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GCE

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Chemistry (Nuffield) (6254/01)

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Mark Scheme (Results)

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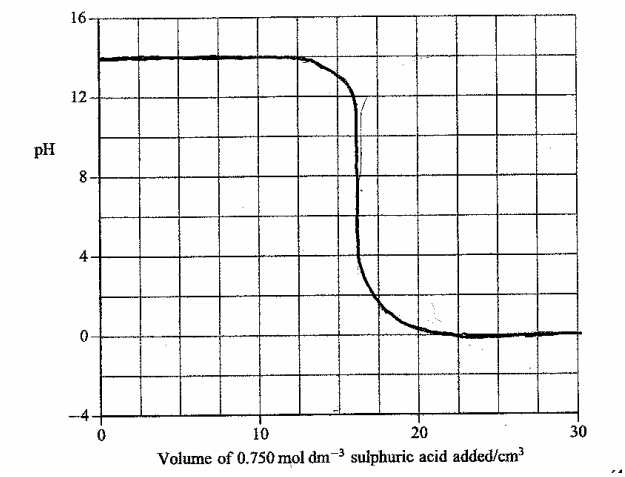
1	(a)	(i)	1 mol of KOH = 39 + 16 + 1 = 56 **(1)** *ALLOW this mark if 56 seen in calculation* Concentration = 70/56 = 1.25 (mol dm^{-3}) **(1)** *ALLOW TE for incorrect mass of KOH* *IGNORE minor slip in units if given* *Answer* 1.25 (mol dm^{-3}) *with no working* **(2)**	**(2 marks)**
		(ii)	pH = - log $[H^+]$ $[H^+]$ $[OH^-]$ = 1.0 x 10^{-14} mol $^2dm^{-6}$ $[OH^-]$ = 1.25 $[H^+] = \frac{1.0 \times 10^{-14}}{1.25}$ **(1)** = 8 x 10^{-15} *ALLOW TE from (a)(i)* pH = 14.1 **(1)** *ALLOW* 14.10, 14.097 *or* 14 *if a correction to 2SF from more SF* *Answer* 14.1 *with no working* **(2)** *No TE within (ii) from wrong* $[H^+]$	**(2 marks)**
	(b)	(i)	$H_2SO_4 + 2KOH \rightarrow K_2SO_4 + \mathbf{2}H_2O$ *Formulae and balancing* *Check carefully the balancing of* $2H_2O$ *IGNORE state symbols*	**(1 mark)**
		(ii)	moles of KOH = $\frac{25}{1000}$ = 0.025 moles of $H_2SO_4 = \frac{0.025}{2} = 0.0125$ **(1)** titration value = $\frac{1250}{75}$ = 16.7 cm^3 **(1)** *ALLOW TE from (b)(i) if 1:1 titration value 33.3* cm^3 *ALLOW 16⅔* cm^3 *NOT 16.6 / 17 / 16.67* cm^3 *Must be 3SF and include correct units* *Answer 16.7* cm^3 *with no working* **(2)**	**(2 marks)**

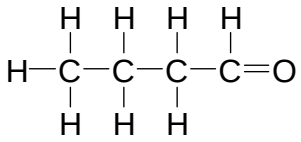
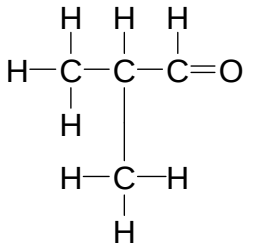
		(iii)	 Starting at about pH 14 and finishing between 2 and -1 **(1)** *Do not allow starting point from answer to (a)(ii) except for 14.1* Vertical portion must cover pH 10 → 4 and vertical means no more than ½ a scale unit horizontally and be not more than 12 and not less than 2 covering 6-10 pH units **(1)** Centred on pH 7 **(1)** *ALLOW centred between pH 6.5 and 7.5* Vertical portion corresponding to 16.7 cm^3 of sulphuric acid **(1)** *ie approximately halfway between 15 and 17.5 on horizontal axis* *ALLOW TE from (b)(ii)* *If graph drawn wrong way up only 2nd, 3rd and 4th marks are possible*	**(4 marks)**
		(iv)	Any named indicator with some explanation eg changes colour at the right point **(1)** *Mention of litmus or U.I. scores* **(0)** The indicator changes colour within the vertical part of the graph/at the equivalence point *OR* because titration involves a strong acid and strong base **(1)** Methyl orange because a strong acid is used **(2)** Phenolphthalein because a strong base is used **(2)**	**(2 marks)**

