



Mark Scheme (Results)

Summer 2025

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

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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)	An answer that makes reference to two of the following points: (cobalt chloride paper) turns (from blue to) pink (1) - condensation (at mouth of test tube) (1) - solid melts/turns into a liquid (1)	Ignore explanations even if incorrect Ignore (cobalt chloride paper) becomes damp Do not award red for pink Do not award any other initial colour for blue Allow drops of water/liquid (at mouth of test tube) Allow steam/water vapour Allow just water Ignore steamy/misty fumes/fog Ignore gas given off Ignore bubbling Do not award effervescence/fizzing Allow solid disappears / decreases in size/mass/amount Allow forms a solution Ignore (any single) colour of liquid/solution Ignore solid decomposes/turns powdery Ignore any reference to the solid changing colour Do not award other incorrect observations	2

Question Number	Answer	Additional Guidance	Mark
1(a)(ii)	An answer that makes reference to the following point: Mn^{2+}	Ignore Mn(II) Do not award any other cation	1

Question Number	Answer	Additional Guidance	Mark
1(a)(iii)	An answer that makes reference to the following points: (mixture of two solutions is) nitric acid/HNO₃((aq)) and silver nitrate/AgNO₃((aq)) (1) (precipitate dissolves on addition of aqueous) ammonia/NH₃((aq)) (1)	M1 and M2 are independent marks If name and formulae given both must be correct Ignore any reference to concentrations in M1 and M2 Ignore any reference to heat in M1 and M2 Do not award additional reagents in M1 and M2 Allow just acidified silver nitrate/AgNO₃ Allow H⁺((aq)) and Ag⁺((aq)) Do not award hydrochloric acid/HCl((aq)) Do not award sulfuric acid/H₂SO₄((aq))	2

Question Number	Answer	Additional Guidance	Mark
1(a)(iv)	An answer that makes reference to the following points: - MnCl₂ (1) .4H₂O (1)	M2 dependent on M1 (or a slip on the formula in M1, eg MnCl₂) <u>Example of working, which is not required:</u> 197.9 – (54.9 + 2 × 35.5) = 72 72 ÷ 18.0 = 4 MnCl₂.4H₂O scores (2) TE on 1(a)(ii) for any first-row transition metal ion (titanium to copper) with a charge between 1+ and 4+	2

Question Number	Answer	Additional Guidance	Mark
1(b)(i)	An answer that makes reference to the following points: - ionic equation for Test 1 - ionic equation for Test 2 - ionic equation for Test 3	Ignore state symbols even if incorrect Penalise uncanceled spectator ions once only <u>Examples of ionic equations:</u> (1) $[\text{Fe}(\text{H}_2\text{O})_6]^{2+} + 2\text{OH}^- \rightarrow \text{Fe}(\text{H}_2\text{O})_4(\text{OH})_2 + 2\text{H}_2\text{O}$ Allow $\text{Fe}^{2+} + 2\text{OH}^- \rightarrow \text{Fe}(\text{OH})_2$ Allow $\text{Fe}^{2+} + 2\text{OH}^- + 4\text{H}_2\text{O} \rightarrow \text{Fe}(\text{OH})_2(\text{H}_2\text{O})_4$ (1) $\text{NH}_4^+ + \text{OH}^- \rightarrow \text{NH}_3 + \text{H}_2\text{O}$ (1) $\text{Ba}^{2+} + \text{SO}_4^{2-} \rightarrow \text{BaSO}_4$ If no other marks awarded, all three product formulae scores (1): $\text{Fe}(\text{H}_2\text{O})_4(\text{OH})_2$ or $\text{Fe}(\text{OH})_2$ in Test 1 and NH_3 in Test 2 and BaSO_4 in Test 3	3

