

Mark Scheme (Results)

January 2014

IAL Chemistry (WCH04/01)

Unit 4: General Principles of 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.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:
  - i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  - ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  - iii) organise information clearly and coherently, using specialist vocabulary when appropriate

## 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.

### Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.

Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

**Section A (multiple choice)**

Question Number	Correct Answer	Reject	Mark
<b>1</b>	C		<b>1</b>

Question Number	Correct Answer	Reject	Mark
<b>2 (a)</b>	B		<b>1</b>

Question Number	Correct Answer	Reject	Mark
<b>2 (b)</b>	D		<b>1</b>

Question Number	Correct Answer	Reject	Mark
<b>2 (c)</b>	B		<b>1</b>

Question Number	Correct Answer	Reject	Mark
<b>3</b>	D		<b>1</b>

Question Number	Correct Answer	Reject	Mark
<b>4</b>	C		<b>1</b>

Question Number	Correct Answer	Reject	Mark
<b>5 (a)</b>	D		<b>1</b>

Question Number	Correct Answer	Reject	Mark
<b>5 (b)</b>	A		<b>1</b>

Question Number	Correct Answer	Reject	Mark
<b>6</b>	C		<b>1</b>

Question Number	Correct Answer	Reject	Mark
<b>7</b>	D		<b>1</b>

Question Number	Correct Answer	Reject	Mark
<b>8</b>	B		<b>1</b>

Question Number	Correct Answer	Reject	Mark
<b>9 (a)</b>	B		<b>1</b>

Question Number	Correct Answer	Reject	Mark
<b>9(b)</b>	A		<b>1</b>

Question Number	Correct Answer	Reject	Mark
<b>9(c)</b>	C		<b>1</b>

Question Number	Correct Answer	Reject	Mark
<b>10</b>	D		<b>1</b>

Question Number	Correct Answer	Reject	Mark
<b>11</b>	D		<b>1</b>

Question Number	Correct Answer	Reject	Mark
<b>12</b>	B		<b>1</b>

Question Number	Correct Answer	Reject	Mark
<b>13</b>	D		<b>1</b>

Question Number	Correct Answer	Reject	Mark
<b>14</b>	C		<b>1</b>

Question Number	Correct Answer	Reject	Mark
<b>15</b>	A		<b>1</b>

**Total for Section A = 20 marks**

## Section B

Question Number	Acceptable Answers	Reject	Mark
<b>16(a)</b>	$\text{CH}_3\text{CH}_2\text{CH}_2\text{C}\equiv\text{N}$  <b>ALLOW</b> displayed formula	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CN}$  molecular formula	<b>1</b>

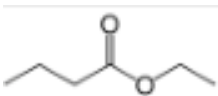
Question Number	Acceptable Answers	Reject	Mark
<b>16(b)</b>	<p><b>IGNORE</b> conditions and solvents, even if incorrect</p> <p><b>Step 1</b>  <math>\text{LiAlH}_4</math>  <b>IGNORE</b> dry ether/ followed by <math>\text{H}_2\text{O}</math></p> <p><b>ALLOW</b>                      lithium tetrahydridoaluminate((III))                      lithium aluminium hydride <b>(1)</b></p> <p><b>Step 2</b>  <math>\text{PCl}_5</math></p> <p><b>ALLOW</b>                      phosphorus(V) chloride/                      phosphorus pentachloride  <math>\text{HCl}</math> / (concentrated) hydrochloric acid  <math>\text{PCl}_3</math> / phosphorus(III) chloride/                      phosphorus trichloride  <math>\text{SOCl}_2</math> / thionyl chloride <b>(1)</b></p> <p><b>Step 4</b>  <math>\text{HCl}</math> / <math>\text{HCl}(\text{aq})</math> / <math>\text{HCl}</math> in water or <math>\text{H}_2\text{O}</math></p> <p><b>ALLOW</b>                      any strong acid/  <math>\text{H}^+</math>/  <math>\text{NaOH}</math> / sodium hydroxide <b>followed by</b>  <math>\text{HCl}</math> / hydrochloric acid <b>(1)</b></p> <p><b>Step 5</b>  <math>\text{CH}_3\text{CH}_2\text{OH}</math> / <math>\text{C}_2\text{H}_5\text{OH}</math> (and any strong acid)</p> <p><b>ALLOW</b>                      ethanol <b>(1)</b></p>	<p>incorrect formulae,                      including subscripts                      written as large                      numbers or                      superscripts eg  <math>\text{LiAlH}_4/\text{LiAlH}^4</math></p> <p>any charges</p> <p><math>\text{NaBH}_4</math></p> <p><math>\text{H}_2</math> / hydrogen</p> <p>dilute hydrochloric                      acid</p> <p>just 'dilute acid'                      just 'concentrated                      acid'                      just '<math>\text{H}_2\text{O}</math> / water'</p> <p><math>\text{OHCH}_2\text{CH}_3</math></p>	<b>4</b>

