CAMBRIDGE
INTERNATIONAL EXAMINATIONS

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

TOTAL 40

CAMBRIDGE
INTERNATIONAL EXAMINATIONS

JUNE 2003

GCE A AND AS LEVEL

MARK SCHEME
MAXIMUM MARK: 60
SYLLABUS/COMPONENT: 9701/02 **CHEMISTRY** **Theory 1 (Structured Questions)**

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1 **(a)** Atoms which have the same number of protons (or same element) but <u>different numbers of neutrons</u> (1) **[1]**

(b) **(i)** ^{35}Cl (1)

(ii) $H^{37}Cl$ (1) **[2]**

(c) H Cl line at 36 has rel. abundance of 90 (1)
38 30

These show ^{35}Cl and ^{37}Cl in ratio 3:1 (1)
[or use of 35 and 37] **[2]**

(d) Mean of the two isotopes $\frac{3 \times 35 + 1 \times 37}{4} = 35.5$ (1) **[1]**

[Total: 6]

2 **(a)** **(i)** That the volume of the gas molecules is negligible compared to the volume of gas (1)

(ii) That there are no intermolecular forces
OR collisions of the molecules are perfectly elastic
Particles are in constant motion, losing no energy on collision (1) any two **[2]**

(b) 6.02×10^{23} (1) **[1]**

(c) **(i)** r = <u>0.192</u> nm (1) Assume most candidates will work in dm^3
$v = \frac{4}{3} \times 3.14 \times (1.92 \times 10^{-9})^3 = 2.96 \times 10^{-26}\ dm^3\ (2.96 \times 10^{-29}\ m^3)$ (1)

(ii) $2.96 \times 10^{-26} \times \underline{6.02 \times 10^{23}}$ (1) $= 1.78 \times 10^{-2}\ dm^3\ (1.78 \times 10^{-5}\ m^3)$ (1)

(iii) $24\ dm^3\ (0.024\ m^3)$ (1)

(iv) $\frac{1.78 \times 10^{-2} \times 10^2}{24} = 0.074\%$ (1)

(v) Some statement which connects with **(a) (i)** above (1) **max [5]**

(d)
- hot metals will react with oxygen in air (or nitrogen)
- to form oxides/will burn out/to a powder
- argon will not react
- at high temperatures O_2 and N_2 in air will react to give NO_x

NOT expansion of gases on heating any two **[2]**

[Total: 10]

3 **(a)** $N_2 + 3H_2 \rightleftharpoons 2NH_3$ (1) exothermic (1) **[2]**

(b) Pr. 5O atm upwards; Temp 400-600ºC; catalyst of iron
(1 each, conditions stated) **[3]**

(c) Too high a temp and equilibrium favours LHS, less ammonia at equilibrium (1)
Too low a temp, rate too slow/not enough molecules have E_{act} (1) **[2]**

(d) **(i)** $K_p = \dfrac{PNH_3^{\,2}}{PN_2 \times PH_2^{\,3}}$ (1)

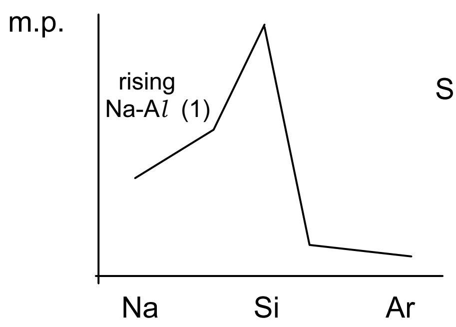
(ii) $K_p = \dfrac{37.2^2}{44.8 \times 105.6^3}$ (1)

$= 2.62 \times 10^{-5}\ \text{atm}^{-2}$ (1) calculation and units **[3]**

(e) Excess (hence uncontrolled) nitrates leach out of fields into streams, seas (1)
Bacteria or algae grow fast/use oxygen/clog up water (1)
Balance destroyed/fish unable to live (1) **[3]**
Process called eutrification (1) any 3