Question Number	Answer	Additional Guidance	Mark
1(b)(ii)	An answer that makes reference to the following point: $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$	Allow $[\text{Fe}(\text{OH})(\text{H}_2\text{O})_5]^{2+}$ with ligands in either order Allow $[\text{Fe}(\text{OH})_2(\text{H}_2\text{O})_4]^+$ with ligands in either order	1

Question Number	Answer	Additional Guidance	Mark
1(b)(iii)	An answer that makes reference to the following point: $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2$	Allow ions in any order, eg $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2$ Ignore any water of crystallisation Ignore name even if incorrect	1

(Total for Question 1 = 12 marks)

Question Number	Answer	Additional Guidance	Mark
2(a)	An answer that makes reference to the following points: • (to form a) saturated solution	Allow so maximum amount/mass of calcium hydroxide is dissolved Allow so concentration (of calcium hydroxide/the solution) is constant Allow (for reaction) to reach equilibrium Ignore just to allow time for calcium hydroxide to dissolve/to dissociate into ions/to react Ignore just rate of dissolving/reaction is slow Ignore so solid separates from solution Do not award so all the calcium hydroxide dissolves Do not award so reaction goes to completion Do not award other incorrect reasons	1

Question Number	Answer	Additional Guidance	Mark
2(b)	An answer that makes reference to the following points: • methyl orange (1) • (from) yellow (to) orange (1)	M2 dependent on M1 (or near miss in M1, eg menthol orange) Do not award yellow to red Do not award reverse colour change (ie orange to yellow) Allow phenolphthalein in M1 (from) pink (to) colourless in M2 Ignore clear for colourless Do not award red to colourless Do not award reverse colour change (ie colourless to pink) Do not award universal indicator	2

Question Number	Answer	Additional Guidance	Mark
2(c)(i)	An answer that makes reference to the following points: • titre 2 and titre 3 • mean titre	9.55 and 9.45 Do not award any other answers M2 dependent on use of concordant titres (ie titres within 0.2 cm³) (= (9.55 + 9.45) ÷ 2 =)9.5(0) (cm³) TE on M1 Do not award 9.65 (cm³) from all three titres	2

Question Number	Answer	Additional Guidance	Mark
2(c)(ii)	Method 1 - calculation of $[\text{Ca}(\text{OH})_2]$ in mol dm^{-3} - calculation of moles of $\text{Ca}(\text{OH})_2$ in 25.0 cm^3 - calculation of moles of HCl in titre - calculation of titre volume (in cm^3) Method 2 - calculation of mass of $\text{Ca}(\text{OH})_2$ in 25.0 cm^3 - calculation of moles of $\text{Ca}(\text{OH})_2$ in 25.0 cm^3 - calculation of moles of HCl in titre - calculation of titre volume (in cm^3)	Allow answer in dm^3 (eg 0.01055 dm^3) Allow TE throughout Ignore SF in M4 provided the titre is given to at least one decimal place for cm^3, and at least 3SF for dm^3 <u>Examples of calculation:</u> (1) $1.56 \div 74.1 = 0.021053 / 2.1053 \times 10^{-2} (\text{mol dm}^{-3})$ Allow $0.021081 / 2.1081 \times 10^{-2}$ from M_r of 74 (1) $0.021053 \times 0.0250 = 0.00052632 / 5.2632 \times 10^{-4} (\text{mol})$ (1) $0.00052632 \times 2 = 0.0010526 / 1.0526 \times 10^{-3} (\text{mol})$ (1) titre volume = $0.0010526 \div 0.100 \times 1000$ = $10.55 (\text{cm}^3)$ Allow $10.526/10.53/10.50/10.5$ (1) $1.56 \times 0.0250 = 0.039 (\text{g})$ (1) $0.039 \div 74.1 = 0.00052632 / 5.2632 \times 10^{-4} (\text{mol})$ Allow $0.00052703 / 5.2703 \times 10^{-4}$ from M_r of 74 (1) $0.00052632 \times 2 = 0.0010526 / 1.0526 \times 10^{-3} (\text{mol})$ (1) titre volume = $0.0010526 \div 0.100 \times 1000$ = $10.55 (\text{cm}^3)$ Allow $10.526/10.53/10.50/10.5$	4