Question Number	Acceptable Answers	Reject	Mark
<b>16(c)</b>	<p> <math>2\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH} + \text{Na}_2\text{CO}_3 \rightarrow</math>  <math>2\text{CH}_3\text{CH}_2\text{CH}_2\text{COO}^{(-)}\text{Na}^{(+)} + \text{CO}_2 + \text{H}_2\text{O}</math> </p> <p><b>ALLOW</b></p> <p>butanoic acid as <math>\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}/</math>  <math>\text{CH}_3(\text{CH}_2)_2\text{COOH}/\text{CH}_3(\text{CH}_2)_2\text{CO}_2\text{H}/</math>  <math>\text{C}_3\text{H}_7\text{COOH}/\text{C}_3\text{H}_7\text{CO}_2\text{H}</math></p> <p>and the salt as <math>\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H} /</math>  <math>\text{CH}_3(\text{CH}_2)_2\text{COO}^{(-)}\text{Na}^{(+)} /</math>  <math>\text{CH}_3(\text{CH}_2)_2\text{CO}_2^{(-)}\text{Na}^{(+)} /</math>  <math>\text{C}_3\text{H}_7\text{COO}^{(-)}\text{Na}^{(+)} / \text{C}_3\text{H}_7\text{CO}_2^{(-)}\text{Na}^{(+)}</math></p> <p>all product formulae correct      <b>(1)</b>  correct balanced equation      <b>(1)</b></p> <p><b>ALLOW</b> correct ionic equation for <b>(1)</b>  <math>2\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH} + \text{CO}_3^{2-} \rightarrow</math>  <math>2\text{CH}_3\text{CH}_2\text{CH}_2\text{COO}^- + \text{CO}_2 + \text{H}_2\text{O}</math></p> <p><b>IGNORE</b> state symbols even if incorrect</p>		<b>2</b>



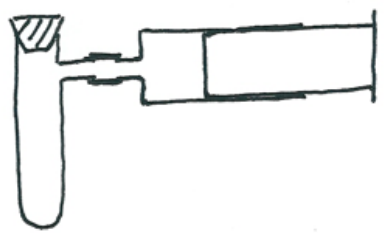
Question Number	Acceptable Answers	Reject	Mark
16(d)	<p><b>Any two correct points from:</b></p> <p><b>First point</b>  butanoic acid has 4 peaks, butan-1-ol has 5 peaks  <b>OR</b>  butanoic acid has one peak fewer  <b>OR</b>  butan-1-ol has one peak more  <b>ALLOW</b>  butanoic acid has fewer peaks/  butan-1-ol has more peaks (1)</p> <p><b>IGNORE</b>  butanoic acid has 4 proton environments and butan-1-ol has 5</p> <p><b>Second point</b>  ratio of peak heights/ area under each peak is 3:2:2:1 for butanoic acid <b>and</b> 3:2:2:2:1 for butan-1-ol (1)</p> <p><b>Third point</b>  the OH (hydrogens) have different chemical shifts  <b>OR</b>  butanoic acid has a (COOH) peak at 10-12 (ppm) (and butan-1-ol does not)  <b>OR</b>  butan-1-ol has (an OH) peak at 2-4 (ppm) (and butanoic acid does not) (1)</p> <p><b>Fourth point</b>  peak at 3.0-1.8 (ppm) for H-C-C=O in acid and not in the alcohol  <b>OR</b>  peak at 3.0-4.4 (ppm) for H-C-O- in alcohol and not in acid  <b>OR</b>  the hydrogens on the alpha carbon have different chemical shifts (1)</p> <p><b>IGNORE</b>  reference to splitting patterns</p>	<p>incorrect numbers of peaks quoted</p> <p>different number of peaks</p> <p>area under peaks in the ratio 8:10</p> <p>incorrect data quoted</p> <p>incorrect data quoted</p>	<p>2</p>

