CAMBRIDGE
INTERNATIONAL EXAMINATIONS

CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the November 2003 question papers

9701 CHEMISTRY

9701/01	**Paper 1 (Multiple Choice), maximum raw mark 40**
9701/02	**Paper 2 (Theory 1 – Structured Questions), maximum raw mark 60**
9701/03	**Paper 3 (Practical 1), maximum raw mark 25**
9701/04	**Paper 4 (Theory 2 – Structured Questions), maximum raw mark 60**
9701/05	**Paper 5 (Practical 2), maximum raw mark 30**
9701/06	**Paper 6 (Options), maximum raw mark 40**

These mark schemes are published as an aid to teachers and students, to indicate the requirements of the examination. They show the basis on which Examiners were initially instructed to award marks. They do 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*.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the November 2003 question papers for most IGCSE and GCE Advanced Level syllabuses.

CAMBRIDGE
INTERNATIONAL EXAMINATIONS

November 2003

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 40

SYLLABUS/COMPONENT: 9701/01

CHEMISTRY
Paper 1 (Multiple Choice)

UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

Question Number	*Key*	*Question Number*	*Key*
1	**C**	21	**C**
2	**B**	22	**B**
3	**A**	23	**C**
4	**B**	24	**A**
5	**C**	25	**C**
6	**D**	26	**B**
7	**B**	27	**B**
8	**C**	28	**B**
9	**D**	29	**D**
10	**A**	30	**A**
11	**C**	31	**B**
12	**C**	32	**C**
13	**B**	33	**B**
14	**D**	34	**D**
15	**B**	35	**A**
16	**A**	36	**C**
17	**A**	37	**C**
18	**D**	38	**B**
19	**B**	39	**B**
20	**C**	40	**D**

TOTAL 40

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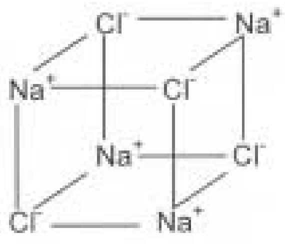
1 **(a)** ionic$^-$ (1)

Na^+ and Cl^- (1)

arranged in cubic lattice (diagram required)



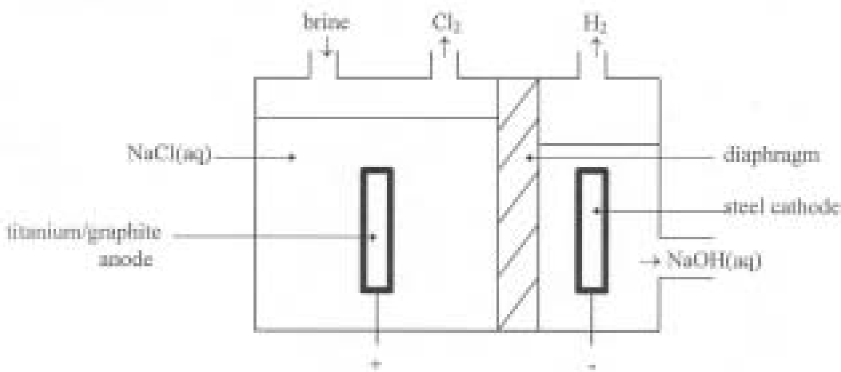
(1)

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, HCl, 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) $Ca(s) \; + \; 2H_2O(l) \rightarrow Ca(OH)_2(aq) + H_2(g) \quad \Delta H = -411$
$\Delta H^{\ominus}_f \quad 2 \times (-286) \quad x$

$\Delta H_{reacn} = x - 2(-286) = -411$ (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)** $CH_3CH_2CH_2CH_2Br + NaOH$ **or** $OH^- \rightarrow$

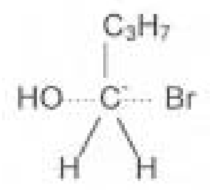
$CH_3CH_2CH_2CH_2OH +$ NaBr **or** Br^- (1)

(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 $CH_3C(CH_3) = CH_2$ (1)

(iii) I $CH_3CH_2CO_2H$ (1)

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

(c)

[3]

[Total: 13]

CAMBRIDGE
INTERNATIONAL EXAMINATIONS

November 2003

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 25

SYLLABUS/COMPONENT: 9701/03

CHEMISTRY
Practical 1

UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

N.B. Boxed references within this marking scheme relate to the accompanying booklet of Standing Instructions.