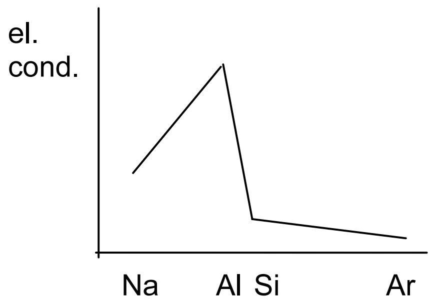
[Total: 13]

4 **(a)** **(i)**



Si to Ar (1) **[2]**

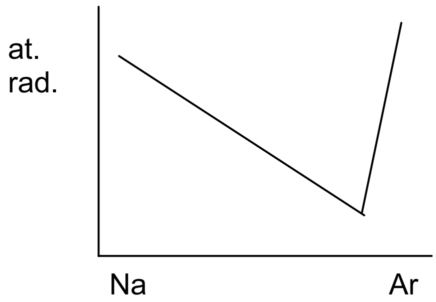
(ii)



rising
Na-Al (1)

P – Ar (below Na) (1) **[2]**

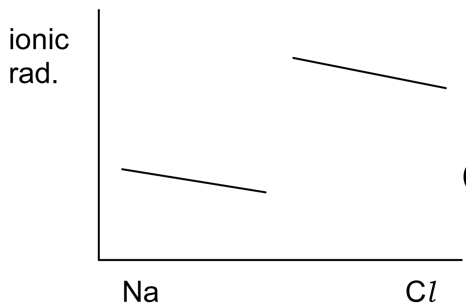
(iii)



(in data booklet)

(1) **[1]**

(iv)



(in data booklet)

(1) **[1]**

[6]

(c) **(i)** Na_2O MgO Al_2O_3 P_2O_5 (or P_4O_{10} or P_2O_3) SO_2 or SO_3 (1)

(ii) $Na_2O + H_2O \rightarrow 2NaOH$ (1)

(iii) $2NaOH + SO_2 \rightarrow Na_2SO_3 + H_2O$ (1) or $NaHSO_3$

<u>OR</u> $2NaOH + SO_3 \rightarrow Na_2SO_4 + H_2O$ (1) $NaHSO_4$ **[3]**

[Total: 9]

5 **(a)**

$$\begin{array}{ccccccccccc} — CH_2 — & CH & — CH_2 — & CH & — CH_2 — & CH & — \\ & | & & | & & | & \\ & CH_3 & & CH_3 & & CH_3 & \end{array}$$

(1) **[1]**

(b) Alkane (1) **[1]**

(c) **(i)** Not biodegradable/does not decompose/unreactive
Not affected by enzymes
Not attacked by aqueous or polar reagents found in tissues
Insoluble/does not absorb water/cotton absorbs water
NOT is stronger than cotton
[equivalent worthy points; they may overlap - but allow - max 2] **[2]**

(ii) Alkanes react with oxygen (combustion)
Not possible in muscle (1)
also react with halogens/in U.V. light
muscle is internal and no halogens (1)
[ecf for alkene answers in **(b)**] **[2]**

[Total: 6]

6 (a) $\frac{66.7}{12}$ $\frac{11.1}{1}$ $\frac{22.2}{16}$

= 5.5 = 11.1 = 1.3875
Divide by 1.3875
C_4H_8O (1) 48 + 8 + 16 = 72 hence C_4H_8O (1) **[2]**

(b) (i) orange ppt (1) red to yellow/crystals or solid

(ii) ketone (1)

(iii) $CH_3CH_2COCH_3$ or butanone (1) **[3]**

(c) (i) $NaBH_4$ allow $NaAlH_4$ ($LiAlH_4$) (1) H_2/Ni or Pt

(ii) secondary alcohol (1)

(iii) $CH_3CH_2CHOHCH_3$ (1)
[Allow ecf marks if **(b) (iii)** is butanal] **[3]**

[Total: 8]

7 (a) (i) e.g.
$CH_3CO_2C_3H_7$ $CH_3CO_2CH(CH_3)_2$ $CH_3CH_2CO_2C_2H_5$ $H\text{-}CO_2C_4H_9$
$C_3H_7CO_2CH_3$ + branches any three **[3]**

(ii) $RCO_2R' + NaOH \rightarrow RCO_2Na$ (1) + $R'OH$ (1)
$\rightarrow RCO_2H + R'OH$ (1) only **[2]**