Question Number	Acceptable Answers	Reject	Mark
16(e)	<p><b>First mark – bond and range</b> C=O(stretching) in butanoic acid (has an absorption at) 1725 – 1700 (cm<sup>-1</sup>) (1)</p> <p><b>Second mark – bond and both ranges</b> O-H/ OH (stretching) in butan-1-ol 3750 – 3200 (cm<sup>-1</sup>) <b>and</b> O-H/ OH (stretching) in butanoic acid 3300 – 2500 (cm<sup>-1</sup>) <b>ALLOW</b> COOH in butanoic acid (1)</p> <p><b>ALLOW</b> any wavenumber or range of wavenumbers within the ranges above and ranges written in reverse order</p> <p>If no other marks are awarded, then <b>ALLOW</b> 1 mark if all 3 ranges are identified but bonds are missing/incorrect</p> <p><b>IGNORE</b> reference to fingerprint region</p>	<p>COOH/ incorrect name of bond/ 1740 – 1720 (cm<sup>-1</sup>)/ other incorrect range</p> <p>incorrect name of bonds</p>	2

Question Number	Acceptable Answers	Reject	Mark
16(f)	 <p><b>IGNORE</b> bond lengths and bond angles <b>ALLOW</b> any orientation</p>		1

Question Number	Acceptable Answers	Reject	Mark
16(g)	<p><b>First step –</b>  <math>\text{PCl}_5</math>/ phosphorus(V) chloride/  phosphorus pentachloride</p> <p><b>ALLOW</b>  <math>\text{PCl}_3</math> / phosphorus(III) chloride/  phosphorus trichloride  <math>\text{SOCl}_2</math> / thionyl chloride (1)</p> <p><b>Second step – conditional on first mark</b>  <math>\text{CH}_3\text{CH}_2\text{OH}</math>/ <math>\text{C}_2\text{H}_5\text{OH}</math>/ ethanol (1)</p> <p><b>Advantage - stand alone mark</b>  higher yield (of ester)  <b>OR</b>  reaction goes to completion/  not an equilibrium reaction/  not reversible  <b>OR</b>  no heat energy needed/  reacts at room temperature/  no (concentrated acid) catalyst needed (1)</p> <p><b>IGNORE</b>  atom economy/  faster/  requires less energy</p>	HCl	3

Total for Question 16 = 15 marks

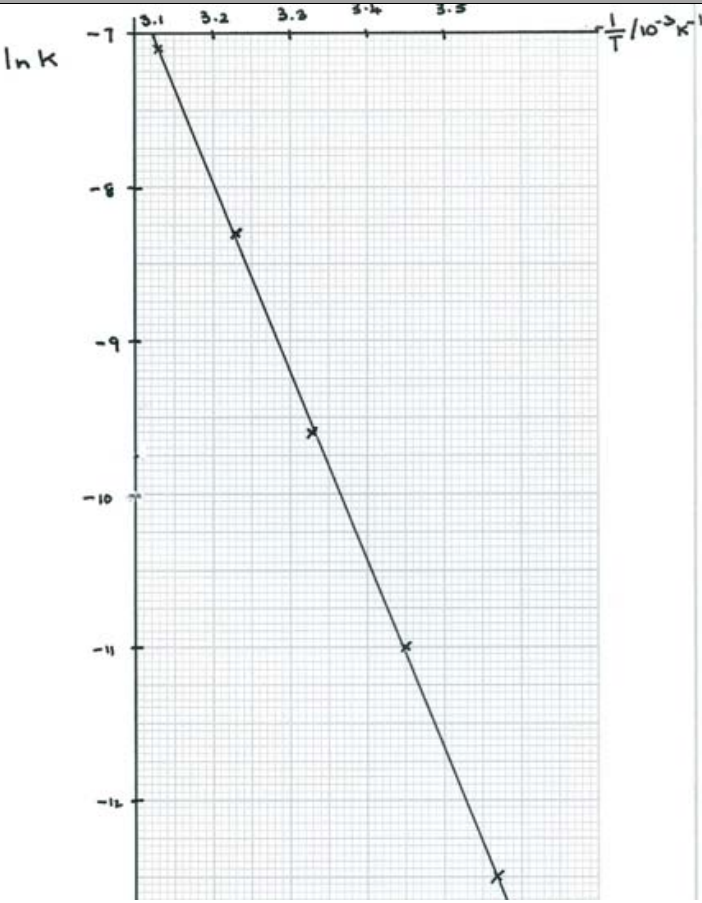
Question Number	Acceptable Answers	Reject	Mark
17(a)	 <p><b>Method 1 – gas collection</b>  <b>Diagram 2 marks</b>  stopped/ sealed side arm test tube/  stopped/ sealed test tube with delivery tube/  stopped/ sealed side arm flask/  stopped/ sealed flask with delivery tube (1)</p> <p>gas syringe  <b>OR</b>  collection of gas over water in a measuring cylinder/  upturned burette/ graduated gas tube (1)</p> <p><b>IGNORE</b> heat</p> <p><b>Measurements</b>  <b>volume</b> of gas <b>and</b> time (1)</p> <p><b>Method 2 – mass loss</b>  <b>Diagram 2 marks</b>  digital balance (1) amount of gas</p> <p>flask with cotton wool/ mineral wool in neck  <b>OR</b>  open flask/ beaker (1)</p> <p><b>Measurements</b>  mass (loss) <b>and</b> time (1)</p> <p><b>Method 3 – colour change</b>  <b>Diagram 2 marks</b>  colorimeter (1)  light and filter shown (1)</p> <p><b>Measurements</b>  transmission/ absorbance <b>and</b> time (1)</p>		3