Question 1

Table 1.1

Give **one mark** if all weightings (1st 4 lines of Table 1.1) ar to 2 d.p. or better (1)

Accuracy

From the Supervisor's script calculate $\frac{\textbf{mass of water droven off}}{\textbf{mass of anhydrous sodium carbonate}}$

Work to 2 decimal places. Use the lowest mass after heating. Record the Supervisor's value as a ringed value to the side of Table 1.1.

Calculate the same ratio for each candidate, recorded alongside the |Supervisor's value and calculate the difference between Supervisor and candidate. Award marks as follows:

Mark	**Difference to Supervisor**				
	S ⩾ 1.6	**S ≅ 1.3**	**S ≅ 1.0**	**S ≅ 0.6**	**S ≅ 0.3**
5	0.00 to 0.10	0.00 to 0.08	0.00 to 0.06	0.00 to 0.04	0.00 to 0.02
4	0.10+ to 0.20	0.08+ to 0.16	0.06+ to 0.12	0.04+ to 0.08	0.02+ to 0.04
3	0.20+ to 0.30	0.16+ to 0.24	0.12+ to 0.18	0.08+ to 0.12	0.04+ to 0.06
2	0.30+ to 0.40	0.24+ to 0.32	0.18+ to 0.24	0.12+ to 0.16	0.06+ to 0.08
1	0.40+ to 0.60	0.32+ to 0.48	0.24+ to 0.36	0.16+ to 0.24	0.08+ to 0.12
0	Greater than 0.60	Greater than 0.48	Greater than 0.36	Greater than 0.24	Greater than 0.12

(5)

If more than half the candidates in a Centre score less than 2 marks for accuracy, try 1.70 as a standard value.

If this produces no improvement, examine the candidates' values to see if there is a suitable average.

(a) Give one **mark** for a **<u>statement</u>** referring to heating to constant mass or words to that effect (Accept ±0.02 g as constant mass.
N.B. This mark is for understanding the concept – not a reflection of the numbers in Table 1.1 (1)

(b) Give **one mark** for correctly calculating the mas of crystals used.
(Line 2 – Line 1 of Table) (1)

(c) Give **one mark** for correctly calculating the mass of water driven from the crystals
(Line 2 – lower value from Lines 3 or 4 of Table) (1)

(d) Give **one mark** for calculating the water driven from the crystals as a % by mass. (1)

$$\frac{\textbf{answer (c)}}{\textbf{answer (b)}} \times \textbf{100}$$ (Ignore evaluation unless no working is shown)

Total for Question 1 = 10

Question 2

Table 2.1

Give **one mark** if both weighings (1st two lines of Table 2.1) are to 2 dp or better and there is no error in subtraction (1)

Titration Table 2.2

Give **one mark** if all final burette readings (except any labelled Rough) are to 2 dp and the readings are in the correct places in the table. Do **not** give this mark if "impossible" initial or final burette readings (e.g. 23.47 cm^3) are given

Give one mark if there are two titres within 0.10 cm^3 and a "correct" average has been calculated.

See section (f) for acceptable averages

The subtraction of a Rough value need only be checked when the Rough value has been included in the selection of titres for calculating the average.

Do not give this mark if there is an error in subtraction. (2)

Accuracy

See section (g). Adopt procedure (ii) in (h) for any suspect Supervisor's result

From the Supervisor's titre calculate to 2 decimal places)

$$\frac{\mathbf{3.50}}{\textbf{mass of crystals dissolved}} \times \textbf{titre}$$

Record this value as a ringed total below Table 2.2

Calculate the same ration to 2 dp for each candidate and compare with that calculated for the Supervisor.

The spread penalty referred to in (g) of Standing Instructions may have to be applied using the table below

Accuracy Marks	
Mark	**Difference to Supervisor**
6	Up to 0.20
5	0.20+ to 0.25
4	0.25+ to 0.30
3	0.30+ to 0.50
2	0.50+ to 1.00
1	1.00+ to 2.00
0	Greater than 2.00

Spread Penalty	
Range used/cm^3	**Deduction**
0.20+ to 0.25	**1**
0.25+ to 0.30	**2**
0.30+ to 0.40	**3**
0.40+ to 0.50	**4**
0.50+ to 0.70	**5**
Greater than 0.70	**6**

If the Supervisor provided no titration details – see two possible approaches to assigning accuracy marks described at the top of page 3

Action to be taken when no Titre results are provided by the Supervisor

(i) If the majority of candidates have similar "calculated titres" work with a suitable mean derived from the candidates' results.

