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2002

**XVIII**

1583

Time allowed  
**62 Minutes**

Score

**/52**

Percentage

**%**

**CHEMISTRY**

**Edexcel  
AS & A LEVEL**

**Mark Scheme**

**Paper 2: Advanced Organic  
and Physical Chemistry**

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Question Number	Correct Answer	Reject	Mark
<b>1</b> (a)	<p>EITHER (consideration of kinetics)</p> <p>Rate of reaction increases (1)</p> <p>As collisions are more frequent / increases frequency of collisions / more collisions per second</p> <p>IGNORE Just 'more collisions' or just 'more successful collisions' (1)</p> <p>OR (if assumes an equilibrium reaction)</p> <p>Yield increases / eq'm shifts to RHS (1)</p> <p>Since fewer moles of gas / no moles of gas / fewer molecules of gas (on RHS) (1)</p> <p>MUST AWARD MARKS BY ONLY CONSIDERING ONE OF THE ROUTES – CANNOT score full marks via one mark from each route if 'MIX UP' KINETICS AND EQUILIBRIUM ARGUMENTS</p> <p>Eg Rate increases, so yield of product increases scores (1)</p>		2



Question Number	Correct Answer	Reject	Mark
<b>1 (b)</b>	<p>[FIRST, CHECK THE FINAL ANSWER IF ANSWER = 3.1 (tonnes), award 3 marks]</p> <p>EITHER</p> <p>1 tonne <math>C_6H_5ONa</math> : 180/116 tonnes <math>C_6H_4(OH)(CO_2H)</math> (1)</p> <p>2.5 tonnes <math>C_6H_5ONa</math> : <math>(180/116) \times 2.5</math> (tonnes) <math>C_6H_4(OH)(CO_2H)</math> at 100% yield (1) (= 3.879 tonnes)</p> <p>So actual yield = <math>(180/116) \times 2.5 \times 79/100</math> <math>(3.06) = 3.1</math> (tonnes) (1)</p> <p>OR</p> <p>Moles <math>C_6H_5ONa</math> (<math>= 2.5 \times 10^6 \div 116</math>) <math>= 21\,551.7</math> (mol) (1)</p> <p>Moles <math>C_6H_5ONa</math> (79% yield) (<math>= 21\,551.7 \times 0.79</math>) <math>= 17025.8</math> (mol) (1)</p> <p>Mass <math>C_6H_5ONa</math> (<math>= 17025.8 \times 180</math> <math>= 3064644</math> g <math>= 3.06</math> tonnes) <math>= 3.1</math> (tonnes) to 2SF (1)</p> <p>Correct answer TO 2 SF, no working (3)</p> <p>Can work in g (instead of tonnes) until final answer</p> <p>So final answer of 3.06 (tonnes) scores M1 and M2 only</p> <p>Award only (1) mark for 3.07 (tonnes) without working</p>	g	3

Question Number	Correct Answer	Reject	Mark
<b>1</b> (c)	<p>Esterification / acylation / ethanoylation  ALLOW  'acetylation'</p> <p>OR</p> <p>'(nucleophilic) addition-elimination'</p> <p>BOTH words (addition and elimination) are needed for this option</p> <p>IGNORE  'Condensation'</p> <p>(1)</p> <p>CH<sub>3</sub>COCl / ethanoyl chloride  OR  (CH<sub>3</sub>CO)<sub>2</sub>O / ethanoic anhydride</p> <p>(1)</p> <p>ALLOW</p> <p>CH<sub>3</sub>COOH / ethanoic acid  (in presence of H<sub>2</sub>SO<sub>4</sub>)</p> <p>Correct displayed / skeletal formulae</p> <p>IGNORE</p> <p>JUST 'acid anhydride' / 'acid chloride'</p>		2