Question Number	Acceptable Answers	Reject	Mark
17(b)(i)	$s^{-1}$ <b>ALLOW</b> 1/s $sec^{-1}$ any actual unit of time to power -1	$time^{-1}$ $t^{-1}$	1

Question Number	Acceptable Answers	Reject	Mark
17(b) * (ii)	<p><b>First mark</b>            1<sup>st</sup> Step – slow            2<sup>nd</sup> Step – fast            3<sup>rd</sup> Step – fast            (1)</p> <p><b>Second mark – stand alone</b>            the slow(est)/ first step is the rate determining step            (1)</p> <p><b>Third mark – consequential on correct first mark</b>            (1 mol) <math>N_2O_5</math> is in the rate equation so the reaction with <math>N_2O_5</math> is the slow/ rate determining step  <b>OR</b>            only the species in the rate equation is in the first/ slow/ rate determining step  <b>ALLOW</b>            (there is only 1 mol of) one species/ <math>N_2O_5</math> in the first/ slow/ rate determining step (1)</p> <p><b>ALLOW</b>            1<sup>st</sup> Step – fast            2<sup>nd</sup> Step – slow            3<sup>rd</sup> Step – fast            (1)</p> <p>the slow(est) step/second step is the rate determining step (1)</p> <p>there is only (1 mol of) one species in the steps up to and including the rate determining step (1)</p>		3

Question Number	Acceptable Answers	Reject	Mark
<b>17(c)(i)</b>	(thermostatically controlled) water bath/ ice bath  <b>ALLOW</b> oil bath	direct heating with flame  electrical heater	<b>1</b>

Question Number	Acceptable Answers	Reject	Mark
<b>17(c)(ii)</b>	(1/T) $3.13 \times 10^{-3}$ / $3.125 \times 10^{-3}$ <b>(1)</b>  (lnk) -7.1 / -7.05 / -7.0528 <b>(1)</b>	$3.12 \times 10^{-3}$  -7.0	<b>2</b>

Question Number	Acceptable Answers	Mark
<p>17(c) * (iii)</p>	<div style="text-align: center;">  </div> <p><b>Graph – 3 marks</b></p> <p><b>First mark</b> axes correct with sensible scales i.e. points/line covering at least 3 large squares on the x axis and 5 on the y axis, with <math>\ln k</math> values becoming more negative down the axis and the negative signs shown (1)</p> <p><b>Second mark</b> both axes labelled, with units on x axis and no units on y axis x axis: 3.1-3.5 <math>1/T / 10^{-3}K^{-1}</math> OR 3.1-3.5 <math>1/T \times 10^3/K^{-1}</math> <b>OR</b> 0.0031-0.0035 OR <math>3.1 \times 10^{-3}</math>-<math>3.5 \times 10^{-3}</math> <math>1/T / K^{-1}</math> <b>ALLOW</b> x axis labels at bottom of page (1)</p> <p><b>Third mark</b> points correctly plotted and straight line drawn (1)</p>	