(ii) If the Supervisor obtained a "good" ratio when heating in expt 1 (1.5 – 1.7)
Use the ratio/derived % of Na_2CO_3 to calculate the expected titre if 3.50 g of crystals were dissolved into 250 cm^3 of solution

In all calculations, ignore evaluation errors if working is shown

(a) Give **one mark** for $\frac{\text{titre}}{1000} \times 0.1000$ (1)

(b) Give **two marks** for answer to (a) x $\frac{1}{2} \times \frac{250}{25}$
(one) (one)

answer to (a) x 5 scores both marks (2)

(c) Give **one mark** for **answer to (b) x 106**

If $\frac{250}{25}$ is missing from an otherwise correct answer in **(b)** but introduced in **(c)** allow the mark for **(c)** (1)

(d) Give **one mark** for **mass of crystals weighed – answer to (c)** (1)

(e) Give **one mark** for $\frac{\text{answer to (d)}}{\text{mass of crystals weighed}} \times 100$ (1)

Total for Question 2 = 15

Total for Paper = 25

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

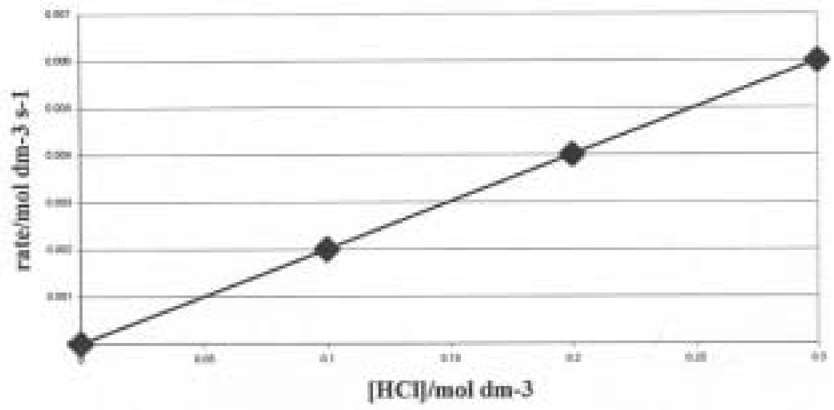
or: the value of *a* in the expression rate = $k[A]^a$ (1) **[1]**

(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) $k = \text{rate}/[\text{propanone}][H^+] = 3.3 \times 10^{-6}/(0.2 \times 0.5) = 3.3 \times 10^{-5}$ (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) $pH = -\log_{10}(0.05)$ = **1.30** (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 cm^3** (1)
(*or* $= 0.5 \times 10^{-3} \times 22400$ = **12 cm^3**

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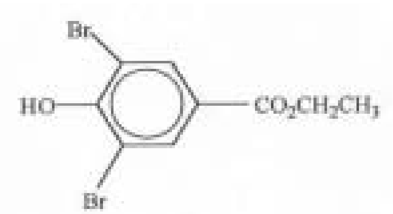
4 **(a)** phenol, ester, arene/bezene ring *any two* (1) + (1) **[2]**

(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

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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]**

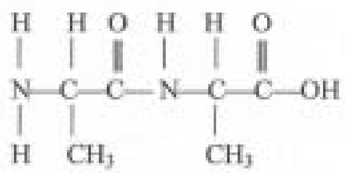
(c)

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

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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

CAMBRIDGE
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GCE A AND AS LEVEL

MARK SCHEME
MAXIMUM MARK: 30
SYLLABUS/COMPONENT: 9701/05 **CHEMISTRY** **Practical 2**

UNIVERSITY *of* CAMBRIDGE
Local Examinations Syndicate

N.B. Boxed references within this marking scheme relate to the accompanying booklet of Standing Instructions

Question 1

Experiment 1

Tables 1.1 and 1.2

Give **one mark** if all weighings are to at least two decimal places, temperatures to at least one decimal place and the subtraction is correct in each table. (1)

Table 1.2 – Accuracy

Calculate $\frac{\textbf{temperature rise}}{\textbf{mass of FB2}}$ for the Supervisors values – work to 2 d.p. Record this one the front of the Supervisor's script and as a ringed total below Table 1.2 on each Candidate's script.