Question Number	Answer	Additional Guidance	Mark
2(c)(iii)	An answer that makes reference to the following point: temperature (of experiment) higher (than 20°C)	Ignore any reference to measurement errors Allow any stated temperature between 21°C and 50°C Allow (titration) reaction is exothermic/releases heat Ignore just different temperature / temperature not 20°C Do not award temperature lower (than 20°C) If calculated titre in (c)(ii) is lower than mean titre in (c)(i) Accept temperature was lower (than 20°C) Allow any stated temperature between 5°C and 19°C Allow (titration) reaction is endothermic/absorbs heat Ignore just different temperature / temperature not 20°C Do not award temperature higher (than 20°C)	1

Question Number	Answer	Additional Guidance	Mark
2(d)	- value of K_c - units of K_c	M1 and M2 are independent marks <u>Example of calculation:</u> (1) $(K_c = 0.0190 \times (2 \times 0.0190)^2 =) 2.7436 \times 10^{-5}$ Ignore SF except 1SF (1) $\text{mol}^3 \text{ dm}^{-9}$ Allow $\text{dm}^{-9} \text{ mol}^3$ Allow mol^3/dm^9	2

(Total for Question 2 = 12 marks)

Question Number	Answer	Additional Guidance	Mark
3(a)	An explanation that makes reference to the following points: - to react with iodine/I₂ - to delay the colour change	M1 and M2 are independent marks (1) Allow to remove/reduce iodine/I₂ Allow to convert iodine/I₂ to iodide/I⁻ Allow so iodine/I₂ reacts with starch after forming S₄O₆²⁻ Ignore just as a reducing agent Do not award to react with iodide/I⁻ (1) Allow colour forming for colour change Allow to prevent an immediate colour change Allow so colour changes after thiosulfate/S₂O₃²⁻ is used up Allow so colour changes after S₄O₆²⁻ formed Allow so colour changes after a known amount of iodine/I₂ formed Ignore any reference to reaction rate Ignore to quench/stop reaction Ignore to make colour change more obvious Ignore end-point for colour change	2

Question Number	Answer	Additional Guidance	Mark
3(b)	An explanation that makes reference to the following points: - to keep the (total) volume the same (so) concentration (of $\text{S}_2\text{O}_8^{2-}/\text{I}^-/\text{S}_2\text{O}_3^{2-}/\text{reactants}$) remains constant	Ignore any reference to colour change Allow so volume of starch is the same Allow as some solution would remain in the measuring cylinder Allow just more accurate/precise Allow just smaller (percentage) uncertainty Ignore starch must be added drop by drop/slowly Ignore just easier to use / easier to add 2.5 cm^3 Ignore measuring cylinder cannot measure small volumes/2.5 cm^3 Allow as concentration is (inversely) proportional to volume Ignore so temperature is the only variable Do not award so concentration of starch/iodine remains constant Do not award so amount/moles remains constant	2

Question Number	Answer	Additional Guidance	Mark
3(c)	An answer that makes reference to the following points: (from) colourless (to) blue-black	Ignore clear Do not award any other answer, eg yellow Allow blue or black Do not award pale or light Do not award any other colour, eg yellow/brown Reverse colour change scores (1)	2