	<p><b>Gradient – 2 marks – this may be shown on the graph</b>  gradient = –11550 to –12760 (K)</p> <p>negative sign (1)  value (ignore sf) (1)</p> <p>maximum 1 mark if an incorrect unit is given</p> <p><b>ALLOW</b> these marks if the correct sign and value for the gradient are shown in the calculation for <math>E_a</math></p> <p><b>Calculation - 2 marks</b></p> <p><b>If <math>E_a = (+)96.0</math> to <math>(+)106</math> kJ mol<sup>-1</sup> or <math>(+)96000</math> to <math>(+)106000</math> J mol<sup>-1</sup>, award 2 marks</b>  <b>If <math>E_a</math> is in this range but is not given to 3 sf, or the units are incorrect or missing, award 1 mark</b></p> <p><b>If not,</b>  <math>E_a = -8.31 \times</math> their gradient  OR  gradient = <math>-E_a/R</math> (1)</p> <p>value to 3 sf <b>and</b> units <b>and</b> consequential sign if negative (1)</p> <p><b>ALLOW</b>  correct answer to 3 sf, in range, <b>with sign and units,</b>  but no working for gradient or <math>E_a</math> (3)</p>	
		<b>7</b>

**Total for Question 17 = 17 marks**



Question Number	Acceptable Answers	Reject	Mark
<b>18(a)(i)</b>	<p><b>IGNORE</b> sf except 1</p> <p><b>If answer is <math>8.485 \times 10^{-3}</math> (mol dm<sup>-3</sup>), award 2 marks</b></p> <p>If not,  <math>[\text{OH}^-(\text{aq})] = \sqrt{K_b [\text{NH}_3]}</math>  <math>= \sqrt{1.8 \times 10^{-5} \times 4.0}</math> (1)  <math>= 8.485 \times 10^{-3}</math> (mol dm<sup>-3</sup>) (1)</p>		<b>2</b>

Question Number	Acceptable Answers	Reject	Mark
<b>18(a)(ii)</b>	<p><b>IGNORE</b> sf except 1</p> <p><b>If answer is 11.9(3)/12, award 2 marks</b></p> <p>If not,  <b>EITHER – Method 1</b>  <math>[\text{H}^+] = \frac{1 \times 10^{-14}}{[\text{OH}^-]}</math>  <math>= \frac{1 \times 10^{-14}}{8.485 \times 10^{-3}}</math> (1)  <math>= 1.179 \times 10^{-12}</math>  <b>ALLOW</b> ecf from their answer to (i)  <math>\text{pH} = -\log 1.179 \times 10^{-12} = 11.9(3)</math>  <b>ALLOW</b> ecf from their answer for <math>[\text{H}^+]</math> (1)  <b>OR – Method 2</b>  <math>\text{pOH} = -\log 8.485 \times 10^{-3} = 2.07</math>  <b>ALLOW</b> ecf from their answer to (i) (1)  <math>\text{pH} = (14 - 2.07 =) 11.9(3)</math>  <b>ALLOW</b> ecf from their answer to pOH (1)</p>		<b>2</b>

Question Number	Acceptable Answers	Mark
18(b)(ii)	<p>(pH = <math>-\log 4.0</math>) = 0.6(021)</p>	1
	<div data-bbox="354 294 1006 976" data-label="Figure"> </div> <p><b>First mark</b> graph starting at 11.9/ answer to a(ii), <math>\pm 1</math> small square, provided above 7 (1)</p> <p><b>Second mark</b> buffering region to 25 cm<sup>3</sup> <b>ALLOW</b> any line showing a decrease in pH from 0 to 25 cm<sup>3</sup> of HCl added (1)</p> <p><b>Third mark</b> straight <b>vertical</b> portion between 8 and 1, midpoint below 7 and between 2 and 7 pH units long (1)</p> <p><b>Fourth mark</b> finishing at +0.5 to -0.8, with at least 27.5 cm<sup>3</sup> of HCl added <b>ALLOW</b> final pH as answer to (b)(i), within 1 pH unit, if pH is less than answer to (b)(i) or within 1 small square if pH is more than answer to (b)(i) (1)</p> <p><b>ALLOW</b> If graph is drawn with aqueous ammonia added to hydrochloric acid, only the second and third marks are available for the correct vertical portion at 25cm<sup>3</sup></p>	4