Calculate the same ratio for each candidate and calculate the difference to the Supervisor value. Award accuracy marks for differences as follows:

Mark	*Difference / °C*
4	0.00 to 0.15
3	0.15+ to 0.20
2	0.20+ to 0.30
1	0.30+ to 0.45
0	Greater than 0.45

(4)

(a) Give **one mark** for **50 x 4.3 x Δt and appropriate unit (J/kJ)**
No mass of sodium carbonate to be included. *Ignore sign in* **(a)** (1)

(b) Give **one mark** for a calculation showing moles of HC*l* and moles of sodim carbonate (correct use of 106) **and**
Reference to 2:1 ratio from the equation (1)

(c) Give **one mark** for $\frac{\textbf{answer to (a)}}{\textbf{correctly calculated moles of } \mathbf{Na_2CO_3}}$ **or**

$\frac{\textbf{answer to (a)}}{\mathbf{0.5 \times} \textbf{moles of } \mathbf{HC}l}$ if Na_2CO_3 stated to be in excess

and **one mark** for
an answer correct to 3 significant figures using the numerical values in the expression in **(c)** (or correct value from **(a) and (b)** if no working given in **(c)**)
(Do not penalise use of moles of Na_2CO_3 carried in calculator memory from **(b)*)***
and sign consistent with experimental results (+ sign required for endothermic reactions)
and unit (J mol^{-1} or kJ mol^{-1})
The second mark can be given providing the answer to **(a)** has been divided by a value for moles of Na_2CO_3 or moles of HC*l* calculated by the candidate.(2)

Experiment 2

Table 1.3 and 1.4

Give **one mark** if all weighings are to at least two decimal places, temperatures to at least one decimal place and the subtraction is correct in each table. (1)

Table 1.4 – Accuracy

Calculate $\frac{\textbf{temperature rise}}{\textbf{mass of FB3}}$ for the Supervisor's values – work to 2 d.p. Record this on the front of the Supervisor's script and as a ringed total below Table 1.4 on each Candidate's script.

Calculate the same ratio for each candidate and calculate the difference to the Supervisor's value. Award accuracy marks for differences as follows:

Mark	*Difference / °C*
4	0.00 to 0.11
3	0.10+ to 0.20
2	0.20+ to 0.30
1	0.30+ to 0.50
0	Greater than 0.50

(4)

(d) Give **one mark** for **50 x 4.3 x Δt and appropriate unit (J/kJ)** *unless already penalised in* **(a)** *Ignore sign in* **(d)** (1)

(e) Give **one mark** for $\frac{\textbf{mass of NaHCO}_3}{\textbf{84}}$ *Do not penalise a repeat error in calculating M_r e.g. repeated use of an incorrect A_r* (1)

(f) Give **one mark** for $\frac{\textbf{answer to (d)}}{\textbf{answer to (e)}}$

and **one mark** for
an answer correct to 3 significant figures using the numerical values in the expression in **(f)**
(Do not penalise use of moles of $HaHCO_3$ carried in calculator memory from* (e)*)
and sign consistent with experimental results (+ sign required for endothermic reactions)
and unit (J mol^{-1} or kJ^{-1})
***Do not penalise if missing mol^{-1} is only error and already penalised in* (c)**
The second mark can be given providing the answer to **(d)** has been divided by a value for moles of Na_2CO_3 or moles of HC*l*. (2)

(g) Give **one mark** for use of ΔH_1 and $2\Delta H_2$.

Give **one mark** for $\Delta H_1 - 2\Delta H_2$ in the final part of the calculation

Watch out for sign errors if the candidate has not stated $\Delta H_1 - 2\Delta H_2$ (2)

ASSESSMENT OF PLANNING SKILLS

Look for the following points in nay part of the plan or carrying out of the plan and award **one mark** for each point

(i) Weights a sample, adds to known volume of water and measures change in temperature.

(ii) Calculates energy change for volume of solution used

(iii) Converts mass $NaHCO_3$ into moles.

Numerical answers are required in parts **(ii)** *to* **(iv)**.

