

CONFIDENTIAL

January 2006

ADVANCED GCE UNIT MARK SCHEME					
FINAL					
MAXIMUM MARK: 120					
Syllabus / Component: 2854/01					
Chemistry (Salters): Chemistry by Design					
Paper Set Date: 25/01/06					

SUBJECT OFFICER: Steven Evans

CHECKED BY	APPROVED (Tick or initials or signature)	DATE

## ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

- 1. Please ensure that you use the **final** version of the Mark Scheme. You are advised to destroy all draft versions.
- 2. Please mark all post-standardisation scripts in red ink. A tick (3) should be used for each answer judged worthy of a mark. Ticks should be placed as close as possible to the point in the answer where the mark has been awarded. The number of ticks should be the same as the number of marks awarded. If two (or more) responses are required for one mark, use only one tick. Half marks () should never be used.
- 3. The following annotations may be used when marking. <u>No comments should be written on</u> scripts unless they relate directly to the mark scheme. Remember that scripts may be returned to Centres.
  - x = incorrect response (errors may also be underlined)
  - ^ = omission mark
  - bod = benefit of the doubt (where professional judgement has been used)
  - ecf = error carried forward (in consequential marking)
  - con = contradiction (in cases where candidates contradict themselves in the same response)
  - sf = error in the number of significant figures
- 4. The marks awarded for each <u>part</u> question should be indicated in the margin provided on the right hand side of the page. The mark <u>total</u> for each question should be ringed at the end of the question, on the right hand side. These totals should be added up to give the final total on the front of the paper.
- 5. In cases where candidates are required to give a specific number of answers, (e.g. 'give three reasons'), mark the first answer(s) given up to the total number required. Strike through the remainder. In specific cases where this rule cannot be applied, the exact procedure to be used is given in the mark scheme.
- 6. Correct answers to calculations should gain full credit even if no working is shown, unless otherwise indicated in the mark scheme. (An instruction on the paper to 'Show your working' is to help candidates, who may then gain partial credit even if their final answer is not correct.)
- 7. Strike through all blank spaces and/or pages in order to give a clear indication that the whole of the script has been considered.
- 8. An element of professional judgement is required in the marking of any written paper, and candidates may not use the exact words that appear in the mark scheme. If the science is correct <u>and</u> answers the question, then the mark(s) should normally be credited. If you are in doubt about the validity of any answer, contact your Team Leader/Principal Examiner for guidance.

Abbreviations, annotations and conventions used in the Mark Scheme	<ul> <li>alternative and acceptable answers for the same marking point</li> <li>separates marking points</li> <li>answers which are not worthy of credit</li> <li>words which are not essential to gain credit</li> <li>() = words which are not essential to gain credit</li> <li>() = (underlining) key words which <u>must</u> be used to gain credit</li> <li>ecf = error carried forward</li> <li>AW = alternative wording</li> <li>ora = or reverse argument</li> </ul>
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Question	Expected A	nswers			Marks		
1 a	idea of <u>contrast</u> , eg "lettering/it absorbs more light"; "white stands out better"						
1 b i	NiSO₄/NiCl₂/N NaH₂PO₂ or p	li(NO <sub>3</sub> ) <sub>2</sub> otassium salt but NOT acid			2		
1 b ii	pH goes dowr H+ formed (1)	n (1);			2		
1 b iii	H <sub>3</sub> PO <sub>3</sub>				1		
1 c i	0 (1); +1 (1);	+3(1); one mark for second tw	vo if signs follow	numbers	3		
1 c ii	Redox – oxidation states change (unless refers to element other than P) / $P/H_2PO_2^-$ is both oxidised and reduced /exchange of electrons/ no proton exchange NOT just reference to oxidation and/or reduction.						
1 d i	nitrogen dioxide/nitrogen(IV) (di)oxide IGNORE gaps						
1 d ii	Ni + 2HNO <sub>3</sub> $\rightarrow$ NiO + 2NO <sub>2</sub> + H <sub>2</sub> O (2) Balanced equation with water molecules and/or hydrogen ions not cancelled(1)						
1 e	Reacts with acids (to neutralise them)/ accepts protons (1) <i>IGNORE references to alkali/solubility</i> reactants correct for NiO + HCI/HNO <sub>3</sub> /H <sub>2</sub> SO <sub>4</sub> /H <sup>+</sup> (1) correct equation (1)						
1 fi	complete reaction (with water)/ fully dissociated/ almost fully dissociated/ Ka> 1 (1) <i>IGNORE references to ability to donate protons</i> HNO <sub>3</sub> (ignore "+aq") $\longrightarrow$ $\longrightarrow$ ) H <sup>+</sup> + NO <sub>3</sub> <sup>-</sup> or reaction with H2O to give H <sub>3</sub> O <sup>+</sup> (1) <i>ALLOW equation for other strong acids. Accept "general" acid such as HA, provided there is an arrow rather than an equilibrium sign.</i> _						
1 f ii	pH = 2 (1)				1		
1 g	400 5 wa line starting a super black lir	- 00 600 700 velength/nm nd continuing parallel across to ne more than half-way below bl	700 at least (1) ack paint (1)	;	2		

