CAMBRIDGE
INTERNATIONAL EXAMINATIONS

November 2003

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 60

SYLLABUS/COMPONENT: 9701/02

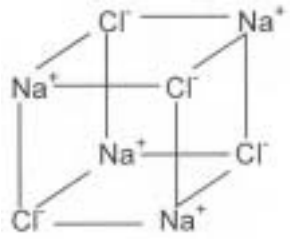
CHEMISTRY
Theory 1 (Structured Questions)

UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

1 (a) ionic$^-$ (1)

Na^+ and Cl^- (1)

arranged in cubic lattice (diagram required)



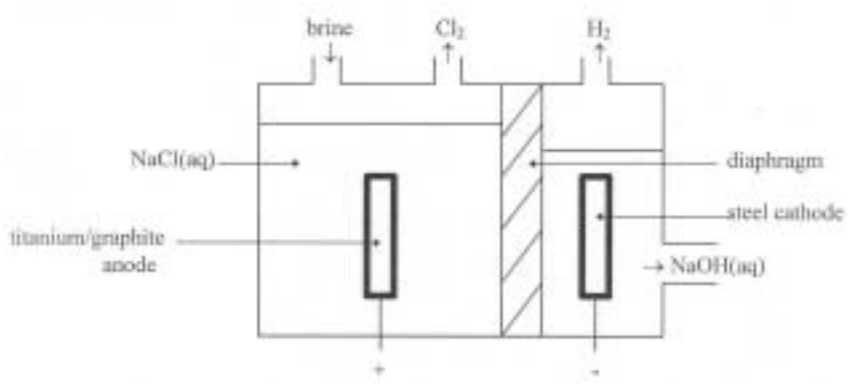
(1)

each na^+ ion surrounded by six Cl^- ions
or each Cl^- ion surrounded by six Na^+ ions
may be in diagram or stated in words (1) **[4]**

(b) in the solid, the ions cannot move (1)

in the melt, the ions move
or carry the charge/current (1) **[2]**

(c) (i)



container + compartment + electrodes + diaphragm (1)

steel **or** inert cathode (1)

titanium **or** graphite **or** inert anode (1)

(ii) at the anode

$2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$ (1)

at the cathode

$2H^+(aq) + 2e^- \rightarrow H_2(g)$

or

$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$ (1)

(iii) hydrogen – ammonia, HC*l*, margarine, fuel (1)

sodium hydroxide – soap, paper, bleach (1)

(iv) Cl_2 produced reacts with the NaOH(aq) (1)

$Cl_2 + 2NaOH \rightarrow NaClO + NaCl + H_2O$ (1) **[9]**

[Total: 14 max]

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2 (a) $C_8H_{18} + 12\frac{1}{2}O_2 \rightarrow 8CO_2 + 9H_2O$ (1) **[1]**

(b) (i) nitrogen (1)

(ii) from the combustion of the fuel (1) **[2]**

(c) (i) CO reacts with haemoglobin/reduces absorption of oxygen

nitrogen oxides/NO/NO_2/NO_x
acidic/breathing problems/acid rain/photochemical smog

hydrocarbons – breathing problems

SO_2 – breathing problems/acid rain (any 2)

(ii) $CO + NO \rightarrow CO_2 + \frac{1}{2}N_2$

or $CO + \frac{1}{2}O_2 \rightarrow CO_2$

$NO + CO \rightarrow CO_2 + \frac{1}{2}N_2$ (again)

or $NO + HC \rightarrow CO_2 + H_2O + N_2$ (qualitative)
or $NO + H_2 \rightarrow H_2O + \frac{1}{2}N_2$ (1)

(iii) toxic gases are not removed until the catalytic converter has warmed up

or there is too much CO to be completely removed as in **(c)(ii)**

or the converter may become less efficient over a period of time/gets clogged up

or CO_2 passes through – causes global warming

or SO_2 passes through – causes acid rain (1) **[5]**

[Total: 8]

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3 **(a)** **(i)** energy/enthalpy change when 1 mol of a compound is formed from its elements (1)

at 25°C and 1 atm (1)

(ii) $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$ (1)

(b) **(i)** $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$ (1)

(ii) heat released = $mc\Delta T$ (1)

= 200 x 4.2 x 12.2 = 10.25 kJ (1)

(iii) ΔH_{reacn} = 40.1 x (–10.25) = –411 kJ mol^{-1} sign necessary

for ecf, ΔH_{reacn} = 40.1 x [answer to **(b)(ii)**]

(1) **[4]**

(c) **(i)** The enthalpy (energy) change for converting reactants into products (1)

is the same regardless of the route taken (1)

(ii)

	$Ca(s)$	+	$2H_2O(l)$	→	$Ca(OH)_2(aq)$	+	$H_2(g)$	ΔH = –411
$\Delta H^{\ominus}_f$			2 x (–286)		x			

ΔH_{reacn} = x – 2(–286) = –411 (1)

x = –411 + 2(–286) = –983 kJ mol^{-1} (1)
sign necessary

for ecf, x = ans. to (b)(iii) + (–572) **[4]**

(d) 40.1 g of Ca give 24000 cm^3 of H_2 (1)

1 g of Ca gives $\frac{24000}{40.1}$ = 598.5 cm^3 units needed

allow 40 g of Ca giving 600 cm^3 (1) **[2]**

[Total: 14]

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4 **(a)** **(i)** dehydration/elimination/cracking (1)

$C_2H_5OH – H_2O \rightarrow CH_2 = CH_2$

or $C_2H_5OH \rightarrow CH_2 = CH_2 + H_2O$ (1) **[2]**

(b) **(i)** yellow/red/orange/brown to colourless

do **not** allow clear or white (1)

$CH_2 = CH_2 + Br_2 \rightarrow CH_2BrCH_2Br$ (1)

(ii) purple to colourless (1)

$CH_2 = CH_2 + H_2O + [O] \rightarrow CH_2OHCH_2OH$ (1) **[4]**

(c) **(i)** $-CH_2CH_2CH_2CH_2-$ 'tails required' (1)

$-CH_2CHClCH_2CHCl-$ 'tails required' (1) **[2]**

(d) **(i)** C_6H_{10} (1)

(ii) $M_r = 82$ (1)

(iii) % carbon = $\frac{72 \times 100}{82}$ = 87.8% (1) **[3]**

[Total: 11]

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5 **(a)** **(i)** $CH_3CH_2CH_2CH_2Br + NaOH \rightarrow$ **or** OH^-

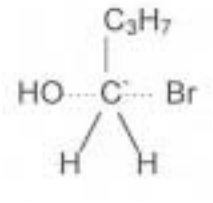
$CH_3CH_2CH_2CH_2OH + NaBr$ **or** Br^- (1)

(ii) nucleophilic substitution (1)

(iii) presence of $C^{\delta+} - Br^{\delta-}$ dipole (1)

attack of OH^- on $C^{\delta+}$ (1)

formation of intermediate



(1)

loss of Br^- (1) (3 max)

may all be in a mechanism **[5]**

(b) **(i)** elimination/dehydrobromination (1)

(ii) I $CH_3CH_2CH = CH_2$ (1)

II $CH_3C = CH_2$ (1)
CH_3

(iii) I $CH_3CH_2CO_2H$ (1)

II CH_3COCH_3 (1) **[5]**

(c) $(CH_3)_3CBr \xrightarrow[\text{reflux}]{\text{KCN/ethanol}} (CH_3)_3CCN \xrightarrow[\text{reflux}]{\text{dil } H^+} (CH_3)_3CCO_2H$

(1) (1) (1)

[3]

[Total: 13]