(iv) Calculates ΔH_4 including sign *(unless already penalised).*

(v) Adds 2 ΔH_4 to the answer to **(g)**.
Ignore any reference to ΔH_5 and ΔH_6 etc. by the candidate

Total for Question 1: 25

Question 2

ASSESSMENT OF PLANNING SKILLS

GRID 1A

Adds HCl/H_2SO_4 or any soluble chloride or soluble sulphate (or KI) to all three solutions	✓	No precipitate formed with **FB 5** and with **FB 6** (No change or no reaction acceptable)	✓
		White precipitate (yellow with KI) forms with **FB 7** Indicated the presence of Pb^{2+}	✓
(Aqueous) ammonia added to the **two solutions** where no precipitate formed with the first reagent (**FB 5** and **FB 6**) *This mark is lost if 2nd reagent is added to all three solutions*	✓	**FB 5** gives a white precipitate soluble in excess ammonia Indicates the presence of Zn^{2+} **FB 6** gives a white precipitate insoluble in excess ammonia Indicates the presence of Al^{3+}	✓

5

GRID 1B

Adds aqueous ammonia to all three solutions	✓	White precipitate formed with all three solutions	✓
		White precipitate formed in **FB 5** dissolves in excess ammonia solution. Indicates the presence of Zn^{2+}	✓
Adds HCl/H_2SO_4 or any soluble chloride or soluble sulphate (or KI) to the two solutions where the precipitate formed with aqueous ammonia did not dissolve in excess of the reagent. *This mark is lost if 2nd reagent is added to all three solutions*	✓	**FB 7** gives a white precipitate (yellow with KI) Indicates the presence of Pb^{2+} There is no precipitate/no change/no reaction with **FB 6** Indicates the presence of Al^{3+}	✓

(5)

GRID 2A

Adds Na_2CO_3 or $NaHCO_3$ to all three solutions	✓	White precipitates formed with all three solutions	✓
		Effervescence or CO_2 or gas turning lime water milky with **FB 6** Indicates the presence of Al^{3+}	✓
(Aqueous) ammonia added to the **two solutions** where no effervescence was seen with the first reagent (**FB 5** and **FB 7**) *This mark is lost if 2nd reagent is added to all three solutions*	✓	**FB 5** gives a white precipitate soluble in excess ammonia Indicates the presence of Zn^{2+} **FB 7** gives a white precipitate insoluble in excess ammonia Indicates the presence of Pb^{2+}	✓

GRID 2B

Adds Na_2CO_3 or $NaHCO_3$ to all three solutions	✓	White precipitates formed with all three solutions	✓
		Effervescence or CO_2 or gas turning lime water milky with **FB 6** Indicates the presence of Al^{3+}	✓
Adds HCl/H_2SO_4 or any soluble Chloride or soluble sulphate (or KI) to the two solutions where no effervescence was seen with the first reagent (**FB 5** and **FB 7**) *This mark is lost if 2nd reagent is added to all three solutions*	✓	**FB 7** gives a white precipitate (yellow with KI) indicates the presence of Pb^{2+} There is no precipitate/no change/no reaction with **FB 5** Indicates the presence of Zn^{2+}	✓

(5)

GRID 3A

Adds HCl/H_2SO_4 or any soluble chloride or soluble sulphate (or KI) to all three solutions	✓	No precipitate formed with **FB 5** and with **FB 6** (No change or no reaction acceptable)	✓
		White precipitate (yellow with KI) forms with **FB 7** Indicates the presence of Pb^{2+}	✓
Adds Na_2CO_3 to the **two solutions** where no precipitate was seen with the first reagent (**FB 5** and **FB 6**) *This mark is lost if 2nd reagent is added to all three solutions*	✓	**FB 5** gives a white precipitate Indicates the presence of Zn^{2+} **FB 6** gives a (white precipitate and) effervescence, CO_2 or a gas giving white precipitate with lime water. Indicates the presence of Al^{3+}	✓

5)

GRID 3B

Adds aqueous ammonia to all three solutions	✓	White precipitate formed with all three solutions	✓
		White precipitate formed in **FB 5** dissolves in excess ammonia solution. Indicates the presence of Zn^{2+}	✓
Adds Na2CO3 or NaHCO3 to the **two solutions** where the precipitate formed with aqueous ammonia did not dissolve in excess of the reagent (**FB 6** and **FB 7**) *This mark is lost if 2nd reagent is added to all three solutions*	✓	**FB 7** gives a white precipitate Indicates the presence of Pb^{2+} **FB 6** gives a (white precipitate and) effervescence, CO_2 or a gas giving white precipitate with lime water. Indicates the presence of Al^{3+}	✓

(5)

NB:

"Method marks" may be awarded from the plan (page 8) or from the observation table (page 9).
Observation marks are awarded from page 9.
Marks are given for positive experimental identification – not for identification by elimination UNLESS the tests have been fully explained in theory in the Plan on page 8.
Reduce the marks awarded by one for each additional reagent used.