Question Number	Answer	Additional Guidance	Mark																																				
3(d)(i)	- any two or three scores (1) - any four or five scores (2) - all six scores (3)	Penalise incorrect SF once only <u>Example of completed table:</u> <table><tr><th>$T / ^\circ\text{C}$</th><th>T / K</th><th>$(1/T) / \text{K}^{-1}$</th><th>Time, t / s</th><th>$(1/t) / \text{s}^{-1}$</th><th>$\ln(1/t)$</th></tr><tr><td><u>49</u></td><td>322</td><td>0.00311</td><td>33</td><td>0.0303</td><td>−3.49</td></tr><tr><td>43</td><td><u>316</u></td><td><u>0.00316</u></td><td>47</td><td>0.0213</td><td>−3.85</td></tr><tr><td>36</td><td>309</td><td>0.00324</td><td>72</td><td>0.0139</td><td>−4.28</td></tr><tr><td>31</td><td>304</td><td>0.00329</td><td><u>99</u></td><td><u>0.0101</u></td><td>−4.60</td></tr><tr><td>25</td><td>298</td><td>0.00336</td><td>147</td><td>0.00680</td><td><u>−4.99</u></td></tr></table> Allow TE for $1/T$ at 43°C from T / K value Allow TE for Time, t at 31°C from $(1/t)$ value	$T / ^\circ\text{C}$	T / K	$(1/T) / \text{K}^{-1}$	Time, t / s	$(1/t) / \text{s}^{-1}$	$\ln(1/t)$	<u>49</u>	322	0.00311	33	0.0303	−3.49	43	<u>316</u>	<u>0.00316</u>	47	0.0213	−3.85	36	309	0.00324	72	0.0139	−4.28	31	304	0.00329	<u>99</u>	<u>0.0101</u>	−4.60	25	298	0.00336	147	0.00680	<u>−4.99</u>	3
$T / ^\circ\text{C}$	T / K	$(1/T) / \text{K}^{-1}$	Time, t / s	$(1/t) / \text{s}^{-1}$	$\ln(1/t)$																																		
<u>49</u>	322	0.00311	33	0.0303	−3.49																																		
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36	309	0.00324	72	0.0139	−4.28																																		
31	304	0.00329	<u>99</u>	<u>0.0101</u>	−4.60																																		
25	298	0.00336	147	0.00680	<u>−4.99</u>																																		

Question Number	Answer	Additional Guidance	Mark
3(d)(ii)	activation energy (in kJ mol^{-1})	<u>Example of calculation:</u> $E_a = -(-6045) \times 8.31 = 50234$ $= (+)50.234 (\text{kJ mol}^{-1})$ Allow $(+)50\,234 \text{ J mol}^{-1}$ Ignore SF Do not award negative sign Do not award incorrect units	1

(Total for Question 3 = 10 marks)

Question Number	Answer	Additional Guidance	Mark
4(a)	An answer that makes reference to the following point: gloves	Ignore explanations even if incorrect Ignore other relevant safety precautions, eg use of fume cupboard / gas mask / goggles / protective clothing / spatula Do not award irrelevant safety precautions, eg use of tongs / avoiding heat/flames	1

Question Number	Answer	Additional Guidance	Mark
4(b)	An answer that makes reference to the following point: benzoyl chloride/C₆H₅COCl is toxic (by inhalation)	Allow HCl/hydrogen chloride/hydrochloric acid is toxic Allow poisonous for toxic Ignore corrosive/harmful for toxic Ignore phenol/C₆H₅OH is toxic Ignore just toxic gas (produced) Ignore any reference to skin absorption Do not award benzoyl chloride/C₆H₅COCl is carcinogenic Do not award phenyl benzoate/C₆H₅COOC₆H₅ is toxic/irritant	1