Question Number	Acceptable Answers	Reject	Mark
18(b)* (iii)	<p><b>First mark</b> any indicator from 4 to 10 or 12, 13 in the Data booklet – see end <b>ALLOW</b> ecf from the vertical portion on their graph (1)</p> <p><b>Second mark</b> alkaline to acidic colour change for their stated indicator <b>ALLOW</b> acidic to alkaline colour change if their curve shows alkali added to acid (1)</p> <p><b>Third mark</b> pH range (of indicator) is within the vertical section of the graph <b>OR</b> pK<sub>in</sub> (<math>\pm 1</math>) is in the vertical section of the graph <b>OR</b> pK<sub>in</sub> is nearest to the pH at the end/ equivalence point <b>ALLOW</b> indicator will change colour in the vertical section of the graph <b>ALLOW</b> Indicator will change colour at the end/ equivalence point <b>ALLOW</b> (because it is a) titration of a strong acid with a weak base (1)</p>	<p>universal indicator loses all 3 marks</p> <p>litmus loses first mark only</p>	3

Question Number	Acceptable Answers	Mark
18(c)(i)	<p><b>IGNORE</b> sf except 1</p> <p><b>If answer is 3.84</b> (mol dm<sup>-3</sup>), <b>award 3 marks</b></p> <p>If not,  number of moles of acid =  <math display="block">\frac{24.0 \times 4}{1000} = 0.096</math> (1)</p> <p><b>EITHER</b></p> <p>number of moles ammonia = 0.096 <b>in 25 cm<sup>3</sup></b> (1)</p> <p>concentration of ammonia  = <math>\frac{0.096 \times 1000}{25}</math>  = 3.84 (mol dm<sup>-3</sup>) (1)</p> <p><b>OR</b></p> <p>number of moles ammonia = 0.288 <b>in 75 cm<sup>3</sup></b> (1)</p> <p>concentration of ammonia  = <math>\frac{0.288 \times 1000}{75}</math>  = 3.84 (mol dm<sup>-3</sup>) (1)</p> <p><b>IGNORE</b> unit unless incorrect</p> <p><b>ALLOW</b> ecf in both methods on their number of moles of ammonia</p>	<b>3</b>

Question Number	Acceptable Answers	Mark
18(c)(ii)	<p><b>IGNORE</b> sf except 1  (concentration of ammonia in trichloromethane =) 0.16 (mol dm<sup>-3</sup>)</p> <p><b>ALLOW</b> ecf from their answer to (c)(i), provided it is less than 4.0 and given to 2 or more sf</p>	<b>1</b>

Question Number	Acceptable Answers	Reject	Mark
18(c)(iii)	<p><b>Expression for K<sub>c</sub> and answer needed for the mark</b></p> $K_c = \frac{[\text{NH}_3(\text{aq})]}{[\text{NH}_3(\text{CHCl}_3)]}$ <p><b>ALLOW</b> one state symbol missing</p> $= \frac{3.84}{0.16}$ $= 24(.0)$ <p><b>IGNORE</b> sf, including 1 sf, and units</p> <p><b>ALLOW</b> ecf from answers to (c)(i) and (c)(ii)</p>	K <sub>c</sub> expressions without both state symbols	<b>1</b>

Question Number	Acceptable Answers	Reject	Mark
<b>18(c) (iv)</b>	(ammonia/ it is much more soluble in water) as can form <b>hydrogen bonds with water</b>  <b>ALLOW</b> more/ stronger hydrogen bonds with water (than with trichloromethane)  <b>IGNORE</b> answers based on polarity/ hydrophilic		<b>1</b>