(b) (i) and (ii) * volatile, or liquids (1) immiscible, with water (1) smell (1)
any two **[2]**

(c) (i) solvents, perfumes, flavourings, lotions, olive or palm oils any two

and (ii) To make soap, to make Terylene **[2]**
NOT polyesters

[Maximum Total: 8]

CAMBRIDGE
INTERNATIONAL EXAMINATIONS

JUNE 2003

GCE A AND AS LEVEL

MARK SCHEME
MAXIMUM MARK: 25
SYLLABUS/COMPONENT: 9701/03 **CHEMISTRY** **Practical 1**

UNIVERSITY of CAMBRIDGE
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1 (a) Table 1.1

Do not penalise times that have been recorded to 1 or 2 decimal places.

The Examiner is to inspect the candidate's calculation of $\frac{1000}{time}$.

If the candidate has recorded the ratio to more (or less) than 1 decimal place there is no need to check the calculation for **experiments 1, 3 and 5** unless $\frac{1000}{time}$ is an integer.

If all 6 calculations are recorded to 1 decimal place **the Examiner** is to check the calculation for **experiments 1, 3 and 5**. (**X.X5** may be rounded up or down.)

Give **one** mark if all three are correctly calculated. **1**

The Examiner is to calculate **volume of FA 1 x Time <u>to the nearest second</u> for experiments 1, 3 and 5.**

If the candidate fails to complete experiments 1, 3 and 5 or states that a value is inaccurate/unreliable; work with the closest available value.

Award accuracy marks as follows:

List the three **Vt** values in decreasing numerical order.
The % difference will always be assessed on the top or middle value.
Where all three values are not within 10% of the largest value, identify the closest pair,

e.g. $\left.\begin{matrix}\textbf{1800}\\\textbf{1760}\end{matrix}\right\}$ **Closest pair - 2 within 10%**
1590

Take the difference between 1590 and 1800, the **further** of the 10% pair.
The difference (210) is calculated as a % of 1800, the **greater** of the 10% pair.

$$\frac{210}{1800} \times 100 = 11.7\%$$ **1 within 20%**

e.g. 2 **1400**
$\left.\begin{matrix}\textbf{1290}\\\textbf{1250}\end{matrix}\right\}$ **Closest pair - 2 within 10%**

Take the difference between 1400 and 1250, the **further** of the 10% pair.
The difference (150) is calculated as a % of 1290, the **greater** of the 10% pair.

$$\frac{150}{1290} \times 100 = 11.6\%$$ **1 within 20%**

Award marks:

Mark	volume of FA 1 x Time
6	If all three values are within 10% of the largest
5	If all three values are within 15% of the largest or Two values are within 10% of the larger of the closest pair and the spread of all three values is ≤ 20% of the larger of the closest pair
4	If all three values are within 20% of the largest or Two values are within 15% of the larger of the closest pair and the spread of all three values is ≤ 25% of the larger of the closest pair or Two values are within 10% of the larger of the closest pair and the spread of all three values is ≤ 40% of the larger of the closest pair
3	If all three values are within 25% of the largest or Two values are within 20% of the larger of the closest pair and the spread of all three values is ≤ 30% of the larger of the closest pair or Two values are within 15% of the larger of the closest pair and the spread of all three values is ≤ 40% of the larger of the closest pair or Two values are within 10% of the larger of the closest pair and the spread of all three values is ≤ 50% of the larger of the closest pair
2	If all three values are within 30% of the largest or Two values are within 25% of the larger of the closest pair and the spread of all three values is ≤ 35% of the larger of the closest pair or Two values are within 20% of the larger of the closest pair and the spread of all three values is ≤ 40% of the larger of the closest pair or Two values are within 15% of the larger of the closest pair and the spread of all three values is ≤ 60% of the larger of the closest pair or Two values are within 10% of the larger of the closest pair and the spread of all three values is ≤ 80% of the larger of the closest pair