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2 a i	$C_{21}H_{20}O_{3}CI_{2}$ ( (1) one error;	C <sub>21</sub> H <sub>20</sub> O <sub>3</sub> Cl <sub>2</sub> (2) completely correct (order immaterial) (1) one error;					
2 a ii	two from: ethe	er, alkene, chloro(alkene	)/halo/halogeno NO	T cylcoalkane	2		
2 a iii	(1) each						
2 a iv	2 (chlorine) at	oms/same groups (ora)	on one carbon (of o	double bond)	1		
2 b i	CH <sub>3</sub> -CH <sub>2</sub> -CH <sub>2</sub> Allow more st	-CH <sub>2</sub> -CH <sub>2</sub> -CH <sub>2</sub> -CH <sub>2</sub> -CH <sub>2</sub> ructured (1) NOT C-H-O	-OH		1		
2 b ii	four from: A large K <sub>ow</sub> means more in fat/octan-1-ol/non-polar solvents B octan-1-ol "resembles" fat/ is non-polar; C pesticides must be more soluble in fat than water/ easily absorbed in fat/organic; D they can pass from spraying solution (into insect)/ not leached off/ insoluble in water/ high concentrations not needed; E in the fatty tissues of insect they do damage						
2 c	co व व or shown skel	он но etally (1) (1	) Allow sodium salt	of acid.	2		
2 d	<i>two from</i> higher K <sub>ow</sub> ; smaller quantities have the same effect; break down quicker/ more completely/ in water more specific on certain pests (AW) inactive when outside insects						
2 e i	radical ignore	<i>substitution</i> (1) (uv) ligh	t (1);		2		
2 e ii	Br , H (1) in ei	ther order.			1		
2 e iii	CN-/KCN/HCI	N			1		
					20		

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	1						
3 a i	$(1 \text{ x})10^{-8}$ (1); mol dm <sup>-3</sup> (1) mark separately provided concn is $10^{-7}$ or smaller						
3 a ii	<i>K</i> <sub>w</sub> = [H <sup>+</sup> ] x [ [OH <sup>-</sup> ] = 1 x	OH <sup>–</sup> ] <i>stated or implied</i> (1); 10 <sup>−6</sup> (mol dm <sup>−3</sup> ) <i>units not essei</i>	ntial (1)			2	
3 b	five from the	e following:				5	
	<ul> <li>CO<sub>2</sub></li> <li>A CO<sub>2</sub> has instantaneous dipole-induced dipole between molecules;</li> <li>BBCO<sub>2</sub> forms hydrogen bonds with water (2);</li> <li>B <i>Reference to permanent/induced dipole - permanent/induced dipole</i> (1);</li> <li>C detail of imf, eg diagram;</li> </ul>						
	<ul> <li>ions</li> <li>D electrostatic forces between ions;</li> <li>E ions form ion-dipole bonds with water (or description);</li> <li>F hydration description;</li> <li>G detail (eg diagram);</li> </ul>						
	<ul> <li><i>reasons</i></li> <li>H water forms hydrogen bonds with itself;</li> <li>J more hydrogen bonds broken than made for CO<sub>2</sub>/ imf in water stronger than in CO<sub>2</sub>;</li> <li>K imf between ions and water stronger than hydrogen bonds/ stronger than imf in CO<sub>2</sub>;</li> </ul>						
	QWC Writte (allow one e	en in sentences, spelling, punct error) SEE QWC rules	uation and grammar	correct		1	
3 c	(i) lattice energy/enthalpy (1) (ii) enthalpy (change) of hydration/solvation (1) (iii) enthalpy (change) of solution (1) allow symbols, eg $\Delta H$					3	
3 d	$\Delta S_{tot}$ must b $\Delta S_{sys}$ must b	e positive for process to occur be positive (1); and greater thar	n <i>∆H/T</i> (1)			3	
3 ei	$K_{\rm a}$ = [H <sup>+</sup> ] [H(	CO <sub>3</sub> <sup>-</sup> ]/[CO <sub>2</sub> ] (1)				1	
3 eii	[HCO <sub>3</sub> <sup>-</sup> ] [CO <sub>2</sub> ]	= $K_a/[H^+]$ (1) stated or imp	lied, ecf from c(i)			3	
	$= 4.5 \times 10^{-7}$ = 45(1) ecf	/ 1 x 10 <sup>-8</sup> (1) ecf from first mark if any marks scored previously	k if all four quantities	given;			
3 e iii	<i>M</i> r NaHCO (1) = 3.3 x 10 <sup>-1</sup>	$p_3 = 84 \text{ stated or implied (1); [N]}{2 \times 84 = 2.8 \text{ g (1)} \text{ ALLOW 2.78}}$	NaHCO <sub>3</sub> ] = [CO <sub>2</sub> ] <i>sta</i> 3	ted or imp	lied	3	
3 e iv	(H <sup>+</sup> added) I restoring pH because [H0	Equilibrium (position) moves to l/pH does not change much (A) $CO_3^{-}$ ] large (similar to [CO <sub>2</sub> ])/ac	left (1); W) (1) ts as sink for H <sup>+</sup> (1)			3	
						26	

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4 a	crude oil					1
4 b	solvent/fuel/c	leaning agent/source of name	ed chemical			1
4 c	1000 x 46/28 (1) stated or implied = 1.6 kg (1) ecf provided these three numbers used in expression 2 sf (1) mark separately, provided answer follows from some working shown (or answer correct)					
4 d i	(forward) reaction exothermic <i>ora</i> (1) <i>plus one from</i> Yield too low (AW)(1); <u>equilibrium (position)</u> moves to left when temperature raised (1) <i>ora</i> rate increases with increased temperature					
4 d ii	cost with son	ne discussion(1); compressor/	thick walls (AW)	of plant (1)		2
4 e i	$K_p = pC_2H_5OH/pH_2O pC_2H_4$ partial pressures shown correctly (NOT square brackets – ignore round brackets) (1) terms in correct sequence (1) mark separately even if square brackets shown					
4 e ii	4/21 x 35 = 5 Allow 5.44 x	x 10 <sup>-3</sup> /5.4 x 10 <sup>-3</sup> (1) atm <sup>-1</sup> (1 <i>10<sup>-3</sup></i>	) both ecf from e(	i).		2
4 f i	two from: (34	00) O–H (1); (2900) C–H (1);	(1050) C–O (1)			2
4 f ii	C–H (allow C–O if chosen above) (1) O–H not used as in H <sub>2</sub> O (in breath) (1) allow answers to count also for 4 f i if this is incomplete or blank					2
4 g i	$H = \begin{pmatrix} H \\ C \\ H \end{pmatrix}$ $H = \begin{pmatrix} H \\ C \\ H \end{pmatrix}$ $H = \begin{pmatrix} H \\ C \\ H \end{pmatrix}$ $H = \begin{pmatrix} H \\ C \\ H \end{pmatrix}$ $H = \begin{pmatrix} H \\ C \\ H \end{pmatrix}$ $H = \begin{pmatrix} H \\ C \\ H \end{pmatrix}$ $H = \begin{pmatrix} H \\ C \\ H \end{pmatrix}$ $H = \begin{pmatrix} H \\ C \\ H \end{pmatrix}$ $H = \begin{pmatrix} H \\ H \\ H \end{pmatrix}$ $H = \begin{pmatrix} H \\ H \\ H \end{pmatrix}$ $H = \begin{pmatrix} H \\ H \\ H \end{pmatrix}$ $H = \begin{pmatrix} H \\ H \\ H \end{pmatrix}$ $H = \begin{pmatrix} H \\ H \\ H \end{pmatrix}$ $H = \begin{pmatrix} H \\ H \\ H \end{pmatrix}$ $H = \begin{pmatrix} H \\ H \\ H \end{pmatrix}$ $H = \begin{pmatrix} H \\ H \\ H \end{pmatrix}$ $H = \begin{pmatrix} H \\ H \\ H \end{pmatrix}$					2
4 g ii	(potassium/s (sulphuric) ac	odium) dichromate/ correct foi cid/correct formula (1)	rmula (1);			2
4 h	distilling flask connected with no leaks to (1); water condenser on side, sloping down (1); <i>ignore fractionating tower; ignore thermometer</i> rest of detail: reagents labelled (minimum – line on flask), collection vessel, not sealed, water connections correct (1)					3
4 i	i.r. Two pair ethanal C=C no O–H ora nmr Four fro both 2 peak height/ area	rs from: ) different (1); 1720 - 1740/no (1) 2500 - 3200 (1) no C–O o om: s (1), two hydrogen/proton en (1); 3:1 hydrogen atoms (1)	t 1700 - 1725 <i>ora</i> ra (1) 1050-1300 vironments (1); 3: both 2.2 (1) CH30	(1) (1) 1 ratio of p CO (1)	beak	8
	QWC logica logica bond, absor relative inter	I, correct use of <i>three</i> words fi I, correct use of <i>two</i> words fro ption, wavenumber, peak, pro nsity	rom list (2) m list (1) ton, environment,	, (chemica	l) shift,	2

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5 a i	They make black together/ they can make any colour/ they are (sub) primaries					
5 a ii	Decompose	at 400°C				1
5 b i	azo					1
5 b ii	<i>four from:</i> delocalised electrons; ring; above and below ring of carbons/plane of atoms;					4
	six electrons/ not attached	one electron from each carbo to particular carbons/spread c	on is not involved out over <u>all carbo</u>	in other bo <u>ns/</u> benzene	onding; e ring	
5 c i	solubility (in water)/ acidity					1
5 c ii	<u>conc</u> sulphuric acid (1); reflux <i>if sulphuric acid mentioned</i> (1)					2
5 c iii	hydrogen on ring is replaced (by $-SO_3H$ ) (1)					1
5 c iv	positive ion/molecule with partial positive charge (1); attracted to area of negative charge/high electron density (1); accept pair of electrons to form a bond (1)					3
5d	excitation of electrons/ movement from lower to higher energy level (1); absorbs in visible (1); transmits the complementary colour (1); $(\Delta)$ E=hv/ energy difference related to frequency (1), 2 maximum if emission is described				4	
						18