**Total for Question 18 = 18 marks**

Question Number	Acceptable Answers	Mark
19(a)(i)	<p><b>Penalise lack of + sign once only in (a)(i) or (ii) in each final answer</b></p> <p><b>IGNORE</b> sf in (a)(i), (ii), and (iii) in each final answer, except 1 sf</p> <p><b>FIRST, CHECK THE FINAL ANSWER</b>  +479.7 J mol<sup>-1</sup> K<sup>-1</sup> scores <b>3</b> marks</p> <p>479.7 J mol<sup>-1</sup> K<sup>-1</sup> scores <b>2</b> marks (+ sign missing)</p> <p>+479.7/ 479.7 scores <b>2</b> marks (units and/or + missing)</p> <p>+1709.7 J mol<sup>-1</sup> K<sup>-1</sup> scores <b>2</b> marks – multiple of 12 used for oxygen</p> <p>1709.7 J mol<sup>-1</sup> K<sup>-1</sup>/ +1709.7/ 1709.7 score <b>1</b> mark – multiple of 12 used for oxygen and positive sign and/or units</p> <p>If these answers are not given, award marks as follows:</p> <p><b>First mark</b>  correct data for CO<sub>2</sub> (213.6) <b>and</b> H<sub>2</sub>O (69.9) <span style="float:right"><b>(1)</b></span></p> <p><b>Second mark</b>  correct multiples (12, 11, 1 and 24) <b>and</b> Hess's Law applied  <math display="block">\Delta S^{\circ}_{\text{system}} = 12 \times 213.6 + 11 \times 69.9</math> <math display="block">-(392.4 + 24 \times 102.5)</math></p> <p><b>ALLOW</b> ecf from incorrect data for CO<sub>2</sub> and/or H<sub>2</sub>O <span style="float:right"><b>(1)</b></span></p> <p><b>Third mark</b>  correct answer with sign and units  = +479.7 J mol<sup>-1</sup> K<sup>-1</sup></p> <p><b>ALLOW</b> ecf from incorrect data for CO<sub>2</sub> and/or H<sub>2</sub>O and incorrect multiples <span style="float:right"><b>(1)</b></span></p>	<b>3</b>

Question Number	Acceptable Answers	Reject	Mark	
19(a)(ii)	<p><b>If answer is +18925.2 J mol<sup>-1</sup> K<sup>-1</sup>/</b>  <b>+18.9252 kJ mol<sup>-1</sup> K<sup>-1</sup>, then award 2 marks</b></p> <p><b>If not,</b></p> $\Delta S^{\circ}_{\text{surroundings}} = \frac{-\Delta H^{\circ}}{T}$ $= - \frac{(-5639.7) \times 1000}{298}$ $= + 18925.2 \text{ J mol}^{-1} \text{ K}^{-1} /$ $+18.9252 \text{ kJ mol}^{-1} \text{ K}^{-1}$	<p><b>(1)</b></p> <p><b>(1)</b></p>	<p>+18925.1 J mol<sup>-1</sup> K<sup>-1</sup>/</p> <p>+18.9251 kJ mol<sup>-1</sup> K<sup>-1</sup></p>	<b>2</b>

Question Number	Acceptable Answers	Mark
19(a)(iii)	<p><b>First mark</b>  <math>(\Delta S^{\circ}_{\text{total}} = \Delta S^{\circ}_{\text{surroundings}} + \Delta S^{\circ}_{\text{system}} = 18925.2 + 479.7)</math>  <math>= (+)19404.9 \text{ (J mol}^{-1} \text{ K}^{-1}) / (+)19.4049 \text{ (kJ mol}^{-1} \text{ K}^{-1})</math></p> <p>if units given they must be correct</p> <p><b>ALLOW</b>  <math>(+)19500 \text{ (J mol}^{-1} \text{ K}^{-1}) / (+)19.5 \text{ (kJ mol}^{-1} \text{ K}^{-1})</math> (from 19.0 + 0.480)</p> <p><b>ALLOW</b>            ecf on adding answers to (a)(i) and (a)(ii) in the same units            (1)</p> <p><b>Note</b>            If answer to (a)(i) was +1709.7,  <math>\Delta S^{\circ}_{\text{total}} = +20634.9 \text{ (J mol}^{-1} \text{ K}^{-1}) / +20.6349 \text{ (kJ mol}^{-1} \text{ K}^{-1})</math></p> <p><b>Second mark</b>  <math>(\Delta S^{\circ}_{\text{total}}</math> is positive so) reaction is (thermodynamically) spontaneous/            feasible/ goes to completion</p> <p><b>ALLOW</b> thermodynamically unstable</p> <p>If their sign for <math>\Delta S^{\circ}_{\text{total}}</math> is negative, then <b>ALLOW</b> reaction is not            spontaneous/ not feasible/ does not go to completion (1)</p>	2

