ratio} \leq 1.96$

2(b)(i)	Correctly uses M1 Amount ZnSO_4 = mass residue / 161.5 mol AND answer given to 2 – 4 sf Correctly calculates M2 Amount H_2O = mass water lost / 18 mol AND answer given to 2–4 sf
2(b)(ii)	M1 $y = \text{moles H}_2\text{O} / \text{moles ZnSO}_4$ M2 Expression evaluated and y correctly calculated quoted as integer
2(c)	The (anhydrous ethanedioic) acid would decompose (on heating) / is flammable

2(a)	I All the following data are recorded - two burette readings AND titre for the rough titration - initial and final burette readings for two (or more) accurate titrations II Titre values recorded for accurate titrations, AND Correct headings and units in the accurate titration table - initial / start AND (burette) reading / volume - final / end AND (burette) reading / volume - titre OR volume used / added / or FB 5 used / added - unit: / cm^3 OR (cm^3) OR in cm^3 (for each heading) OR cm^3 unit given for each volume recorded. III All accurate burette readings are recorded to the nearest 0.05 cm^3. IV: The final accurate titre recorded is within 0.10 cm^3 of any other accurate titre Accuracy (Q) marks Round burette readings to the nearest 0.05 cm^3. Check and correct titre subtractions where necessary. Select the best mean titre, using the following hierarchy: - two (or more) accurate identical titres (ignoring any that are labelled 'rough'), <i>then</i> - two (or more) accurate titres within 0.05 cm^3, <i>then</i> - two (or more) accurate titres within 0.10 cm^3, <i>etc</i> Calculate the candidate's mean titre value. Calculate the supervisor's mean titre value. Calculate the difference (δ) between the candidate's mean titre and the supervisor's mean titre. Award accuracy Q marks as follows: V award if $\delta \leq 0.60 \text{ cm}^3$ VI award if $\delta \leq 0.40 \text{ cm}^3$ VII award if $\delta \leq 0.20 \text{ cm}^3$
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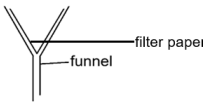
2(b)	Correctly calculates mean titre to 2 d.p. - Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm^3. - Working / explanation must be shown OR ticks must be put next to the two (or more) accurate readings selected. - The mean should be quoted to 2 d.p. and rounded to nearest 0.01 cm^3.
2(c)(i)	Final answers to both parts (c)(ii) and (c)(iii) quoted to 3 or 4 sf.
2(c)(ii)	Correctly calculates amount of $\text{HCl} = 0.2 \times (\mathbf{b}) / 1000$ (mol) AND gives same answer for amount of NaHCO_3
2(c)(iii)	Correctly uses mass of $\text{NaHCO}_3 = (\mathbf{c})(\text{ii}) \times 40 \times 84(.0)$ (g) Correctly uses percentage by mass = $[(17.20 - \text{mass of NaHCO}_3) / 17.20] \times 100$ OR percentage by mass = $100 - [(\text{mass of NaHCO}_3 / 17.20) \times 100]$
2(d)	M1: (ΔH_f) smaller / less positive (for impure NaHCO_3) M2: Impurity does not react with the acid / FB 5

1(a)(i)	2.12 g
1(a)(ii)	M1 add a (small) volume of (distilled) water (to the small beaker) AND dissolve the solid / AgNO_3 (s) M2 Transfer the solution and washings (using a funnel) AND into a 250 cm^3 volumetric flask. M3 Make up to the (calibration) mark / line with <u>distilled</u> water. AND then invert the (stoppered) flask (several times)
1(b)(i)	(20(.0) cm^3) pipette.
1(b)(ii)	barium (ions) could react with chromate (ions).
1(b)(iii)	Potassium chromate(VI) / $\text{K}_2\text{CrO}_4(\text{aq})$ is an irritant / corrosive
1(c)(i)	They are (the only ones that are) concordant.
1(c)(ii)	$\frac{2 \times 0.05}{20.60} \times 100 = 0.48(54\%)$ Correct working must be shown.
1(d)(i)	$20.65 \times 0.05 / 1000 = 0.00103(25)$
1(d)(ii)	$= ((\mathbf{d})(\text{i}) / 2) \times (250 / 20)$ $= (\mathbf{d})(\text{i}) \times 6.25$

1(d)(iii)	M1 $M_r = 1.58 / (d)(ii)$ M2 $x = (M1 - 208.3) / 18$ AND x must be an integer. Some working must be shown.
1(e)	Heat to drive off water of crystallisation. M1 Apparatus - Bunsen burner. - Crucible (supported by pipeclay triangle) M2 Measurements - Measure mass of crucible (+ lid) (empty). - Measure mass crucible (+ lid) + solid before heating - Measure mass of crucible (+ lid) + residue (after heating.) M3 Key step in method - Description of heat to constant mass. OR Produce a suitable precipitate using a viable reaction. M1 Apparatus and method - Chooses suitable reagent. - Filter the precipitate. - Wash and (allow to) dry M2 Measurements - Measure mass of hydrated barium chloride used. - Measure mass of precipitate. M3 Key step in method - Description of dry to constant mass.