Ignore ions listed in the conclusion.

Total for Question 2: 5

Total for Paper: 30

CAMBRIDGE
INTERNATIONAL EXAMINATIONS

November 2003

GCE A AND AS LEVEL

MARK SCHEME
MAXIMUM MARK: 40
SYLLABUS/COMPONENT: 9701/06 **CHEMISTRY** **Options**

UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

Biochemistry

1 (a) Enzymes (1)
globular proteins (1) **[2]**

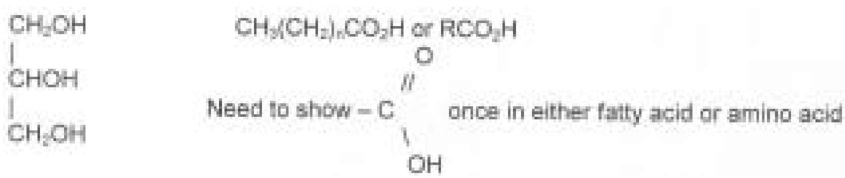
(b) (i) Monasaccharides/simple sugars/glucose (1)

(ii) Glycerol and fatty (or carboxylic) acids/carboxylates – both needed (1)

(iii) Amino acids (1)

(iv) Deoxyribose/ribose, bases/ nucleotides, phosphate (1) **[4]**

(c) 2x(1)



$H_2NCHRCO_2H$ (or the zwitterions) (1)

NOT $CO_2 + H_2O$

Mark consequentially on **(b)(ii)** and **(b)(iii)** **[3]**

(d) Hydrolysis (1)

NOT Hydration

2 (a) UCAG are bases (1)
found in m-RNA (1)

Phe, Leu etc. are amino acids (1)

Sequence of amino acids determines the protein/peptide (1)

This is called the 'triplet code'/codon (1)

Three bases correspond to one amino acid or 4^3 argument (1)

Hence sequence of bases in nucleic acid determines the sequence of amino acids in the protein/transcription takes place (1)

The chief role of DNA/RNA/nucleic acids is in protein synthesis (1)

Code is not unique/more than one base sequence for given amino acid (1) **[max 8]**

(b) Instructions to start a protein molecule (1)

Instructions to end the molecule (1) **[2]**

Environmental Chemistry

3 (a) (i) 2:1 clay with two layers of silicate and one of aluminium oxide. (1)

Units held by water to adjacent silicate units/lamellae by hydrogen bonding (1)

(ii) <u>Regular</u> substitution of A*l* for Si has occurred within the silicate layers (1)

This leads to cation deficiency (1)

which is balanced by the presence of K^+ on the surface of the clay. (1) **[5]**

(b) (i) Ammonium and potassium ions are held firmly at the surface of the soil as a result of ion substitution within the clay
OR the presence of surface oxides in silicate structures
OR the presence of humus. (1)

(ii) $SO_2 + NO_2 + H_2O \rightarrow H_2SO_4 + NO$ (1)
Allow two equations
$SO_2 + H_2O \rightarrow H_2SO_3$
$2NO_2 + H_2O \rightarrow HNO_2 + HNO_3$
} both needed

(iii) Hydrogen ions can also be held at exchange sites (1)

and in high enough concentration (1)

will displace the other cations from the surface (1)
can then be washed away. (1) **[max 5]**

4 (a) (i) Temperature much be high enough for efficient combustion (1)

If chlorinated waste is present when dioxins may form (1)

Temperature must be > 800°C to destroy them (1)

(ii) Organic matter may be suspended in the water (1)

Al^{3+}(aq) precipitates as the hydroxide settling the organic matter (1)

which must be removed otherwise toxic chlorinated organic matter may form (1) **[6]**

(b) (i) Phosphates are added to soften hard water (1)

by forming complexes with calcium and magnesium ions (1)

(ii) Excess phosphate released into waterways encourages growth of algae (1)