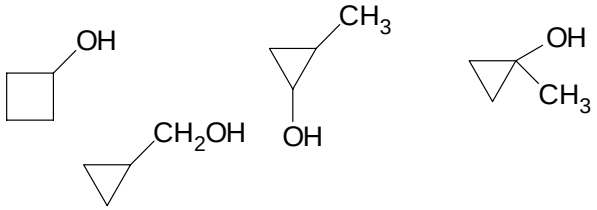
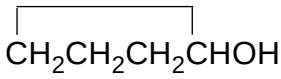
	(c)	(i)	Check rinse water/peaches are no longer alkaline *OR* it is no longer alkaline *OR* check that it is neutral/free from KOH **(1)** as alkalis are corrosive/harmful/irritant **(1)** *NOT* poisonous/toxic/dangerous/fatal/neutralise stomach acid *Mark independently* *Corrosive/harmful plus poisonous etc loses 2nd mark* *If sulphuric acid is mentioned as only problem* **(0)**, *but if it is mentioned with KOH* **(1 max)**	**(2 marks)**
				Total for Question: 15 Marks

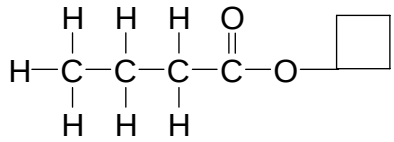
2	(a)	$C_{10}H_8$ *ALLOW* $(C_5H_4)_2$ *NOT* $(C_6H_4)_2$		**(1 mark)**
	(b)	(i)	− 600 *NOT* + 600 *NOT* 600	**(1 mark)**
		(ii)	Naphthalene is more/very stable than double bonds suggest **(1)** *Must be a comparison for the 1st mark* Therefore the electrons/bonds may be/are delocalised (over the ring system) *OR* it is a delocalised system **(1)** *No TE from (i)* *Delocalised mark can be given if delocalisation mentioned in (iii)*	**(2 marks)**
		(iii)	No because it is likely to react like benzene / delocalised structure / no double bonds *OR* bromine not a strong enough electrophile without a catalyst *OR* "yes but only if **bromine** [NOT bromine solution] and a catalyst"	**(1 mark)**
	(c)	(i)	<u>Reagent</u> 2–chloropropane **(1)** *ALLOW* 1–chloropropane *OR* other halogenopropanes *NOT* chloropropane *NOT* bromo–2–propane *ALLOW formula with or without non-systematic name* *ALLOW* $ClCH(CH_3)_2$ *OR* $(CH_3)_2CHCl$ *OR* $C(CH_3)_2HCl$ *OR* $ClC(CH_3)_2H$ <u>Catalyst</u> aluminium chloride / $AlCl_3$/Al_2Cl_6 OR aluminium bromide / $AlBr_3$ *OR* iron(III) chloride/$FeCl_3$ **(1)** *NOT* $AlCl_4^{(-)}$ *NOT* "iron" *on its own* *If both correct but wrong way round* **1 (out of 2)**	**(2 marks)**
		(ii)	electrophilic **(1)** substitution **(1)** *Can be given in any order* *Mark independently*	**(2 marks)**
				Total for Question: 9 marks

3	(a)	(i)	Negative with some sensible explanation eg fewer moles of product **(1)** 3 moles of gases going to 2 moles of gases **(1)** *MUST mention gases or no changes in state*	**(2 marks)**
		(ii)	Positive *with some explanation* eg exothermic so surroundings gain entropy **(1)** $\Delta S_{surroundings} = -\frac{\Delta H}{T}$ [*OR given in words*] *OR* $\Delta S_{total} = \Delta S_{system} + \Delta S_{surroundings}$ [*OR given in words*] as reaction goes, ΔS_{total} must be positive therefore $\Delta S_{surroundings}$ must be positive *OR* Surroundings gain energy so more ways of arranging energy **(1)**	**(2 marks)**
	(b)	(i)	$(K_P) = \frac{P_{NO_2}^2}{P_{NO}^2 \times P_{O_2}}$ **(1)** *Check that it is not a "+" on denominator.* *ALLOW ( ) but NOT [ ]* eg *ALLOW* $(P_{NO_2})^2$ etc *ALLOW* $(pNO_2)^2$ atm^{-1} / Pa^{-1} / kPa^{-1} / $m^2 N^{-1}$ **(1) –** *2nd mark dependent on 1st* *ALLOW* $atms^{-1}$ / $atmospheres^{-1}$ *NOT* atm^{-} *etc* *NOT* Kpa^{-1}	**(2 marks)**
		(ii)	<u>Temperature</u> A lower temperature is needed to get a better yield (and would cost less) because the reaction is exothermic **(1)** but the lower temperature may slow the reaction down too much *OR reverse argument* **(1)** <u>Pressure</u> A high pressure will increase yield as only two moles on the right compared to three on the left/less moles on the right hand side**(1)** It will also increase the rate of the reaction **(1)** *Low pressure because of cost only gets mark if higher yield at higher pressure identified* *To award any of the yield marks must say why*	**(4 marks)**

