Pearson Edexcel

Mark Scheme (Results)

Summer 2025

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

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

Summer 2025
Question Paper Log Number P78747A
Publications Code WCH16_01_2506_MS

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/HNO_3((aq)) **and** silver nitrate/$AgNO_3$((aq)) **(1)** • (precipitate dissolves on addition of aqueous) ammonia/NH_3((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/$AgNO_3$ Allow H^+((aq)) **and** Ag^+((aq)) Do not award hydrochloric acid/HCl((aq)) Do not award sulfuric acid/H_2SO_4((aq))	**2**

Question Number	Answer	Additional Guidance	Mark
1(a)(iv)	An answer that makes reference to the following points: • $MnCl_2$ **(1)** • $.4H_2O$ **(1)**	M2 dependent on M1 (or a slip on the formula in M1, eg MCl_2) <u>Example of working, which is not required</u>: $197.9 – (54.9 + 2 \times 35.5) = 72$ $72 \div 18.0 = 4$ $MnCl_2.4H_2O$ 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 **(1)** • ionic equation for Test 2 **(1)** • ionic equation for Test 3 **(1)**	Ignore state symbols even if incorrect Penalise uncancelled spectator ions once only <u>Examples of ionic equations</u>: $[Fe(H_2O)_6]^{2+} + 2OH^- \rightarrow Fe(H_2O)_4(OH)_2 + 2H_2O$ Allow $Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$ Allow $Fe^{2+} + 2OH^- + 4H_2O \rightarrow Fe(OH)_2(H_2O)_4$ $NH_4^+ + OH^- \rightarrow NH_3 + H_2O$ $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$ If no other marks awarded, all three product formulae scores (1): $Fe(H_2O)_4(OH)_2$ or $Fe(OH)_2$ 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: • $[Fe(H_2O)_6]^{3+}$	Allow $[Fe(OH)(H_2O)_5]^{2+}$ with ligands in either order Allow $[Fe(OH)_2(H_2O)_4]^+$ with ligands in either order	**1**

Question Number	Answer	Additional Guidance	Mark
1(b)(iii)	An answer that makes reference to the following point: • $(NH_4)_2Fe(SO_4)_2$	Allow ions in any order, eg $Fe(NH_4)_2(SO_4)_2$ 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 **(1)** • mean titre **(1)**	9.55 **and** 9.45 Do not award any other answers M2 dependent on use of concordant titres (ie titres within 0.2 cm^3) (= (9.55 + 9.45) ÷ 2 =)9.5(0) (cm^3) TE on M1 Do not award 9.65 (cm^3) from all three titres	**2**

Question Number	Answer		Additional Guidance	Mark
2(c)(ii)			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	**4**
	Method 1 • calculation of $[Ca(OH)_2]$ in mol dm^{-3}	**(1)**	<u>Examples of calculation</u>: $1.56 \div 74.1 = 0.021053 / 2.1053 \times 10^{-2}$ (mol dm^{-3}) Allow $0.021081 / 2.1081 \times 10^{-2}$ from M_r of 74	
	• calculation of moles of $Ca(OH)_2$ in 25.0 cm^3	**(1)**	$0.021053 \times 0.0250 = 0.00052632 / 5.2632 \times 10^{-4}$ (mol)	
	• calculation of moles of HCl in titre	**(1)**	$0.00052632 \times 2 = 0.0010526 / 1.0526 \times 10^{-3}$ (mol)	
	• calculation of titre volume (in cm^3)	**(1)**	titre volume = $0.0010526 \div 0.100 \times 1000$ $= 10.55$ (cm^3) Allow 10.526/10.53/10.50/10.5	
	Method 2 • calculation of mass of $Ca(OH)_2$ in 25.0 cm^3	**(1)**	$1.56 \times 0.0250 = 0.039$ (g)	
	• calculation of moles of $Ca(OH)_2$ in 25.0 cm^3	**(1)**	$0.039 \div 74.1 = 0.00052632 / 5.2632 \times 10^{-4}$ (mol) Allow $0.00052703 / 5.2703 \times 10^{-4}$ from M_r of 74	
	• calculation of moles of HCl in titre	**(1)**	$0.00052632 \times 2 = 0.0010526 / 1.0526 \times 10^{-3}$ (mol)	
	• calculation of titre volume (in cm^3)	**(1)**	titre volume = $0.0010526 \div 0.100 \times 1000$ $= 10.55$ (cm^3) Allow 10.526/10.53/10.50/10.5	

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 **(1)** • units of K_c **(1)**	M1 and M2 are independent marks Example of calculation: ($K_c = 0.0190 \times (2 \times 0.0190)^2 =$) 2.7436×10^{-5} Ignore SF except 1SF $mol^3\ dm^{-9}$ Allow $dm^{-9}\ mol^3$ 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/I_2 **(1)** • to delay the colour change **(1)**	M1 and M2 are independent marks Allow to remove/reduce iodine/I_2 Allow to convert iodine/I_2 to iodide/I^- Allow so iodine/I_2 reacts with starch after forming $S_4O_6^{2-}$ Ignore just as a reducing agent Do not award to react with iodide/I^- Allow colour forming for colour change Allow to prevent an immediate colour change Allow so colour changes after thiosulfate/$S_2O_3^{2-}$ is used up Allow so colour changes after $S_4O_6^{2-}$ formed Allow so colour changes after a known amount of iodine/I_2 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 **(1)** • (so) concentration (of $S_2O_8^{2-}$/I^-/ $S_2O_3^{2-}$/reactants) remains constant **(1)**	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 **(1)** • (to) blue-black **(1)**	 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**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>3(d)(i)</td><td>• any two or three scores (1)
• any four or five scores (2)
• all six scores (3)</td><td>Penalise incorrect SF once only

