CAMBRIDGE
INTERNATIONAL EXAMINATIONS

November 2003

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 60

SYLLABUS/COMPONENT: 9701/04

CHEMISTRY
Theory 2 (Structured Questions)

UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

1 **(a)** The power to which the **concentration** (of reagent) is raised (in the rate equation)

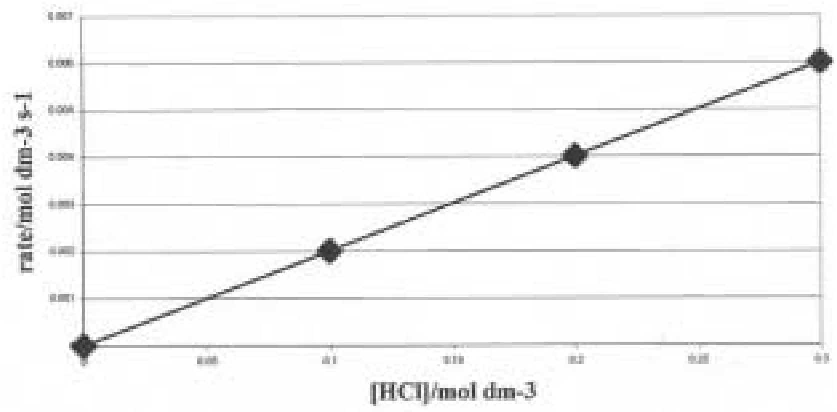
or: the value of *a* in the expression rate = $k[A]^a$ (1) **[1]**

(b) rate = $k[CH_3COCH_3][H^+]$ (1) **[1]**

(c) **(i)** A (1)

(ii) B (1) **[2]**

(d)



line (through zero) (1)

clear points (1) **[2]**

(e) mechanism B (1)

because the rate is determined by the slow step,
which involves propanone + H^+,
but not I_2 any two points (2) **[3]**

(f) **(i)** titration with thiosulphate *or* colorimetry (1)

(ii) k = rate/[propanone][H^+] = $3.3 \times 10^{-6}/(0.2 \times 0.5) = 3.3 \times 10^{-5}$ (1)

(iii) units are $mol^{-1}\ dm^3 s^{-1}$ (1) **[3]**

Total: 12

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2 **(a)** **(i)** $K_a = [HCO_2^-][H^+]/HCO_2H]$ (1)

(ii) $\sqrt{K_a[HCO_2H]} = \sqrt{1.77 \times 10^{-4} \times 0.05} =$ 2.97×10^{-3} (3.0×10^{-3}) (1)

(iii) $100 \times 2.97 \times 10^{-3}/\ 0.05$ = 5.94% (6%) (1)

(iv) pH = $-\log_{10}(2.97 \times 10^{-3})$ = **2.5**(2) (1) **[4]**

(b) pH = $-\log_{10}(0.05)$ = **1.3**0 (1) **[1]**

(c) **(i)** $2HCO_2H + Mg \rightarrow (HCO_2)_2Mg + H_2$ (1)
(*or* $2H^+ + Mg \rightarrow Mg^{2+} + H_2$)

(ii) moles of $H^+ = 0.05 \times 20/1000$ = 1×10^{-3} (1)

moles of $H_2 = 1 \times 10^{-3}/2$ = 0.5×10^{-3}

volume of $H_2 = 0.5 \times 10^{-3} \times 24,000$ = **12 cm³** (1)
(*or* = $0.5 \times 10^{-3} \times 22400$ = **12 cm³**

(iii) (rate α $[H^+]$) lower $[H^+]$ in methanoic acid *or* HCO_2H dissociates slowly/partially (1)

(iv) the equilibrium ($HCO_2H \rightleftharpoons HCO_2^- + H^+$) continually shifts to the right as H^+ is used up (1) **[5]**

Total: 10

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3 **(a)** **(i)** $MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$ (1) + (1)
[*or* $MnO_4^- + 4H^+ + 3Fe^{2+} \rightarrow MnO_2 + 3Fe^{3+} + 2H_2O$]
(reactants + products) + balancing

(ii) $Cr_2O_7^{2-} + 2H^+ + 3SO_2 \rightarrow 2Cr^{3+} + 3SO_4^{2-} + H_2O$ (1) + (1) **[4]**

(or molecular equations including the counter ions K^+ and SO_4^{2-})

(b) **(i)** purple (1)

(ii) the first (permanent) pink colour (from a colourless solution) (1)

$n(MnO_4^-) = 0.01 \times 14/1000$ $= 1.4 \times 10^{-4}$ (1)

$n(Fe^{2+}) = 5 \times 1.4 \times 10^{-4}$ $= 7 \times 10^{-4}$

$FeSO_4 = 55.8 + 32.1 + 64$ $= 151.9$ (1)

so mass = $151.9 \times 7 \times 10^{-4}$ = **0.106** g (1) **[5]**

(c) **(i)** to carry O_2 from lungs to muscles/tissues

the O_2 molecule is a ligand attached to the Fe atom/F^{e2}+ ion in haemoglobin (1)

(ii) CO exchanges with O_2 and forms a **stronger ligand bond**. [1] **[3]**

Total: 12 max 11

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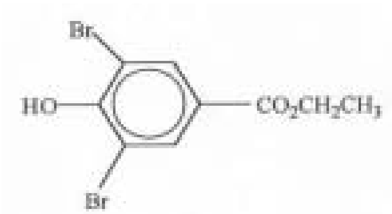
4 **(a)** phenol, ester, arene/bezene ring *any two* (1) + (1) **[2]**

(b) **(i)** $Na^{+}\,{}^{-}O\text{-}C_6H_4\text{-}CO_2C_2H_5$ (1)

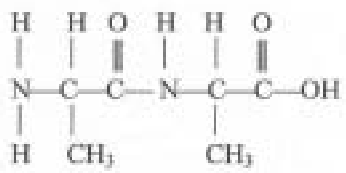
(ii) $Na^{+}\,{}^{-}O\text{-}C_6H_4\text{-}CO_2^-Na^+$ ✓ C_2H_5OH ✓ (2)

(iii)



(1) **[4]**

	(c)	**(i)**	acidity: G > E > F	(1)	
		(ii)	only G reacts/gives off CO_2 with $Na_2\ CO_3$	(1)	
			E and G both dissolve in NaOH(aq)	(1)	**[3]**
					Total: 9

5	**(a)**		reagents: NaOH + I_2	(1)	
			observations: yellow solid/ppt. with H and nothing with L.	(1)	**[2]**
	(b)		J is more acidic than propanoic acid	(1)	
			chlorine is electrogegative/electron-withdrawing	(1)	**[2]**
	(c)				
			balancing	(1)	
			displayed formula	(1)	**[2]**
	(d)		$+NH_3CH(CH_3)CO_2^-$	(1)	**[1]**
	(e)	**(i)**	peptide *or* amide	(1)	
		(ii)		(1)	**[2]**
	(f)	**(i)**	C_6H_5COCl	(1)	
		(ii)	HCl *or* H_2SO_4 *or* NaOH	(1)	
			(aq) + heat/reflux	(1)	**[3]**
					Total: 12

6	**(a)**	**(i)**	$CaCO_3 \rightarrow CaO + CO_2$	(1)	
		(ii)	$CaO + H_2O \rightarrow Ca(OH)_2$	(1)	**[2]**
	(b)		to reduce acidity/raise the pH of soil/neutralize acid soils	(1)	**[1]**
	(c)		more stable down the group	(1)	
			(due to) larger cations	(1)	
			(hence) less polarization/distortion of CO_3^{2-}	(1)	**[3]**
					Total: 6