	(c)	(i)	*Must be a quantity that can be measured* Eg The pressure could be measured **(1)** as it will decrease as the reaction proceeds because there are only two/fewer moles on the right compared to three on the left **(1)** *OR* colour **(1)** as the nitrogen(IV) oxide is brown whereas the other gases are colourless **(1)** *OR* total volume **(1)** which will decrease by one third/because there are fewer moles **(1)** *ALLOW* acidity because NO_2 acidic **and** others not **(1 max)** *NOT* dilatometry *NOT* temperature	**(2 marks)**
		(ii)	[NO] second order **(1)** because when conc of NO is doubled, the rate goes up four times **(1)** $[O_2]$ first order **(1)**	**(3 marks)**
		Then (iii), (iv) and (v) must follow consistently from (ii)		
		(iii)	rate = $k[NO]^2[O_2]$ *ALLOW TE from (ii) e.g.* rate = $k[NO][O_2]$	**(1 mark)**
		(iv)	third / 3 second / 2	**(1 mark)**
		(v)	8000 **(1)** $dm^6\ mol^{-2}\ s^{-1}$ **(1)** 8 **(1)** $dm^3\ mol^{-1}\ s^{-1}$ **(1)** *Units can be given in any order*	**(2 marks)**
	(d)	The activation energy must be low *OR* bond energies low *NOT* "more successful collisions" *NOT* large rate constant		**(1 mark)**
	Total for question: 20 marks			

4	(a)	(i)	 **(1)** Butanal / butan-1-al **(1)**  **(1)** (2-)methylpropanal/(2-)methylpropan-1-al **(1)** *NOT* methylpropan-2-al *Aldehyde must be displayed but rest of molecule not displayed* **(1 out of 2)** *Name must match correct compound. No marks for correctly naming an incorrect compound*	**(4 marks)**
		(ii)	*Any one from* Infrared spectra **(1)** different in 'fingerprint' *OR* differences in frequencies/wavelengths absorbed *OR* different peak/trough patterns **(1)** *NOT* different peaks/troughs Measure Boiling point **(1)** Different boiling points and suggest why e.g. straight chain higher boiling point **(1)** nmr spectra **(1)** A + B would have a different number of peaks **(1)** Mass spec **(1)** Different fragmentation pattern **(1)** X-ray diffraction **(1)** Electron density maps identify branching **(1)** Prepare 2,4-dinitrophenylhydrazone **(1)** and measure melting point **(1)** *NOT* measure melting point	**(2 marks)**

	(b)	(i)	2,4-dinitrophenylhydrazine / 2,4-DNP(h) / Brady's reagent **(1)** orange/yellow/orange-red/yellow-orange **precipitate**/**crystals** *[a solid must be mentioned]* **(1)** *NOT* 'Red' *2nd mark dependent on 1st*	**(2 marks)**
		(ii)	(Heat with) Benedict's reagent/Fehling's reagent **(1)** Result for C remains blue **(1)** *ALLOW no change if blue mentioned somewhere* Result for A and B orange/red/green/yellow/brown **precipitate**/**crystals** *[a solid must be mentioned]* **(1)** *OR* **Acidified** dichromate **(1)** Result for C remains orange **(1)** Result for A + B green/blue **(1)** *Same rules as above but precipitate not needed* *2nd and 3rd marks dependent on 1st*	**(3 marks)**
	(c)	(i)	 *Any two* *ALLOW fully displayed* *ALLOW*  Allow NOT *NOT* $CH_2CH_2CH_2CHOH$ etc	**(2 marks)**
		(ii)	Esters *NOT* esterification	**(1 mark)**

		(iii)	e.g.  ester group - *must be displayed* **(1)** rest of molecule - *need not be fully displayed* **(1) -** *2nd mark dependent on 1st* *ALLOW TE from* $CH_2CH_2CH_2CHOH$ *etc in (c)(i) for 2 marks in (iii)* *If enol in (c)(i) max 2 (out of 5) for (c) ie (ii) and ester displayed in (iii) can be awarded*	**(2 marks)**
	Total for Question: 16 marks			
	Total for paper: 60 marks			