1 If all three values are within 35% of the largest
or
Two values are within 30% of the larger of the closest pair and the spread of all three values is $\leq$ 50% of the larger of the closest pair
or
Two values are within 25% of the larger of the closest pair and the spread of all three values is $\leq$ 60% of the larger of the closest pair
or
Two values are within 20% of the larger of the closest pair and the spread of all three values is $\leq$ 70% of the larger of the closest pair
or
Two values are within15% of the larger of the closest pair and the spread of all three values is $\leq$ 80% of the larger of the closest pair
or
Any two values are within 10% of the larger

0 Outside the above ranges

6

(b) Give **one mark** for any answer that explains that: __**Take care not to miss this mark**__

the unit of rate is **"per second" or** short time = fast rate, long time = slow rate

or **Rate** $\propto \dfrac{1}{time}$

In less clear answers - reward the idea of 'division by time'.

1

(c) **Graph**

Give **one mark** for plotting with a suitable scale on the *y* axis.
Points must be plotted over more than ½ of the *y* axis.
(Place a tick or cross at the top of the y axis and mark in the margin)

Give **two marks** if the points for **experiment 1, experiment 3 and experiment 5** are plotted correctly.
Points must be **precisely** placed on the appropriate vertical line and be in the correct square and within ½ a square of the Examiner plotted point.
If the candidate has not carried out the experiment or not plotted the point, check an adjacent point. (Two points correctly plotted earns one mark)
(Indicate correct plotting with a small tick or cross below each appropriate volume on the y axis and mark in the margin)

Give **one mark** for any straight line, drawn with a ruler, which relates to the results.
Give **one mark** for a smooth curve or straight line passing **precisely** through the origin.
(Place ticks or crosses against the line and marks in the margin)

5

(d) **If a straight line has been drawn** (that has reasonable correlation to the points plotted but does not have to go through the origin) **or**
(There is a statement - that fits the evidence - about what graph should have been drawn)

Give **one mark** for

rate of reaction is directly proportional to concentration of (sodium thiosulphate)
or
explanation such as doubling concentration, doubles rate
or
1st order (wrt sodium thiosulphate)

If a smooth curve has been drawn (that has reasonable correlation to the points plotted but does not have to go through the origin)

Give **one mark** for

concentration (of sodium thiosulphate) is related in some way to **but** is not directly proportional. If the candidate states that there is some proportional relationship they must also say it is not **directly proportional** to get this mark.

Do NOT give this mark if the line drawn is not justified by the results of the experiments. If NO LINE has been drawn and there is a scatter of points on the graph.

Give **one mark** for

there is no correlation or no proportionality
or
is not 1St order (wrt sodium thiosulphate)

1

(e) Give **one mark** for

Volume (of **FA 1**) becomes a measure of concentration
or To keep the depth of solution constant **or** Same amount of sulphur produced
or Constant opacity **or** $Na_2S_Z0_3$ only variable

1

Total for Question 1 **15**

2 **FA 3** is a mixture of two solids, **FA 4** which is soluble in water contains NH_4^+ and I^-, **FA 5** which is insoluble in water contains Mg^{2+} and $C0_3^{2-}$.

Tip the solid **FA 3** into a boiling tube, add distilled water until the tube is half full, stopper and shake for about 30 seconds. Filter the mixture and retain both the filtrate and the residue in the filter paper.

Tests on the Filtrate (FA 4)

(a)	To 2 cm depth of the filtrate in a boiling-tube, add 2 cm depth of aqueous sodium hydroxide then carefully warm the solution.	No reaction, no change, stays colourless or no precipitate **one mark** Ammonia or gas turning (red) litmus blue etc. **one mark** **2**
(b)	To 1 cm depth of the filtrate in a test-tube, add 1 cm depth of aqueous lead nitrate.	Yellow precipitate **one mark** *(Ignore solubility of ppt or subsequent change in colour)* **1**
(c)	To 2 cm depth of the filtrate in a test-tube, add 2 cm depth of aqueous hydrogen peroxide followed by 1 cm depth of dilute sulphuric acid.	Yellow-brown, orange-brown, red-brown, brown solution **or** Grey or black ppt or Iodine (formed/liberated) **one mark** **1**

Tests on the Residue (FA 5)