Question Number	Answer	Additional Guidance	Mark
4(c)	Method 1 – mass of phenol / moles of either reactant • calculation of mass of benzoyl chloride in 9 cm³ (1) • calculation of moles of benzoyl chloride in 9 cm³ (1) • calculation of mass of phenol required OR • calculation of moles phenol in 5.0 g (1) • benzoyl chloride is in excess (1) Method 2 – volume of benzoyl chloride • calculation of moles of phenol in 5.0 g (1) • calculation of mass of benzoyl chloride required (1) • calculation of volume of benzoyl chloride required (1) • benzoyl chloride is in excess (1) Method 3 – mass of benzoyl chloride • calculation of moles of phenol in 5.0 g (1) • calculation of mass of benzoyl chloride required (1) • calculation of mass of benzoyl chloride in 9 cm³ (1) • benzoyl chloride is in excess (1)	M4 is standalone (no prior calculation required) Ignore SF throughout <u>Examples of calculation:</u> 1.21 × 9 = 10.89 (g) 10.89 ÷ 140.5 = 0.077509 (mol) 0.077509 × 94.0 = 7.2858 (g) OR 5.0 ÷ 94.0 = 0.053191 (mol) Allow any indication, eg 7.2858 > 5(.00) or 0.077509 > 0.053191 Allow phenol is limiting / benzoyl chloride is not limiting 5.00 ÷ 94.0 = 0.053191 (mol) 0.053191 × 140.5 = 7.4734 (g) 7.4734 ÷ 1.21 = 6.1764 (cm³) Allow any indication, eg 9 > 6.1764 Allow phenol is limiting / benzoyl chloride is not limiting 5.0 ÷ 94.0 = 0.053191 (mol) 0.053191 × 140.5 = 7.4734 (g) 1.21 × 9 = 10.89 (g) Allow any indication, eg 10.89 > 7.4734 Allow phenol is limiting / benzoyl chloride is not limiting	4

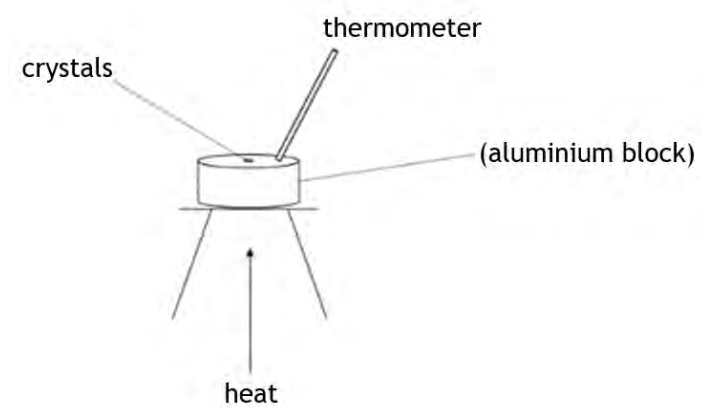
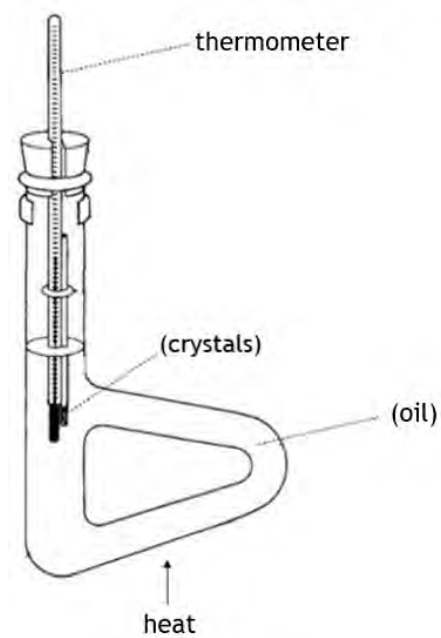
Question Number	Answer	Additional Guidance	Mark
4(d)	An answer that makes reference to the following point: - removes (excess) benzoyl chloride/$\text{C}_6\text{H}_5\text{COCl}$ (1) - to remove HCl/hydrogen chloride/hydrochloric acid OR to remove NaOH/sodium hydroxide OR to remove NaCl/sodium chloride (1)	Accept reacts with/hydrolyses benzoyl chloride/$\text{C}_6\text{H}_5\text{COCl}$ Allow to remove soluble impurities Allow to remove benzoic acid/$\text{C}_6\text{H}_5\text{COOH}$ Allow crude product/phenyl benzoate/$\text{C}_6\text{H}_5\text{COOC}_6\text{H}_5$/it is insoluble in water Ignore just to remove impurities Ignore just to remove reactant(s) Do not award to remove insoluble impurities	2