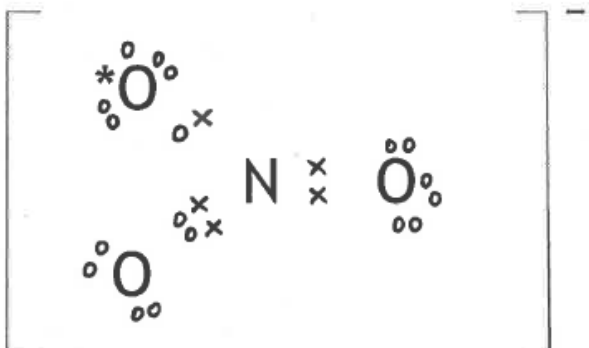


Question Number	Acceptable Answers	Reject	Mark
2(a)	<p>1<sup>st</sup> Mark Mol CuO = <math>(5.60/79.5) = 0.07044 / 0.0704 / 0.070 / 0.07</math> (1)</p> <p>2<sup>nd</sup> Mark Mol of nitric acid = <math>(50 \times 2.50/1000) = 0.125</math> (1)</p> <p>3<sup>rd</sup> Mark Reacting ratio = 2: 1 and nitric acid less than double moles of copper oxide/ Reacting ratio = 2: 1 and copper oxide more than half of moles of nitric acid</p> <p>OR moles acid needed to react with all CuO = <math>(2 \times 0.070 =) 0.140</math> which is more than 0.125</p> <p>OR 0.125 mol nitric acid can only react with 0.0625 mol CuO (1)</p>		3

Question Number	Acceptable Answers	Reject	Mark
2(b)	<p>1<sup>st</sup> Mark  Moles product = <math>0.5 \times 0.125 = 0.0625</math>  (1)</p> <p>Allow TE from moles HNO<sub>3</sub></p> <p>2<sup>nd</sup> Mark  Theoretical yield = <math>(0.0625 \times 295.6 = )</math>  18.475 g  (1)</p> <p>Allow ECF on multiplying moles product by 295.6</p> <p>3<sup>rd</sup> Mark  % yield = <math>(12.52/18.475 \times 100) = 67.767 / 67.8 / 68</math>  (1)</p> <p>Alternative route for 2<sup>nd</sup> and 3<sup>rd</sup> Marks  mol product = <math>(12.52 / 295.6) = 0.04235</math>  (1)</p> <p>% yield = <math>(0.04235/0.0625 \times 100 = 67.767 / 67.8/ 68</math>  (1)</p> <p>TE from (a)</p> <p>If moles of product taken as 0.125, final answer = 33.88% which scores (2)</p> <p>TE for calculation based on moles of copper(II) oxide which gives an answer between 60.128% and 60.506%  max(2)</p>	<p>4.24% scores (0) overall</p>	3

Question Number	Acceptable Answers	Reject	Mark
<b>2(c)</b>	Some product remains in solution/ some product does not crystallize  Allow loss of material on transferring, if explained, such as Crystals remain in / on filter paper 'Spitting' (of solution on heating)  IGNORE References to impure reactants	Incomplete reaction  Just experimental error  'solution evaporates'	1

Question Number	Acceptable Answers	Reject	Mark
<b>2(d) (i)</b>	Covalent bond: (shared pair of electrons using) one electron from each atom (1)  Dative covalent bond: (shared pair of electrons using) two electrons from same atom (1)		2

Question Number	Acceptable Answers	Reject	Mark
<b>2(d) (ii)</b>	Double bond between N and one oxygen atom (1)  Single bond between N and O* (1)  Dative single bond between N and one O atom (1)   Max 2 if any lone pair electrons are missing from any of the three oxygen atoms.		3



Question Number	Acceptable Answers	Reject	Mark				
	In (a) any units given must be correct. Penalise incorrect units once only. Ignore SF except 1 SF in (i), (iii) and (iv). Penalise once only						
<b>3</b> (a) (i)	<table border="1"><tr><td>Volume Added/cm<sup>3</sup></td><td>25(.00)</td><td>24.6(0)</td><td>24.5(0)</td></tr></table> <p style="text-align: center;">24.55 (cm<sup>3</sup>)</p> Allow 24.6 (cm <sup>3</sup> )	Volume Added/cm <sup>3</sup>	25(.00)	24.6(0)	24.5(0)	24.70  24.60	1
Volume Added/cm <sup>3</sup>	25(.00)	24.6(0)	24.5(0)				

Question Number	Acceptable Answers	Reject	Mark
<b>3</b> (a) (ii)	NaOH + HCl → NaCl + H <sub>2</sub> O  Ignore state symbols even if incorrect		1

Question Number	Acceptable Answers	Reject	Mark
<b>3</b> (a) (iii)	Number of moles of NaOH = $\frac{24.55 \times 2.5}{1000} = 6.1375 \times 10^{-2} = 0.061375(\text{mol})$ OR $6.14 \times 10^{-2} = 0.0614$ OR $6.1 \times 10^{-2} = 0.061$  Allow TE from 20(a) (i)	0.0613 0.06	1

