Question Number	Correct Answer	Reject	Mark
1 (a)	**EITHER** (consideration of kinetics) Rate of reaction increases **(1)** As collisions are **more frequent** / **increases frequency** of collisions / more collisions **per second** IGNORE **Just** 'more collisions' or **just** 'more successful collisions' **(1)** **OR** (if assumes an equilibrium reaction) Yield increases / eq'm shifts to RHS **(1)** Since fewer moles **of gas** / no moles **of gas** / fewer molecules **of gas** (on RHS) **(1)** **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** Eg Rate increases, so yield of product increases scores **(1)**		**2**

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

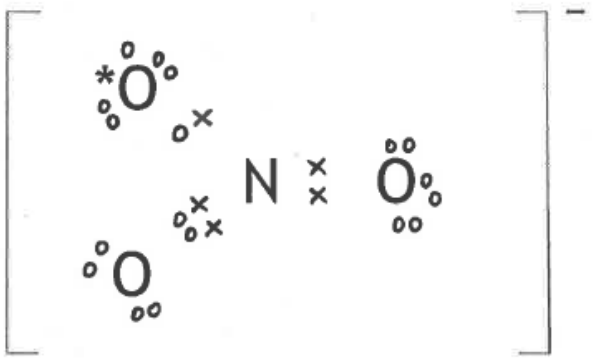
Question Number	Correct Answer	Reject	Mark
1 (c)	Esterification / acylation / ethanoylation ALLOW 'acetylation' **OR** '(nucleophilic) addition-elimination' BOTH words (addition and elimination) are needed for this option IGNORE 'Condensation' **(1)** CH_3COCl / ethanoyl chloride **OR** $(CH_3CO)_2O$ / ethanoic anhydride **(1)** ALLOW CH_3COOH / ethanoic acid (in presence of H_2SO_4) Correct displayed / skeletal formulae **IGNORE** JUST 'acid anhydride' / 'acid chloride'		**2**

Question Number	Acceptable Answers	Reject	Mark
2(a)	**1st Mark** Mol CuO = (5.60/79.5) = 0.07044 / 0.0704 / 0.070 / 0.07 **(1)** **2nd Mark** Mol of nitric acid = (50 x 2.50/1000) = 0.125 **(1)** **3rd 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 OR moles acid needed to react with all CuO = (2 x 0.070 =) 0.140 which is more than 0.125 OR 0.125 mol nitric acid can only react with 0.0625 mol CuO **(1)**		3

Question Number	Acceptable Answers	Reject	Mark
2(b)	**1st Mark** Moles product = 0.5 x 0.125 =0.0625 **(1)** Allow TE from moles HNO_3 **2nd Mark** Theoretical yield = (0.0625 x 295.6 =) 18.475 g **(1)** Allow ECF on multiplying moles product by 295.6 **3rd Mark** % yield = (12.52/18.475 x 100) = 67.767 / 67.8 / 68 **(1)** **Alternative route for 2nd and 3rd Marks** mol product = (12.52 / 295.6) = 0.04235 **(1)** % yield = (0.04235/0.0625 x 100 = 67.767 / 67.8/ 68 **(1)** TE from (a) If moles of product taken as 0.125, final answer = 33.88% which scores **(2)** TE for calculation based on moles of copper(II) oxide which gives an answer between 60.128% and 60.506% **max(2)**	4.24% scores **(0)** overall	3

Question Number	Acceptable Answers	Reject	Mark
2(c)	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
2(d)(i)	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
2(d)(ii)	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**		
3 (a)(i)	Volume Added/cm^3 | 25(.00) | 24.6(0) | 24.5(0) 24.55 (cm^3) Allow 24.6 (cm^3)	24.70 24.60	1

Question Number	Acceptable Answers	Reject	Mark
3 (a)(ii)	$NaOH + HCl \rightarrow NaCl + H_2O$ Ignore state symbols even if incorrect		1

