UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level and GCE Advanced Subsidiary Level

MARK SCHEME for the May/June 2006 question paper

9701 CHEMISTRY

9701/02 Paper 2

Maximum raw mark 60

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which Examiners were initially instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began. Any substantial changes to the mark scheme that arose from these discussions will be recorded in the published *Report on the Examination*.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes must be read in conjunction with the question papers and the *Report on the Examination*.

The minimum marks in these components needed for various grades were previously published with these mark schemes, but are now instead included in the Report on the Examination for this session.

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UNIVERSITY of CAMBRIDGE
International Examinations

1 (a) (i) ammonia/NH_3 **(1)**

(ii) NH_4^+ **(1)**

(iii) iron(II) hydroxide/$Fe(OH)_2$ **(1)** **[3]**

(b) barium sulphate/$BaSO_4$ **(1)** **[1]**

(c) (i) $FeSO_4$ **(1)**

$(NH_4)_2SO_4$ **(1)**

(ii) $FeSO_4$ = 151.9 (allow 151.8 to 152) **(1)**

$(NH_4)_2SO_4$ = 132.1 (allow 132) **(1)**

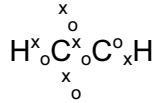
(iii) $xH_2O = 392 - (132.1 + 151.9) = 108$ **(1)**

$x = \frac{108}{18} = 6$ **(1)**

allow e.c.f. on candidate's sulphate in **(c)(i)**
e.c.f. answer must be a whole number **[6]**

[Total: 10]

2 **(a)**



(1) **[1]**

(b) $n = \frac{PV}{RT} = \frac{(1515 \times 10^3) \times (76 \times 10^{-3})}{8.31 \times 298}$ **(1)**

$= 46.5$ **(1)** **[2]**

(c) **(i)** $CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2$ **(1)**

(ii) $n(C_2H_2) = n(CaC_2) = 100 \times 46.5$ **(1)**

mass of $CaC_2 = 100 \times 46.5 \times 64 =$

$= 297\,570$ g

$= 297.6$ kg (accept 298 kg)

correct units necessary **(1)**

allow e.c.f. on candidate's answer in **(b)** **[3]**

(d) $C_2H_2(g) + {}^5/_2O_2(g) \rightarrow 2CO_2(g) + H_2O(g)$

bonds broken:	2(H-C)	2 x 410	=	820
	C≡C	840	=	840
	$^5/_2$(O=O)	$^5/_2$ x 496	=	1240
				2900 kJ mol^{-1}

(1)

bonds made:	4(C=O)	4 x 740	=	2960
	2(O-H)	2 x 460	=	920
				3880 kJ mol^{-1}

(1)

$\Delta H_{comb} = -3880 + 2900 = -980$ kJ mol^{-1} **(1)**

allow e.c.f. on incorrect bonds made/broken **[3]**

(e) **(i)** the enthalpy/energy change when one mole of a substance **(1)**

is burned in an excess of air/oxygen
or completely combusted
under standard conditions **(1)**

(ii) calculation in **(d)** includes $H_2O(g)$ whereas ΔH_{comb} involves $H_2O(l)$
or average bond energy terms are used in the *Data Booklet* **(1)** **[3]**

[Total: 12]

3 (a)

halogen	colour	physical state at room temperature
chlorine	green/yellow	gas
bromine	orange/red	liquid
iodine	black	solid

three colours correct **(1)**

three states correct **(1)** **[2]**

(b) (i) $MgCl_2$ white fumes/steamy fumes (of HCl) **(1)**

$MgBr_2$ red colour (of Br_2) **or** steamy fumes (of HBr) **(1)**

MgI_2 purple colour (of I_2) **or**
black solid (I_2) **or**
yellow solid (S) **or**
stinking gas (H_2S) **(1)**

(ii) $MgCl_2 + H_2SO_4 \rightarrow MgSO_4 + 2HCl$
allow
$MgCl_2 + 2H_2SO_4 \rightarrow Mg(HSO_4)_2 + 2HCl$ **(1)** **[4]**

(c) (i) AgBr/silver bromide **(1)**

(ii) $AgBr(s) + 2NH_3(aq) \rightarrow Ag(NH_3)_2Br(aq)$

equation (may be ionic) **(1)**

state symbols **(1)**

allow ecf on wrong halide in **(i)** **[3]**

(d) (i) **HCl** no reaction **(1)**

HI purple vapour/black solid **(1)**

$2HI \rightarrow H_2 + I_2$ **(1)**

(ii) bond energy in HCl is high **(1)**

bond energy in HI is lower/more easily broken **(1)**

(iii) hot glass rod provides activation energy **(1)** **[6]**

[Total: 15]

4 **(a)** **(i)** $BrCH_2CHBrCH_2OH$ **(1)**

(ii) $CH_2=CHCO_2H$ **(1)** **[2]**

(b) oxidation **(1)** **[1]**

(c) structural **or** functional group isomerism **(1)** **[1]**

(d) **step I**
$CH_2=CHCH_2OH \rightarrow CH_3CH_2CH_2OH$

H_2 **(1)**

Ni catalyst and heat **or** Pt at room temperature **(1)**

step II $CH_3CH_2CH_2OH \rightarrow CH_3CH_2CHO$

acidified dichromate(VI) **(1)**

heat **not** under reflux
or distil off aldehyde as it is formed **(1)**
for both steps, conditions mark is only awarded if correct reagent is given **[4]**

(e) **both** oxidation and reduction have occurred **(1)** **[1]**

(f) **(i)** $HOCH_2CHOHCH_2OH$ formed

$CH_2=CH$- forms $HOCH_2CHOH^-$ **(1)**

$^-CH_2OH$ is unchanged **(1)**

(ii) HO_2CCO_2H **(1)** **[3]**

[Total: 12]

5 **(a)** A reaction in which one atom or group of atoms replaces another. **(1)** **[1]**

(b) **(i)** $C_2H_5Br + NaOH \rightarrow C_2H_5OH + NaBr$

allow OH^- **(1)**

(ii) heat with aqueous $NaOH/OH^-$ **(1)** **[2]**

(c) **(i)** $C_2H_5Br + KCN \rightarrow C_2H_5CN + KBr$

allow CN^- **or** NaCN **(1)**

(ii) heat with KCN under reflux in ethanol **(1)** **[2]**

(d) **(i)** **K** is $C_2H_5Cl/C_2H_5Br/C_2H_5I$ **(1)**

L is C_2H_5CN **(1)**

(ii) **step I**

reagent - PCl_3 **or** PCl_5 **or** $SOCl_2$
or NaBr +conc H_2SO_4 **or** P + Br_2
or P + I_2 **(1)**

conditions - room temperature **or** heat under reflux depending on reagent **(1)**

step III

reagent - mineral acid **(1)**

conditions - heat under reflux **(1)**

for both steps, conditions mark is only awarded if correct reagent is given **[6]**

[Total: 11]