Question Number	Answer	Additional Guidance	Mark
4(e)(i)	An answer that makes reference to the following point: so (crystals) do not melt	Allow (crystals) melt above $70^\circ\text{C}/71^\circ\text{C}$ Allow recrystallisation should be done from solid Allow boiling temperature of ethanol/78°C is higher than/close to the melting temperature/$70^\circ\text{C}/71^\circ\text{C}$ Ignore just melting temperature (of the crystals) is 71°C Ignore any reference to impurities lowering the melting temperature (of phenyl benzoate) Ignore any reference to evaporation of ethanol Ignore any reference to yield Ignore any reference to safety Do not award so (crystals) do not decompose	1

Question Number	Answer	Additional Guidance	Mark
4(e)(ii)	An explanation that makes reference to the following points: • (washed to) remove (ethanol-)soluble impurities (1) • (cold so the crystals) do not dissolve (1)	Allow to remove dissolved impurities Allow as impurities are soluble Ignore just to remove impurities Do not award to remove insoluble impurities Accept (crystals) less soluble (in cold ethanol) Allow (crystals) insoluble (in cold ethanol) Allow (crystals) soluble/dissolve in hot/warm (ethanol) Allow to maximise yield / avoid loss of yield Allow so maximum mass/amount (of crystals) collected Ignore (cold so crystals) do not react/decompose/melt	2

Question Number	Answer	Additional Guidance	Mark
4(f)	An answer that makes reference to the following points: Apparatus 1 - Thiele tube and containing liquid (oil or water) (1) - labelled thermometer and heat source (1) - capillary tube (for crystals) (1) Apparatus 2 (aluminium) heating block (1) - labelled thermometer (inserted into block) and heat source (1) - labelled crystals (on surface of block) (1)	Accept boiling tube/beaker for Thiele tube Allow sealed or unsealed apparatus Allow mineral/paraffin/lubricating/engine oil Do not award any unsuitable liquid, eg crude oil Do not award empty tube/beaker M2 dependent on M1 (or near miss, eg Thiele tube/boiling tube/beaker containing unsuitable liquid, or empty) Ignore position of thermometer bulb provided it is in the liquid Allow any unambiguous heat source Do not award electrical heat source M3 dependent on M1 (or near miss, eg Thiele tube/boiling tube/beaker containing unsuitable liquid, or empty) Allow empty capillary tube Allow test tube (for crystals) Do not award labelled boiling tube (for crystals) Do not award tube if not in contact with the liquid / immersed completely in the liquid Do not award any unsuitable metal, eg sodium or gold M2 dependent on M1 (or near miss, eg unsuitable metal) Allow any unambiguous heat source Do not award electrical heat source M3 dependent on M1 (or near miss, eg unsuitable metal) Allow sample/solid/phenyl benzoate for crystals	3

Examples of labelled diagrams:



Question Number	Answer	Additional Guidance	Mark
4(g)	Method 1 - moles of phenol in 5.00 g - multiplication by 0.65 and multiplication by 198.0 to calculate mass of phenylbenzoate for 65.0% yield Method 2 - mass of phenol for 65.0% yield and moles of phenol for 65.0% yield - mass of phenylbenzoate for 65.0% yield	Ignore SF except 1SF <u>Examples of calculation:</u> moles = $5.00 \div 94.0 = 0.053191$ moles = $0.650 \times 0.053191 = 0.034574$ and mass = $0.034574 \times 198.0 = 6.8457$ (g) Allow operations to be performed in either order TE on M1 mass = $0.65 \times 5.00 = 3.25$ (g) and moles = $3.25 \div 94.0 = 0.034574$ mass = $0.034574 \times 198.0 = 6.8457$ (g) TE on M1	2

(Total for Question 4 = 16 marks)
TOTAL FOR PAPER = 50 marks