(d)	Transfer the solid residue from the filter paper to a boiling-tube and add a minimum quantity of dilute hydrochloric acid to dissolve the solid. Divide the solution into two parts and use one part for each of the following tests.	Effervescence, fizzing, carbon dioxide or gas turning lime water milky **one mark** **1**
	To one part add aqueous sodium hydroxide.	White precipitate, insoluble in excess **one mark** **1**
	To the other part add dilute aqueous ammonia.	White precipitate, insoluble in excess **one mark** **1**

Give **one mark** for correctly identifying the ions in **FA 4** as **NH_4^+ and I^-**.
(Do not give this mark if additional ions are included)

Give **one mark** for a deduction about one of the ions stated to be present providing the deduction fits the recorded observation (**Incorrect ions may gain marks here - ecf**)

If there is a string of ions, including NH_4^+ and I^-, the deduction must be for NH_4^+ or I^-.

Give **one mark** for correctly identifying the ions in **FA 5** as **Mg^{2+} and CO_3^{2-}**.

Give **one mark** for a correct deduction to support the identification of one of the ions stated to be present (**ecf**)

[**Where the Identity of ions in FA 4 have clearly been recorded as FA 5 or vice versa** the deduction mark may be awarded but not the mark for the identity of the ions]

Cancel any mark in excess of 10.

Total for Question 2 is 10 and for the Paper 25

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JUNE 2003

GCE A AND AS LEVEL

MARK SCHEME
MAXIMUM MARK: 60
SYLLABUS/COMPONENT: 9701/04 **CHEMISTRY** **Theory 2 (Structured Questions)**

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1 **(a)** The EMF of a cell made up of the test electrode and a standard hydrogen electrode. [1]

EMF measured under standard conditions of T, P and concentration [1]

2

(b) **(i)** $E_{left} = E_{right} - E_{cell}$ = 0.34 - 0.76 = **-0.42 (V)** [1]

(ii) $\longrightarrow$ (arrow from left to right) [1]

(iii) I pink/red solid/ppt *or* copper will be formed *or* blue solution fades *or* M dissolves/corrodes [1]

$Cu^{2+} + M \rightarrow Cu + M^{2+}$ [1]

II hydrogen/gas evolved *or* M dissolves
(do not allow "M dissolves" for [2] marks in both I and II) [1]

$M + 2H^{+} \rightarrow M^{2+} + H_2$ [1]

6

(c) **(i)** polarity of d. c. source: $\ominus$ is on the left, $\oplus$ is on the right [1]

electrolyte is $Cu^{2+}(aq)/CuSO_4/CuCl_2/Cu(NO_3)_2$ etc. *or* name [1]

(ii) moles of Cu = 0.5/63.5 = 7.87×10^{-3} [1]

moles of e^- = $2 \times 7.87 \times 10^{-3}$ = 1.57×10^{-2}

no. of coulombs = $96500 \times 1.57 \times 10^{-2}$ = 1517 (C) [1]
ecf in n(e^-)

time = 1520/0.5 = 5034 seconds = 50.7 min [1]
ecf in coulombs

5

Total 13

2 **(a)** **(i)** $K_{sp} = [Ba^{2+}][SO4^{2-}]$ [1] units: mol^2dm^{-6} [1] ecf

(ii) $[Ba^{2+}] = \sqrt{(1.3 \times 10^{-10})} = 1.14 \times 10^{-5}$ ($mol\ dm^{-3}$) [1]

(iii) $BaCO_3$ can react with/dissolve in the acid/HCl in the stomach [1]

(*or* unbalanced equation showing, e.g. $BaCO_3 + HCl \rightarrow$)

4

(b) **(i)** $K_{sp} = [Mg^{2+}][OH^-]^2$ [1] units: mol^3dm^{-9} [1] ecf

(ii) calling $[Mg^{2+}] = x$, then $K_{sp} = x(2x)^2 = 4x^3 \Rightarrow x = \sqrt[3]{\ }(K_{sp}/4)$ [1]

$\therefore [Mg^{2+}] = \sqrt[3]{\ }(2 \times 10^{-11}/4) = \mathbf{1.7 \times 10^{-4}}$ ($mol\ dm^{-3}$) [1]

allow ecf for use of $\sqrt[3]{\ }$

(iii) % left = $100 \times (1.7 \times 10^{-4})/(0.054)$ = 0.32%

$\therefore$ % extracted = **99.7** (%) [1]