Question Number	Acceptable Answers	Reject	Mark
<b>3</b> (a) (iv)	$6.1375 \times 10^{-2} / 0.061375 / 6.14 \times 10^{-2} / 0.0614 / 0.061(\text{mol})$  Allow TE = answer to (a) (iii)		1

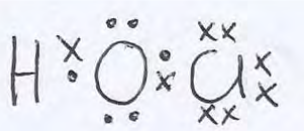
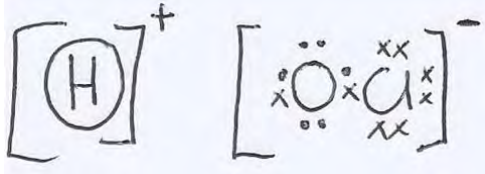
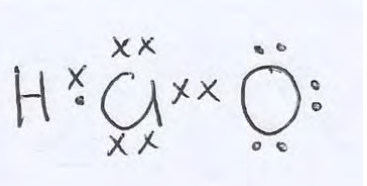


Question Number	Acceptable Answers	Reject	Mark
<b>3</b> (a) (v)	<p>Multiply by 4 and by 36.5 (1)</p> <p>Using <math>6.1375 \times 10^{-2}</math> gives 8.96075 = 8.96 (g)</p> <p>OR</p> <p>Using <math>6.14 \times 10^{-2}</math> gives 8.9644 = 8.96(g)</p> <p>OR</p> <p>Using <math>6.1 \times 10^{-2}</math> gives 8.906 = 8.91(g)</p> <p>Answer to 3 SF (1)</p> <p>Correct answer without working score (2)</p> <p>Allow TE from (a)(iv)</p> <p>ALLOW one mark for correct answer to 3SF where the multiplication by 4 has been omitted, e.g.  <math>(6.1375 \times 10^{-2} \times 36.5 = 2.2401875 =) 2.24(g)</math> (1)</p>		2

Question Number	Acceptable Answers	Reject	Mark
<b>3</b> (a) (vi)	<p>The statement is valid as 8.96 ~9/very close</p> <p>Allow appropriate comment from answer to (a)(v) e.g 2.24 is not valid because it is too far away from 9g.</p>	Just 'not valid / valid'	1

Question Number	Acceptable Answers	Reject	Mark
<b>3</b> a(vii)	<p>(Too) corrosive Damages eyes/burns (skin)/caustic</p> <p>Ignore Dangerous/Strong/Too concentrated</p>	<p>Just 'Harmful/Irritant/Toxic/Hazardous'</p> <p>Acid</p>	1



Question Number	Acceptable Answers	Reject	Mark
20 (b)	 <p>Allow all dots or all crosses</p> <p>ALLOW ionic dot and cross</p>  <p>Or dative covalent bond from chlorine</p> 		1

Question Number	Acceptable Answers	Reject	Mark
20 (c)	$\text{HCl} + \text{HOCl} \rightarrow \text{H}_2\text{O} + \text{Cl}_2$ (1) Ignore state symbols even if incorrect		2
	Chlorine is toxic/poisonous (1) Allow fumes are toxic Ignore references to smell or colour	Just 'Harmful/ irritant/dangerous/ hazardous'	

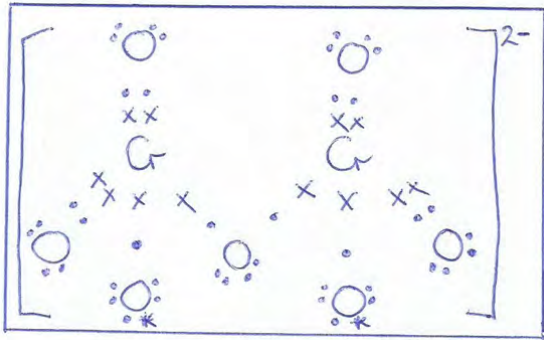


Question Number	Acceptable Answers	Reject	Mark
<b>3</b> (d) (i)	$(2\text{NaOH} + \text{Cl}_2 \rightarrow \text{NaCl} + \text{NaClO} + \text{H}_2\text{O})$ $\quad\quad\quad 0 \quad\quad\quad -1 \quad\quad\quad +1$ All oxidation numbers correct (1) Type: Disproportionation (1) Allow phonetic spellings Allow redox and disproportionation Second mark consequential on the first except if  (i) all the oxidation numbers are zero (ii) the plus sign is missing, (iii) first two oxidation numbers are correct and the third one is positive  If all the elemental oxidation numbers are given correctly then both marks are available	Just redox	2