2(a)(i)	(25.0 cm ³) volumetric pipette
2(a)(ii)	(wear) chemically resistant gloves

2(b)(i)	<table border="1"> <thead> <tr> <th>Total volume in beaker / cm³</th><th>Corrected conductivity / $\mu\text{S cm}^{-1}$</th></tr> </thead> <tbody> <tr><td>25.00</td><td>37000</td></tr> <tr><td>30.00</td><td>27600</td></tr> <tr><td>35.00</td><td>16800</td></tr> <tr><td>40.00</td><td>3680</td></tr> <tr><td>45.00</td><td>9000</td></tr> <tr><td>50.00</td><td>24000</td></tr> <tr><td>55.00</td><td>39600</td></tr> <tr><td>60.00</td><td>50400</td></tr> <tr><td>65.00</td><td>63700</td></tr> </tbody> </table> M1 Total volume in beaker values M2 Corrected conductivity values	Total volume in beaker / cm ³	Corrected conductivity / $\mu\text{S cm}^{-1}$	25.00	37000	30.00	27600	35.00	16800	40.00	3680	45.00	9000	50.00	24000	55.00	39600	60.00	50400	65.00	63700
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2(b)(ii)	volume of 0.100 mol dm ⁻³ Ba(OH) ₂ (aq) added to beaker																				
2(c)	M1: all points 1–4 and 5–9 plotted correctly M2: two straight lines of best fit line drawn going through most points. lines must intersect. Place M2 tick in 'V' of graph Place M1 tick or cross on left hand side of grid Place cross (or highlight) against mis-plot																				

2(d)(i)	intersection point volume (read from within grid)
2(d)(ii)	$n\text{SO}_4^{2-} = 0.100 \times \text{ans } (d)(i) / 1000 = \text{mol}$ $[\text{SO}_4^{2-}(\text{aq})] = [0.100 \times (d)(i) / 1000] / 0.025$
2(e)(i)	diagram showing labelled filter paper in a labelled (filter) funnel 
2(e)(ii)	wash the residue with distilled water
2(e)(iii)	heat to constant mass
2(e)(iv)	higher value and (water would cause) (measured) mass / amount (of residue) would be greater

1(a)	I All the following data recorded. - two burette readings AND titre for the rough titration - initial and final readings for two (or more) accurate titrations II Titre values recorded for accurate titrations, AND correct headings and units in the accurate titration table - initial / start AND (burette) reading / volume - final / end AND (burette) reading / volume - titre OR volume used / added OR FB 2 used / added - unit: / cm³ OR (cm³) OR in cm³ (for each heading) OR cm³ unit given for each volume recorded. III All accurate burette readings recorded to 0.05 cm³. IV The final accurate titre recorded must be within 0.10 cm³ of any other accurate titre. Accuracy (Q) marks Round burette readings to the nearest 0.05 cm³. Check and correct titre subtractions where necessary. Select the best mean titre, using the following hierarchy: - two (or more) accurate identical titres (ignoring any that are labelled "rough"), <i>then</i> - two (or more) accurate titres within 0.05 cm³, <i>then</i> - two(or more) accurate titres within 0.10 cm³, <i>etc.</i> Calculate the Supervisor's mean titre to two decimal places. Calculate the Candidate's mean titre to two decimal places. Calculate the difference (δ) between the Supervisor's and Candidate's mean titre. Award accuracy Q marks as follows: V award if $\delta \leq 0.50 \text{ cm}^3$ VI award if $\delta \leq 0.30 \text{ cm}^3$ VII award if $\delta \leq 0.20 \text{ cm}^3$
1(b)	Correct calculation of the mean titre - Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm³. - Working/explanation must be shown OR ticks must be put next to the two (or more) accurate readings selected. - The mean should be quoted to 2 d.p. and be rounded to nearest 0.01 cm³ (e.g. 26.675 cm³ must be rounded to 26.68 cm³).
1(c)(i)	Final answers for (c)(ii), (c)(iii) and (c)(iv) to 3 or 4 significant figures.
1(c)(ii)	Correctly calculates amount of manganate(VII) = $0.01 \times \text{volume in (b)} / 1000 \text{ mol}$
1(c)(iii)	Correctly uses amount of Fe²⁺ reacting with FB 2 = (c)(ii) $\times$ 5 mol AND concentration of Fe²⁺ = (c)(ii) $\times$ 5 $\times$ 40 mol dm⁻³
1(c)(iv)	Correctly uses concentration of Fe²⁺ = (c)(iii) $\times$ 55.8 g dm⁻³
1(c)(v)	Conclusion yes / correct (because) AND (c)(iv) $\times 1000 / 14$ (> 150 claimed as present in tablet)
1(d)	no because chloride (ions) are oxidised by manganate(VII) / KMnO₄. OR no because hydrochloric acid is monoprotic AND might not produce enough H⁺. OR yes because hydrochloric acid is a strong acid.