5

(c) **(i)** $\Delta H_r = \Delta H^\ominus_f(Mg^{2+}) + 2\Delta H^\ominus_f(Cl^-) - \Delta H^\ominus_f(MgCl_2)$

$= -467 + 2(-167) - (-641)$

$= \mathbf{-160}$ ($kJ\ mol^{-1}$) [1]

(ii) highly exothermic enthalpy change of solution
or ΔH_{sol} is very negative [1]

2

(d) mention of hydration enthalpy and lattice enthalpy [1]

hydration enthalpy decreases more than does lattice enthalpy
or
enthalpy change of solution *or* ΔH_{sol} becomes
less negative/more positive [1]

2

Total: 13, max 12

3 **(a)** **(i)** simple/discrete covalent/molecular [1]

(ii) giant/macro covalent/molecular (NOT atomic) [1]

(iii) (giant) ionic [1]

a general statement that strong attraction means high m.pt.
and weak means low [1]

4

(b) **(i)** $CO_2 + 2NaOH \rightarrow Na_2CO_3 + H_2O$
or $CO_2 + NaOH \rightarrow NaHCO_3$ [1]
(this mark is negated if candidate states that SiO_2 dissolves/reacts)

$SnO_2 + 2NaOH \rightarrow Na_2SnO_3 + H_2O$
or $SnO_2 + 2NaOH + H_2O \rightarrow Na_2Sn(OH)_4$ etc [1]

(if neither of the above marks can be awarded, allow CO_2 **and** SnO_2 dissolve/react but SiO_2 *does not, for [1])*

(ii) CO_2 **and** SiO_2 - no reaction [1]

$SnO_2 + 4HCl \rightarrow SnCl_4$ (*or* $Sn^{4+} + 4Cl^-$) $+ 2H_2O$ [1]

4

(c) $PbO_2 + 4HCl \rightarrow PbCl_2 + 2H_2O + Cl_2$ [1]

E_{cell} = 1.47 -- 1.36
= **0.11** (V) [for 1 M HCl] [1]

or

$Pb^{4+} + 2Cl^- \rightarrow Pb^{2+} + Cl_2$ [1]

E_{cell} = 1.69 -- 1.36
= **0.33** (V) [for 1 M HCl] [1]

2

Total: 10, max 9

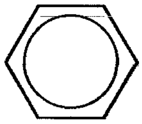
4 **(a)** Cl_2 + light/heat (aq negates) [1]

1

(b) Cl_2+ $AlCl_3$/$FeCl_3$/Fe etc. (aq negates) [1]

1

(c)



CO_2H

[1]

1

(d) NaOH +I_2(+ aq) (*or* I^- + OCl^- + aq) [1]

C: (pale) yellow ppt.
D: no reaction (**both**) [1]

2

(e) mass of *CN* needed = 0.03 x 60 = 1.8g [1]

M_r = 154.5, ∴ amount = 1.8/154.5 = **0.0117** (mol) (allow **0.012**) ecf [1]

2

(f) **(i)** increasing ease: H < D < G [1]

(ii) chlorine on the aryl ring is very inert *or* strong C-C*l* bond
or overlap between C*l* lone pair and π bond on ring (OWTTE) [1]

chlorine on C=O is reactive because of highly δ+ carbon atom bonded to electronegative O and C*l* (OWTTE) [1]

3

Total 10

5 **(a)** **(i)** $SOCl_2/PCl_5/PCl_3/P + Cl_2$ (aq negates) [1]

(ii) $C_6H_5OH + NaOH \rightarrow C_6H_5O^- Na^+$ (*or* C_6H_5ONa) + H_2O [1]

(iii) **J** = $C_6H_5OCOCH_3$ [1]

K = CH_3CONH_2 [1]

4

(b) **(i)** condensation [1]

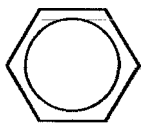
(ii) $ClCOCH_2CH_2COCl + 2HOCH_2CH_2OH \rightarrow$ [1]

$HOCH_2CH_2OCOCH_2CH_2CO_2CH_2CH_2OH$ (+ H_2O) [1]

3

(c) **(i)** polyamide *or* nylon (allow condensation) [**NOT** peptide *or* protein] [1]

(ii)

HO_2C  CO_2H (*or* dichloride) $NH_2(CH_2)4NH_2$

[1] + [1]

3

Total 10

6 **(a)** **(i)** $1s^2 2s^2 2p^6 3s^2 3p^6\ 4s^2 3d^2$ *or* [Ar] $4s^2 3d^2$ (*or* vice versa) [1]

(ii) **two** of $TiCl_2$, $TiCl_3$, $TiCl_4$ [1]

2

(b) **(i)** blue solution is formed [1]

containing $[Cu(H_2O)_6]^{2+}$ [1]

(ii) NH_3 **replaces** H_2O ligands *or* forms $[Cu(NH_3)_4]^{2+}$
(*or* $[Cu(NH_3)_4(H_20)_2]^{2+}$ [1]

which is **deep blue/purple** [1]

4

Total 6

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GCE A AND AS LEVEL

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

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Question 1

(a) Titration Tables 1.1 and 1.2

Give **one mark** if
all final burette readings in both tables are to 2 decimal places, in the correct places in both tables and the subtraction in Table 1.1 is correct. titrations in Table 1.2 that are labelled Rough do **not** need to be to 2 d.p. and subtraction need not be checked **unless** the value has been included in calculating the average.

Titration Table 1.1

Give **one mark** if
A **candidate recorded** volume between 45.00 cm^3 and 45.50 cm^3 has been diluted.

Titration Table 1.2

Give **one mark** if
Two (uncorrected) titres are within 0.10 cm^3

Give **one mark** if
a suitable average has been selected. (Do not give this mark if there is an error in subtraction in Table 1.2)

4

Accuracy

From the Supervisor's results calculate, **to 2 decimal places**,

$$\frac{\text{Volume of FB 1 diluted}}{45.00} \times \text{Titre}$$

Record this value as a ringed total below Table 1.2.

Calculate the same ratio for each candidate and compare with the Supervisor's value.

Award accuracy marks as shown in the table below.

The spread penalty may have to be applied using the table below.

Accuracy Marks	
Mark	**Difference from Supervisor**
8	Up to 0.10
7	0.10+ to 0.15
6	0.15+ to 0.20
5	0.20+ to 0.30
4	0.30+ to 0.40
3	0.40+ to 0.60
2	0.60+ to 0.80
1	0.80+ to 1.00
0	Greater than 1.00

Spread Penalty	
Range used/cm^3	**Deduction**
0.20+ to 0.25	1
0.25+ to 0.30	2
0.30+ to 0.35	3
0.35+ to 0.40	4
0.40+ to 0.50	5
0.50+ to 0.60	6
0.60+ to 0.80	7
Greater than 0.80	8

8

In all calculations, ignore evaluation errors if working is shown

(c) Give **one mark** for

$$\mathbf{\frac{100.0}{248.2}} \quad \textbf{or} \quad \mathbf{0.403} \quad \textbf{or} \quad \mathbf{0.4029}$$

1

Do not give this mark if 32 is seen to be used instead of 32.1 for A_r of sulphur
0.403 without working gains this mark

(d) Give **one mark** for **Answer to (c) x** $\mathbf{\frac{\text{volume of FB 1 diluted}}{250}}$

1

(e) Give **two marks** for **Answer to (d) x** $\mathbf{\frac{\text{titre}}{1000}}$ **(1) x ½ (1)**

2

(f) Give **one mark** for $\mathbf{\frac{25}{1000}}$ **x 0.023 or 0.000575**

1

(g) Give **one mark** for $\mathbf{\frac{\text{answer to (e)}}{\text{answer to (f)}}}$

1

(h) Give **one mark** for correctly calculating the oxidation numbers of

Chromium in CrO_4^{2-} (+)6
Iodine in I^- -1
Iodine in 1_2 0

Give **one mark** for **using the reacting quantities** in **(g)** to show that

$CrO_4^{2-} \equiv 1½\ I_2 \equiv 3e^-$.