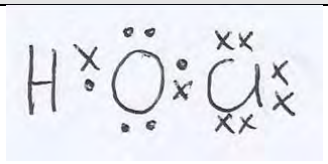
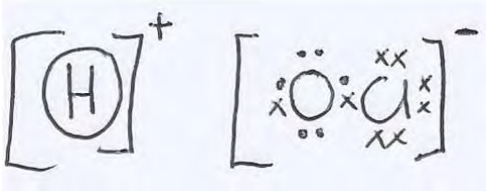
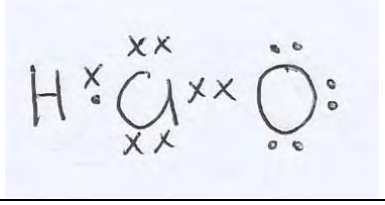
Question Number	Acceptable Answers	Reject	Mark
3 (a)(iii)	Number of moles of NaOH $= (\frac{24.55}{1000} \times 2.5) = 6.1375 \times 10^{-2} = 0.061375$(mol) OR $6.14 \times 10^{-2} = 0.0614$ OR $6.1 \times 10^{-2} = 0.061$ Allow TE from 20(a)(i)	0.0613 0.06	1

Question Number	Acceptable Answers	Reject	Mark
3 (a)(iv)	6.1375×10^{-2} /0.061375/ 6.14×10^{-2} / 0.0614/0.061(mol) Allow TE = answer to (a)(iii)		1

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

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

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

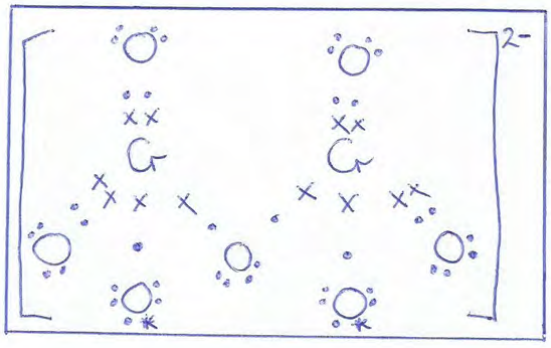
Question Number	Acceptable Answers	Reject	Mark
20 (b)	 Allow all dots or all crosses ALLOW ionic dot and cross  Or dative covalent bond from chlorine 		1

Question Number	Acceptable Answers	Reject	Mark
20 (c)	$HCl + HOCl \rightarrow H_2O + Cl_2$ **(1)** Ignore state symbols even if incorrect Chlorine is toxic/poisonous **(1)** Allow fumes are toxic Ignore references to smell or colour	Just 'Harmful/ irritant/dangerous/ hazardous'	2

Question Number	Acceptable Answers	Reject	Mark
3 (d)(i)	($2NaOH + Cl_2 \rightarrow NaCl + NaClO + H_2O$) 0 -1 **+**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)** irst 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
3 (d)(ii)	Heat/increase temperature ALLOW (more) concentrated NaOH	Just 'warm' / 'excess NaOH' Acid	1

Question Number	Acceptable Answers	Reject	Mark
3 (d)(iii)	$3Cl_2 + 6NaOH \rightarrow 5NaCl + NaClO_3 + 3H_2O$ OR $3Cl_2 + 6OH^- \rightarrow 5Cl^- + ClO_3^- + 3H_2O$ Formula of $NaClO_3$ / ClO_3^- **(1)** Rest of equation correct **(1)** Ignore state symbols even if incorrect		2

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

Question Number	Acceptable Answers	Reject	Mark
4 (b)(i)	(n=14.71 ÷ 294.2 =) 0.0500 (mol) **(1)** (c= 0.0500 ÷ 0.25 =) 0.200 (mol dm^{-3}) **(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
4 **(b)(ii)**	(0.00250 x 6 =) 0.0150 (mol) (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		2

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

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

Question Number	Acceptable Answers	Reject	Mark
4 (c)(i)	$Cl^- \rightarrow \frac{1}{2}Cl_2 + e^{(-)}$ OR $Cl^- - e^{(-)} \rightarrow \frac{1}{2}Cl_2$ Ignore state symbols even if wrong Allow multiples Allow $2HCl \rightarrow Cl_2 + 2e^{(-)} + 2H^+$	Reverse equation Iodide equation	1

Question Number	Acceptable Answers	Reject	Mark
4 (c)(ii)	(Gas X) Ammonia / NH_3 Allow ammonia (solution) / 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
4 (d)	Cream ppt / solid ALLOW Off white / pale yellow **(1)** Cream ppt/AgBr remains in dilute NH_3 but dissolves in conc. NH_3 **(1)** AgCl dissolves in both dilute and conc. NH_3 **(1)**	Just yellow/ Just white Just bromide ions	3