<u>Example of completed table</u>:

<table>
<tr><th>T / °C</th><th>T / K</th><th>$(1/T)$ / K^{-1}</th><th>Time, t / s</th><th>$(1/t)$ / 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</td><td>3</td></tr>
</table>

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>3(d)(ii)</td><td>• activation energy (in kJ mol^{-1})</td><td><u>Example of calculation</u>:
$E_a = -(-6045) \times 8.31 = 50234$
$= (+)50.234$ (kJ mol^{-1})
Allow (+)50 234 J mol^{-1}
Ignore SF

Do not award negative sign
Do not award incorrect units</td><td>1</td></tr>
</table>

(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/C_6H_5COCl is toxic (by inhalation)	Allow HCl/hydrogen chloride/hydrochloric acid is toxic Allow poisonous for toxic Ignore corrosive/harmful for toxic Ignore phenol/C_6H_5OH is toxic Ignore just toxic gas (produced) Ignore any reference to skin absorption Do not award benzoyl chloride/C_6H_5COCl is carcinogenic Do not award phenyl benzoate/$C_6H_5COOC_6H_5$ is toxic/irritant	**1**

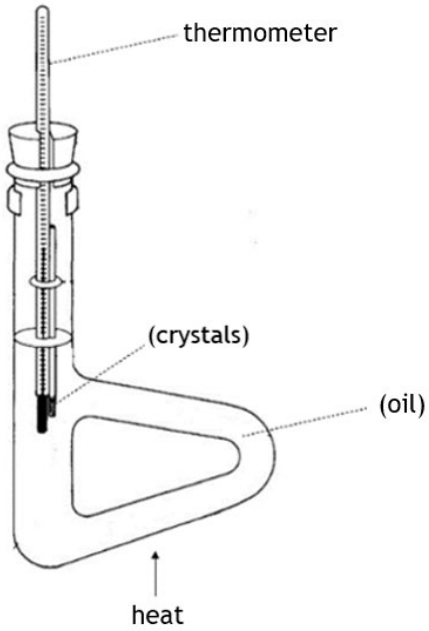
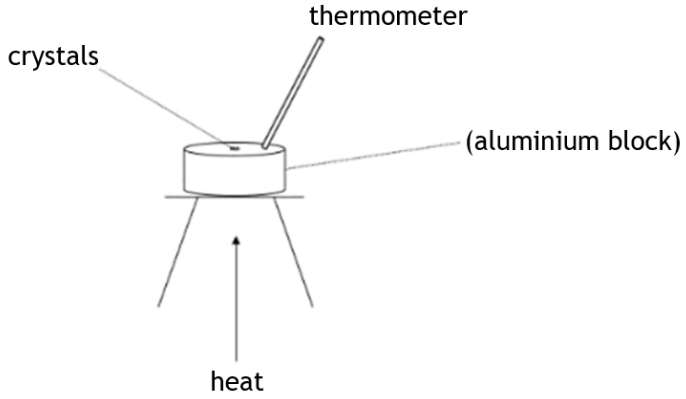
Question Number	Answer		Additional Guidance	Mark
4(c)			M4 is standalone (no prior calculation required) Ignore SF throughout <u>Examples of calculation:</u>	**4**
	Method 1 – mass of phenol / moles of either reactant			
	• calculation of mass of benzoyl chloride in 9 cm^3	**(1)**	1.21 × 9 = 10.89 (g)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

Question Number	Answer	Additional Guidance	Mark
4(d)	An answer that makes reference to the following point: • removes (excess) benzoyl chloride/C_6H_5COCl **(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/C_6H_5COCl Allow to remove soluble impurities Allow to remove benzoic acid/C_6H_5COOH Allow crude product/phenyl benzoate/$C_6H_5COOC_6H_5$/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°C/71°C Allow recrystallisation should be done from solid Allow boiling temperature of ethanol/78°C is higher than/close to the melting temperature/70°C/71°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)**	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	**3**
	• labelled thermometer **and** heat source	**(1)**	**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	
	• capillary tube (for crystals)	**(1)**	**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	
	Apparatus 2 • (aluminium) heating block	**(1)**	Do not award any unsuitable metal, eg sodium or gold	
	• labelled thermometer (inserted into block) **and** heat source	**(1)**	**M2 dependent on M1 (or near miss, eg unsuitable metal)** Allow any unambiguous heat source Do not award electrical heat source	
	• labelled crystals (on surface of block)	**(1)**	**M3 dependent on M1 (or near miss, eg unsuitable metal)** Allow sample/solid/phenyl benzoate for crystals	

		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	**(1)** **(1)** **(1)** **(1)**	Ignore SF except 1SF <u>Examples of calculation:</u> moles = 5.00 ÷ 94.0 = 0.053191 moles = 0.650 × 0.053191 = 0.034574 **and** mass = 0.034574 × 198.0 = 6.8457 (g) Allow operations to be performed in either order TE on M1 mass = 0.65 × 5.00 = 3.25 (g) **and** moles = 3.25 ÷ 94.0 = 0.034574 mass = 0.034574 × 198.0 = 6.8457 (g) TE on M1	**2**

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

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom