

2854 Chemistry (Salters)

June 2004

Mark Scheme

The following annotations may be used when marking:

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


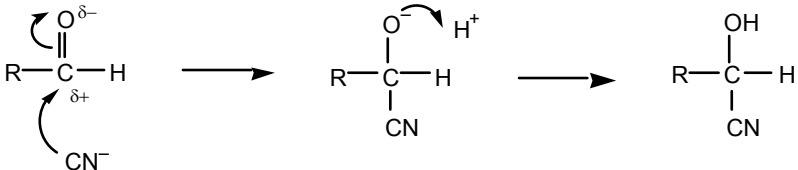
Abbreviations, annotations and conventions used in the Mark Scheme:

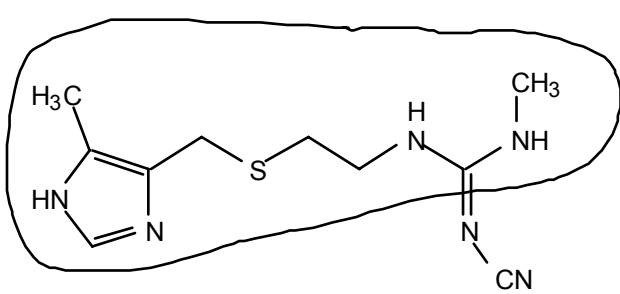
/	=	alternative and acceptable answers for the same marking
;	=	separates marking points
NOT	=	answers not worthy of credit
()	=	words which are not essential to gain credit
___ (underlining)	=	key words which <u>must</u> be used
ecf	=	allow error carried forward in consequential marking
AW	=	alternative wording
ora	=	or reverse argument

Question	Expected Answers	Marks
1 a i	nitrogen dioxide/ nitrogen(IV) oxide <i>nothing else</i>	1
1 a ii	Manufacture of fertilizers/explosives/dyes <i>can be named ones</i> . 'Making' must be implied Named lab use, eg nitration of benzene	1
1 b	-3 +4 (allow 2 x +4) +5 (1) each <i>max 2 if plus signs missing or signs after numbers</i> . ALLOW Roman numerals.	3
1 c i	Increases (1) <i>mark separately</i> ; More <u>molecules/particles</u> collide (1); (with) energy greater than <u>activation enthalpy/energy</u> (<i>ignore "barrier"</i>)(1) "successful collisions" can score second mark only.	3
1 c ii	(forward) reaction exothermic (<i>ora</i>) (1); <u>equilibrium</u> (position) moves to oppose change/in endothermic direction (1); lower yield (1) <i>must follow some correct reasoning (which can be in (c)(i))</i> <i>Apart from this, c(i) and c(ii) must be answered in the correct places to score.</i>	3
1 d	this temperature a compromise/balance (AW)(1); between rate and yield (1);	2
1 e i	$K_p = p \text{N}_2\text{O}_4 / p\text{NO}_2^2$ (1) for mathematical expression $\text{N}_2\text{O}_4/\text{NO}_2^2$ whatever symbols (1) for indicating partial pressures correctly. <i>Ignore (), allow $p^2\text{NO}_2$.</i> <i>Mark separately</i>	2
1 e ii	atm^{-1} (1) <i>ecf from expression but NOT concentration units</i> ALLOW atmos^{-1} , atmospheres^{-1} , $1/\text{atm}$.	1
1 e iii	$p\text{N}_2\text{O}_4 = K_p \times p\text{NO}_2^2 = 8.7 \times 0.60^2 = 3.1$ (1) 2 sig figs (1) <i>mark separately provided SOME working</i>	2
1 f	Be, B, C, F <i>Any two (Names [allow small mis-spellings] or symbols [must be correct])</i> ALLOW names or correct formulae of oxides.	2
1 g i	<i>two from:</i> toxic/ poisonous/ specific effect (eg respiratory problems); (gives rise to) acid rain/ causes corrosion <u>of metal/stone</u> ; (photochemical) smog/ more ozone; <i>NOT depletes ozone</i> greenhouse gas /global warming	2
1 g ii	recycled/used again/some reference to using it in Equation 1.1 .	1
1 h i	negative, fewer (gas) molecules on right	1
1 h ii	positive, exothermic/ ΔH negative/reference to $-\Delta H/T$	1
1 h iii	positive(1) <u>because</u> the reaction goes/ is spontaneous(1) <i>mark separately</i> " $\Delta S = 0$ for an equilibrium" scores (1)	2

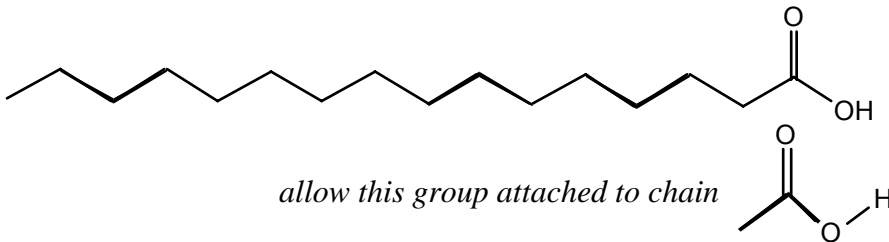
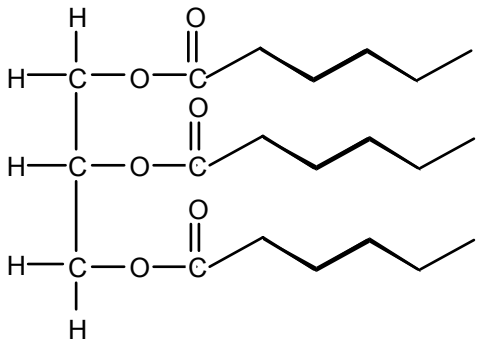
1 i i	complete reaction (with water)/fully dissociated/ almost fully dissociated/ $K_a > 1$	1
1 i ii	HNO_3 (ignore "+aq") $\longrightarrow (\rightleftharpoons) \text{H}^+ (1) + \text{NO}_3^- (1)$ or reaction with H_2O to give H_3O^+	2
1 i iii	$\text{pH} = -\lg[\text{H}^+]$ stated or implied (1) = $-\lg(0.05) = 1.3$ (1)	2

2 a	alkene, alcohol/hydroxy(l) <i>NOT</i> 'hydroxide' or 'carbon-carbon double bond'	2
2 b	<p><i>Five marks from:</i> mass spectroscopy: Mr /(relative) molecular mass/ molar mass (IGNORE total mass)(1); from M⁺ peak/peak of highest <u>mass</u> /molecular/parent ion (AW) (1) <i>must follow from first marking point.</i> Fragments (from other peaks) (1)</p> <p>i.r: (max four points) C=C (1) at 1620 – 1680 (cm⁻¹)(1) <i>ALLOW descriptions of groups</i> O–H (1) at 3600 – 3640 (cm⁻¹)(1) <i>eg alkene etc a</i> C–O (1) at 1050 – 1300(cm⁻¹)(1) <i>within range</i> C – H <i>if qualified</i> 'alkane' or 'alkene' (1) with appropriate range (1) (2850–2950 or 3000 – 3010) <i>If nothing scored above for bonds, allow:</i> i.r. identifies bonds/ functional groups (1) <i>If nothing scored for absorptions allow</i> general statement about absorption values (1)</p> <p><i>QWC 2</i> 2 sentences, logical, 3 words from list below used correctly (or plurals, verbs), <i>QWC 1</i> 2 sentences, logical, 2 words from list below used correctly (or plurals, verbs) molecular/molar mass; peak; molecular/parent ion; fragment; bond; absorption</p>	<p>5</p> <p>2</p>

2 c i		1
2 c ii	 <p>Idea of CN^- attacking carbonyl carbon*/polarisation of $\text{C}=\text{O}$ (1) Intermediate with O^- (1) <i>not</i> O^{2-} Rest of detail correct (1) (<i>partial charges optional</i>) <i>not single arrows here.</i> * can be HCN <i>here</i> but then do not award third marking point.</p>	3
2 d i	2 peaks (1) 1:1 (AW) (1)	2
2 d ii	$\text{C}_3\text{H}_7\text{COOH}/\text{HOOC}(\text{CH}_2)_7\text{COOH}$ (<i>allow</i> $\text{HOOC}(\text{CH}_2)_8\text{OH}$) Correct number of C atoms (4 or 9) (1); correct group(s) at end(s) (<i>if first mark scored</i>)(1)	2
2 e	A cis (1); B trans (1). <i>one mark for correct words the wrong way round.</i>	2
2 f	<i>Three from</i> Receptor <u>site(s)</u> <i>ALLOW active site</i> ; will have a certain/specific shape; Pheromone molecule must fit/ If pheromone is not correct shape it will not be detected/ smelled; Bonding/ imf / binding occurs; pheromone fitting site triggers response (AW);	3
2 g i	bromine/ Br_2 <i>Allow aqueous bromine</i>	1
2 g ii	$-\text{OH}$, alcohol, hydroxy(l)	1
2 g iii	heat/reflux (1); (Aqueous)NaOH (1); <i>mark separately.</i> <i>Extra reagents negate second mark.</i>	2

3 a i	carbon: 10 (1); hydrogen: 16 (1);	2
3 a ii	A 109 (1); B 120 (1); (both ± 4 , angle sign not required)	2
3 b	Side-effects/suggested specific side-effect/ only active for a short time/ toxic Not very effective (or <i>molecular</i> descriptions implying this but NOT that it is ineffective)	1
3 c i	<i>Three from (can be obtained from a <u>labelled</u> diagram)</i> each carbon atom has four outer shell electrons; but only uses three to form bonds; six electrons; shared by/evenly spread/distributed over the <u>carbon</u> atoms/ conjugated; form rings (of electrons); above and below (plane of) molecule; <i>plus ONE from:</i> all C–C bonds equal in length; undergoes substitution (rather than addition reactions); more stable (AW); planar;	4
3 c ii	CH ₃ Cl (1); AlCl ₃ (1); Heat/reflux/no water (1) <i>mark separately</i> <i>Max 1 for reagent marks if extra reagents added.</i>	3
3 c iii	electrophilic	1
3 c iv	<i>Four from the following points.</i> A* Coloured substances absorb (certain frequencies of)visible light; B (when) electrons excited (to higher energy-level); C more highly delocalised molecules(AW) need less energy to excite electrons; D* (burimamide/ metiamide/ benzene) do not absorb in visible/ are colourless – they absorb in u.v./at higher frequency/ energy; E energy level difference measures frequency absorbed/ $E = h\nu$; F visible light has lower energy than u.v. * if neither A nor D scored, can award “A/D” for idea of molecules absorbing e-m radiation or light. <i>If emission mentioned, max 2.</i>	4
3 d	 <p>double bond may be included or not but N atom must not be. <i>Accept if drawn on metiamide structure</i></p>	1

4 a i	$\text{CaCO}_3 \longrightarrow \text{CaO} + \text{CO}_2$	1
4 a ii	Amount $\text{CaCO}_3 = 1000/100 (= 10 \text{ moles}) (1)$; Mass $\text{CaO} = 10 \text{ ecf} \times 56 = 560 \text{ g} (1)$	2
4 b	$\left[\begin{array}{ccc} & \times \times & \\ \times & \text{Ca} & \times \\ & \times \times & \end{array} \right]^{2+} \quad \left[\begin{array}{c} \cdot \cdot \\ \times & \text{O} & \cdot \\ \times & & \cdot \end{array} \right]^{2-}$ <p>(1) each. Ca may have no electrons. Oxygen may have all same symbol (dot or cross) If all other detail correct but no charges shown, award (1). Square brackets optional. ALLOW charges on symbols or inner shells if correct</p>	2
4 c i	A - ionisation <u>enthalpies/energies</u> (1) B - O(g) (1) C - <u>enthalpy</u> (change) of formation (of CaO) (1) ALLOW <u>enthalpy (change) of combustion of calcium/Ca</u>	3
4 c ii	1st and 2nd $E_a = -1748 - 635 - 178 - 249 - (-3419) (1) = +(1) 609 (1) \text{ kJ mol}^{-1}$ ecf on sign; ecf on number, provided all quantities used in calculation. -609, 609 score (2)	3
4 d i	<p>Allow ΔH for "enthalpy" and accepted symbols, eg ΔH_{LE}</p>	4
4 d ii	increase down Group	1
4 e i	$0.032 \text{ mol dm}^{-3} (2)$ one mark for $0.016 \text{ mol dm}^{-3}$	2
4 e ii	$K_w = [\text{H}^+][\text{OH}^-]$ stated or implied (1); $[\text{H}^+] = 10^{-14}/0.032 = 3.13 \times 10^{-13} (\text{mol dm}^{-3})$ ecf from (e)(i)(1); (6.16×10^{-13} from 0.016) $\text{pH} = -\lg(3.13 \times 10^{-13}) = 12.5$ ecf (1); (12.2 from 6.16×10^{-13})	3
4 e iii	$\text{Ca(OH)}_2 + 2\text{HCl} \longrightarrow \text{CaCl}_2 + 2\text{H}_2\text{O}$ compounds (1); balancing tied to first mark (1)	2
4 e iv	Amount $\text{Ca(OH)}_2 = 10 \times 0.015/1000 (= 1.5 \times 10^{-4} \text{ mol}) (1)$ Amount $\text{HCl} = \text{twice this} (3.0 \times 10^{-4} \text{ mol})$ ecf from ratio in equation, even if equation unbalanced Volume $\text{HCl} = 3.0 \times 10^{-4} \times 1000/0.02 = 15.(0) \text{ cm}^3 (1)$ (ecf $7.5(0) \text{ cm}^3$ from 1:1 ratio)	2

5 a	<p>A sample (of ointment) (1); <i>ALLOW 'ointment as gas'</i></p> <p>B detector (1);</p> <p>C column (1); <i>ALLOW 'tube' with description of contents</i></p> <p>D oven /heater (1)</p>	4
5 b	(retention) time	1
5 c i	 <p>allow this group attached to chain</p> <p>16 carbon atoms (no C-H hydrogens shown, nor "dots" (1) 16th carbon can be part of COOH; COOH skeletal detail, provided no other groups are present (1)</p>	2
5 c ii	alkene <i>NOT</i> C=C	1
5 c iii	ends in "-ol" / "anol"	1
5 c iv	hydrolysis	1
5 d	 <p>glycerol residue correct (1) ester correct and full structural (1) <i>but can score this mark(not previous one) if COO rather than OOC.</i> carbon chains(1) (allow dots and C-H hydrogens shown if penalised in 5(c)(i)) <i>DO NOT</i> award third mark if other substituents on chain, though double bonds allowed.</p>	3