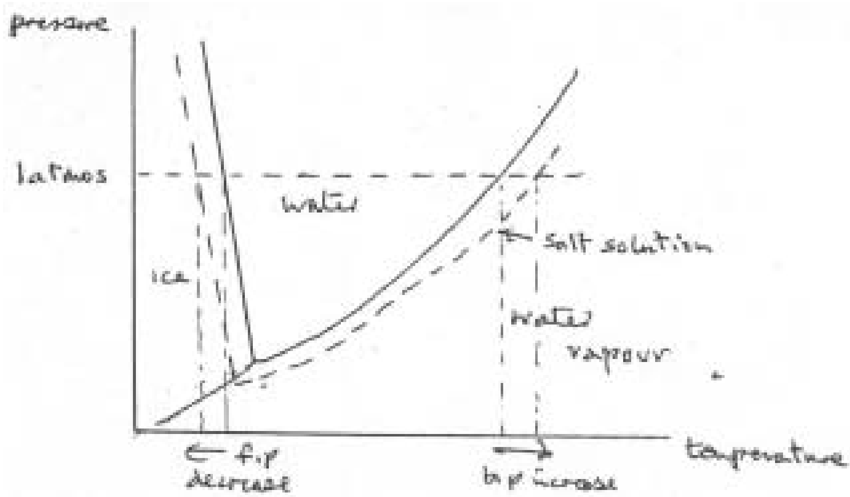
Eutrophication can then occur (1)

Increases BOD (1)

[max 2] **[4]**

Phase Equilibria

5 (a)



Axes labeled and sketch	(1)	
areas labeled	(1)	
Slope of ice/water line is atypical	(1)	
since the solid (ice) is less dense than water/floats on water	(1)	
High pressure favours a smaller volume of liquid	(1)	**[max 4]**

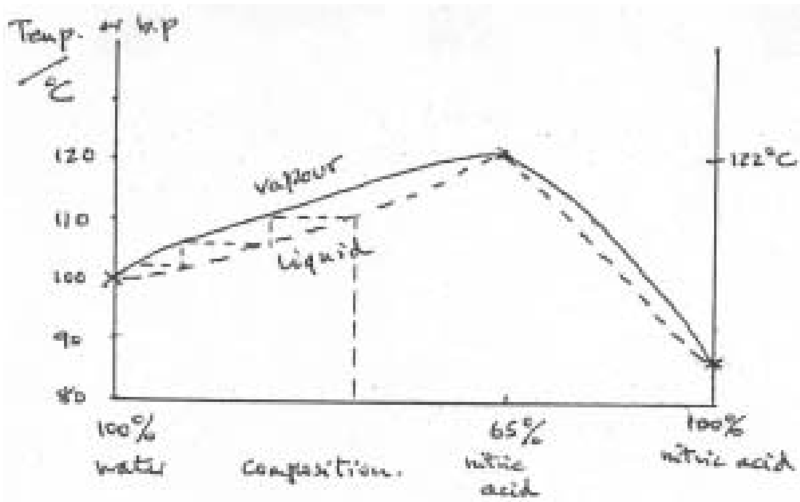
(b)

1 atmosphere (or other labeled pressure) line drawn	(1)	
Salt solution line drawn	(1)	
F.p. decrease **and** b.p. increase	(1)	
lines drawn on diagram	(1)	**[4]**

(c)

At any temperature vapour pressure of water is greater than salt soln	(1)	
Rate of evaporation is proportional to vapour pressure	(1)	
Ions attract water molecules making evaporation more difficult.	(1)	**[max 2]**

6 (a)



Sketch,	(1)	
two labels,	(1)	
three points	(1)	
axes labeled	(1)	**[4]**

(b) **(i)** Pure water — lines on graph (1) (1)

(ii) Azeotrope (or 65% nitric acid) (1)

This may be consequential on **(a)** if candidates vertical line is wrong **[3]**

(c) **(i)** $V = n_A p_A$ etc (or in words) (allow proportionality) (1)

(ii) Any 2 of:
Nitric acid and water react/attract each other more strongly than molecules of each/mixing is exothermic (1)

Show negative deviation from Raoult's law (1)

$HNO_3 + H_2O \rightarrow H_3O^+ + NO_3^-$ OR (1)
(or equivalent) **[3]**

Spectroscopy

7 **(a)** **(i)** Protons possess nuclear spin (1)

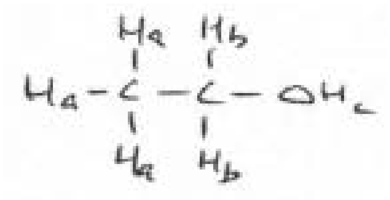
This generates a magnetic moment (1)

This moment can align with or against an external magnetic field (1)

This gives two energy (1)

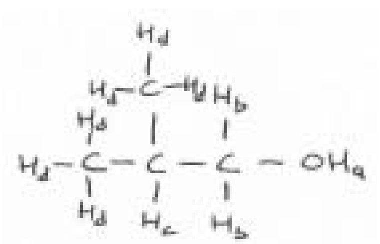
(ii) External magnetic field may be modified by moments from other protons in the molecule (1)