Question Number	Acceptable Answers	Reject	Mark
<b>3</b> (d) (ii)	Heat/increase temperature ALLOW (more) concentrated NaOH	Just 'warm' / 'excess NaOH'  Acid	1

Question Number	Acceptable Answers	Reject	Mark
<b>3</b> (d) (iii)	$3\text{Cl}_2 + 6\text{NaOH} \rightarrow 5\text{NaCl} + \text{NaClO}_3 + 3\text{H}_2\text{O}$ OR $3\text{Cl}_2 + 6\text{OH}^- \rightarrow 5\text{Cl}^- + \text{ClO}_3^- + 3\text{H}_2\text{O}$  Formula of $\text{NaClO}_3$ / $\text{ClO}_3^-$ (1) Rest of equation correct (1)  Ignore state symbols even if incorrect		2



Question Number	Acceptable Answers	Reject	Mark
4 (a)	 <p>The correct number of dots and crosses around both chromium atoms (1)</p> <p>All the oxygen atoms to have the correct number of bonds and the lone pairs (1)</p> <p>The extra 2 electrons from the potassium on the oxygen(s) (1)</p>	Both * on the same oxygen	3

Question Number	Acceptable Answers	Reject	Mark
4 (b) (i)	$(n = 14.71 \div 294.2 = ) 0.0500 \text{ (mol)}$ (1)  $(c = 0.0500 \div 0.25 = ) 0.200 \text{ (mol dm}^{-3}\text{)}$ (1) Allow TE on incorrect $M_r$ value  Allow use of 294 Correct answer without working scores (2) Allow 1SF  If units are given then they must be correct		2

Question Number	Acceptable Answers	Reject	Mark
<b>4</b>	(0.00250 x 6 = ) 0.0150 (mol)		2
(b) (ii)	(0.0150 x 166 = 2.49 (g)) (1)		
	2.6 ≤ value ≤ 5.0 (g) (1)		
	TE for suitable mass to use on incorrect calculation		
	Suitable mass must be between 0.10 g more than the calculated value but less than or equal to double the calculated value		
	Allow 1 SF for the suitable mass		

Question Number	Acceptable Answers	Reject	Mark
<b>4</b>	(0.00260 x 2 =) 0.00520 (mol) (1)		2
(b) (iii)	(V=0.00520 ÷ 0.16 x 1000 =) 32.5 (cm <sup>3</sup> ) / 0.0325 dm <sup>3</sup> (1)		
	Allow answer without working (2)		
	Volume must be at least 3 SF		

Question Number	Acceptable Answers	Reject	Mark
<b>4</b>	Percentage error large with a small mass/ Mass is only to 1 SF (1)	Just 'mass is not accurate'	2
(b) (iv)		Reference to concentration.	
	No repeats possible (1)		

Question Number	Acceptable Answers	Reject	Mark
<b>4</b> (c) (i)	$\text{Cl}^- \rightarrow \frac{1}{2}\text{Cl}_2 + \text{e}^{(-)}$ OR $\text{Cl}^- - \text{e}^{(-)} \rightarrow \frac{1}{2}\text{Cl}_2$  Ignore state symbols even if wrong Allow multiples  Allow $2\text{HCl} \rightarrow \text{Cl}_2 + 2\text{e}^{(-)} + 2\text{H}^+$	Reverse equation  Iodide equation	1

Question Number	Acceptable Answers	Reject	Mark
<b>4</b> (c) (ii)	(Gas X) Ammonia / $\text{NH}_3$ Allow ammonia (solution) / $\text{NH}_3$ (aq) (1)  (Observation) White smoke / solid  ALLOW Dense white fumes/white cloud (1)  The observation mark is consequential on the Gas X being correct or a near-miss  If name and formula given then both must be correct	Misty fumes/ White gas/ White ppt/ Steamy fumes	2

Question Number	Acceptable Answers	Reject	Mark
<b>4</b> (d)	Cream ppt / solid  ALLOW Off white / pale yellow (1)  Cream ppt/ $\text{AgBr}$ remains in dilute $\text{NH}_3$ but dissolves in conc. $\text{NH}_3$ (1)  $\text{AgCl}$ dissolves in both dilute and conc. $\text{NH}_3$ (1)	Just yellow/ Just white  Just bromide ions	3