Question Number	Acceptable Answers	Reject	Mark
19(a)(iv)	<p><b>IGNORE</b> comments on <math>\Delta S^\ominus_{\text{system}}</math></p> <p><b>First mark</b>  <math>(\Delta S^\ominus_{\text{surroundings}} = -\Delta H^\ominus/T</math> so increase in T makes)  <math>\Delta S^\ominus_{\text{surroundings}}</math> less positive/ decreases  <b>ALLOW</b> more negative (1)</p> <p><b>Second mark</b>  <math>(\Delta S^\ominus_{\text{total}} = \Delta S^\ominus_{\text{surroundings}} + \Delta S^\ominus_{\text{system}}</math> so increase in T makes)  <math>\Delta S^\ominus_{\text{total}}</math> less positive/ decreases  <b>ALLOW</b> more negative  <b>NOTE no ecf</b> on <math>\Delta S^\ominus_{\text{surroundings}}</math> increases (1)</p> <p><b>Third mark</b>            (because <math>\Delta S^\ominus_{\text{total}}</math> is so large and positive to start with)            there is an insignificant effect on the extent of the reaction  <b>ALLOW</b>  <math>\Delta S^\ominus_{\text{total}}</math> is still positive so reaction still goes to completion/is spontaneous  <b>ALLOW</b> ecf on <math>\Delta S^\ominus_{\text{total}}</math> increases (1)</p>	more exothermic	3

Question Number	Acceptable Answers	Reject	Mark
19(a)(v)	<p><b>First mark</b>            (stable because) high activation energy/ <math>E_a</math> (for combustion of sucrose)  <b>ALLOW</b> sucrose is kinetically stable/ inert (1)</p> <p><b>Second mark</b>            (hazardous because small particles/ powder have/ has) larger surface area <b>and</b> react faster (1)</p> <p><b>IGNORE</b> any reference to temperature</p> <p>If answers are not linked to stability and hazardous, still award both marks even if the points are written in the wrong order</p>		2



Question Number	Acceptable Answers	Reject	Mark
<b>19(a) (vi)</b>	Any two of: obesity/ weight gain/ stored as fat/ get fat (1) tooth decay/ cavities/ toothache (1) diabetes/ glycosuria (1) heart/ cardiovascular condition/ disease/ attack (1) strokes (1) damage to the immune system (1) high insulin levels (1) high blood pressure (1) kidney damage (1) liver disease (1) headaches/ migraines (1) arthritis (1) high cholesterol (1) <b>IGNORE</b> risk of cancer/ high blood sugar/ stomach ulcers		<b>2</b>

Question Number	Acceptable Answers	Reject	Mark
<b>19(b) (i)</b>	circles or asterisks on carbons 2-5 all four correct (2) 3 or 2 correct (1) 1 or 0 correct (0) <b>ALLOW</b> 5 carbons circled (1)	all 6 carbons circled (0)	<b>2</b>

Question Number	Acceptable Answers	Reject	Mark
<b>19(b) (ii)</b>	rotate the plane of (plane-) polarized light <b>ALLOW</b> rotate plane-polarized light <b>IGNORE</b> optically active/ optical activity/ non-superimposable	just 'rotate light'	<b>1</b>

Question Number	Acceptable Answers	Reject	Mark
19(b)(iii)	<p><b>First mark – colour change</b> from a <b>blue</b> (solution) to a <b>red/ orange/ brown/ yellow precipitate</b></p> <p><b>ALLOW</b> solid or (s) for precipitate which could be shown in formula or equation (1)</p> <p><b>Second mark – functional group</b> (glucose/it is) an aldehyde / (has) a CHO group (1)</p> <p><b>Third mark – oxidation/reduction</b> copper(II)/Cu<sup>2+</sup> is <b>reduced</b> (to copper(I)/Cu<sup>+</sup> oxide by the aldehyde group) /Cu<sup>2+</sup> + e<sup>(-)</sup> → Cu<sup>+</sup></p> <p><b>OR</b> the aldehyde/ glucose is <b>oxidized</b> (to the carboxylate/carboxylic acid)/ RCHO + [O] → RCOOH</p> <p><b>OR</b> Benedict's and Fehling's (solutions) are oxidizing agents</p> <p><b>ALLOW</b> equation showing oxidation of aldehyde and reduction of Cu<sup>2+</sup> even if not balanced (1)</p>	incorrect observation for one of the reagents for first mark only, eg. silver mirror formed	3

Total for Question 19 = 20 marks