Example from ethanol e.g. comment on 1 : 2 : 1 splitting pattern (1)



[6]

(b)



Correct displayed formula (1)

3, 2 1 for each correct proton (since if 3 are right, 4 must be!) (3) **[4]**

8 **(a)** I.r. peak at 1720 cm^{-1} suggests C=O (1)

	%	%/A_r	Ratio		
C	66.7	5.55	4		
H	11.1	11.1	8		
O	22.2	1.4	1	gives C_4H_8O	(1)

M peak is at 72 hence molecular formula is C_4H_8O (1)

Mass spectrum peat at 57 is (M-CH_3) or $C_2H_5CO^+$ (1)
Mass spectrum peak at 43 could be (M-CHO or M-C_2H_5)
or $C_3H_7^+$ or CH_3CO (1)

E is $CH_3CH_2COCH^3$ **or** $CH_3CH_2CH_2CHO$ (1) **[max 5]**

(b) **(i)** Non-invasive (1)

Flesh is transparent to radio waves (1)

Low energy/no tissue damage (1)

May be 'tuned' to particular protons/types of tissue (1) **[max 3]**

(ii) Standards are prepared (1)

Calibration graph produced (1)

Sample diluted (1)

Concentration read from calibration graph (1) **[max 3]**
[max 5 for (b)]

Transition Elements

9 **(a)** Colour is due to the absorption of visible light (1)

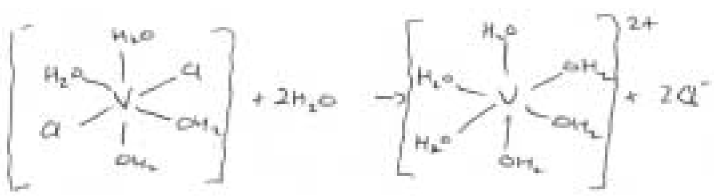
Atom needs vacancy(ies) in the d-orbitals (1)

The d-orbitals are split into two energy levels by ligands (1)

Energy is used to promote electrons from lower to upper d-orbitals
OR Energy gap in non-transition metals does not lie in visible
range (1) **[max3]**

(b) Ligand exchange between chloride and water occurs

OR



Green Violet (1)

d-orbital energy gap with Cl^- ligands is different to that with H_2O
ligands (1) **[2]**

(c) V(III) is V^{3+} (or $[V(H_2O)_6]^{3+}$) and is green (1)

V(IV) is $VO^{2+}(aq)$ and is blue NOT V^{4+} (1) **[2]**

(d) (i) MnO_4^-/Mn^{2+} is +1,52V, higher than VO_2^+/VO^{2+} so final state is 5 (1)

(ii) moles of e^- = 0.02 x 5 x 20/1000 = 0.002 (1)

Hence 2 moles of electrons are used per mole of vanadium
Change is from V(III) to V(V)

(iii) x is 1, hence VOC*l* (1) **[3]**

10 (a) Stainless steel, with iron (+ example use) (1)
Brass, with zinc (+ example use) (1)
Accept also bronze (Cu + Sn), duralumin (Cu+Al), cupronickel (Cu+Ni) nicrome (Ni+Cr)

NB two correct pairs of metals scores (1)
OR two correct alloys and uses scores (1) **[2]**

(b) (i) $Cr_2O_7^{2-} + H_2O \rightleftharpoons 2CrO_4^{2-} + 2H^+$ (1)

$\downarrow Ba^{2+}$

$BaCrO_4(s)$
yellow (1)

Equilibrium shifts to the right as CrO_4^{2-} ions are removed and hence the solution becomes more acidic (1)

(ii) $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$
(i.e. ammonia solution contains OH^- ions) (1)

$CU^{2+} + 2OH^- + Cu(OH)_2$ (pale blue ppte) (1)

Then $4NH_3 + Cu^{2+}(aq) = [Cu(NH_3)_4]^{2+}$ (deep blue solution) (1)

NH_3 is a stronger ligand than H_2O and displaces it (1)

(iii) violet – $[Cr(H_2O)_6]^{3+}$ 3C*l*$^-$ (1)

green – $[Cr(H_2O)_5$ C*l*$^-]^{2+}$ 2C*l*$^-$.H_2O (1) **[max 8]**