And that the oxidation number of +6 is reduced to +3.

2

Total for Question 1 20

Question 2

ASSESSMENT OF PLANNING SKILLS

Plan

Give **one mark** for each of the following points.

Identify the method below that gives the best match - there may be cross-over.

(Record the letter of the point awarded in the text where given and tick the appropriate box in the margin)

Method	A Heat/Mass	B Heat/ Volume	C Acid/ Volume	D Acid/ Mass	E $CuCO_3$ Back-Titre	F CO_2 Back-Titre	G CuO Back-Titre	H Residue method	I $CuCO_3$/ CuO Titration
a	Weighs sample	Weighs sample	Weighs sample	Weighs sample and acid	Weighs sample	Weighs sample	Weighs sample	Weighs sample	Weighs sample
b	Heat	Heat	Placed in acid	Placed in acid	Known moles of acid measured	CO_2 produced in suitable way	CO_2 produced	Adds excess acid	Makes solution in a volumetric flask
c	Reweigh	CO_2 collected	CO_2 collected	Reweigh	$CuCO_3$ dissolved in excess acid	CO_2 dissolved in excess alkali	CuO dissolved in excess acid	Filter/dry residue	Titrates with standard acid
d	Heat to constant mass	Volume of gas measured	Volume of gas measured	Mass of CO_2 calculated	Excess of acid titrated	Excess of alkali titrated	Excess of acid titrated	Weighs residue	

4

Table of Results

Give three **marks** if table(s) show all measurements necessary

Deduct one mark for each measurement missing. (No negative marks)

The candidate must give **all** necessary readings: each relevant unit must be seen at least once.

Examiners must be satisfied that all practical readings needed for the candidate's method have been recorded.

Weighings must include:
Mass of empty container
Mass of container + solid
(Mass of container + residual solid) where appropriate etc.

Collection of gas must include:
An initial volume of gas
A final volume of gas

Titration results must include:
Initial burette readings
Final burette readings
Titre volume

3

Processing of Results

Give **one mark** for each of the following points. (Tick the appropriate box in the margin)

Mathematical expressions (using algebra or specimen values) must be included in the processing of results. Use must be made of the A_r values given in the paper and the GMV where appropriate.

Method	Mass/Volume methods	Back-Titre methods	Residue methods	$CuCO_3$/CuO titre
e	Volume of mass of CO_2 converted to moles	Initial moles of acid/alkali – excess moles of acid/alkali gives moles of CO_2/CuO/$CuCO_3$	Find mass of $CuCO_3$ by subtraction	Moles of acid converted to moles of $CuCO_3$
f	Moles of CO_2 converted to moles and mass of $CuCO_3$	Moles converted to mass of $CuCO_3$	% of $CuCO_3$ calculated	Moles of $CuCO_3$ converted to mass of $CuCO_3$
g	% of $CuCO_3$ calculated	% of $CuCO_3$ calculated		% of $CuCO_3$ calculated

3

Plan Marks

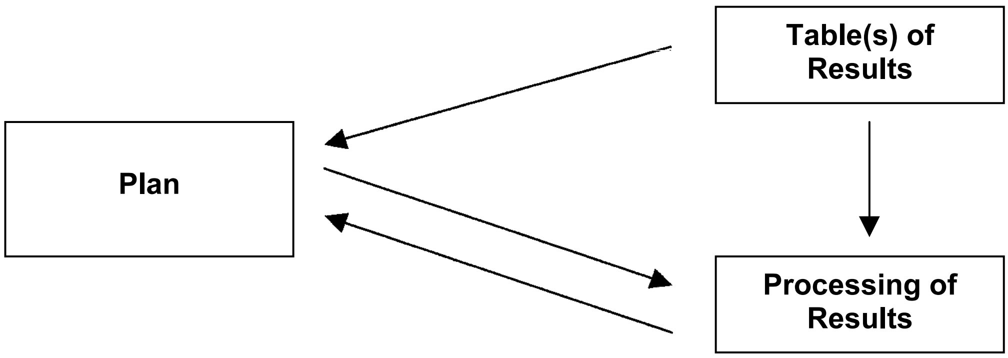
Marks for the Plan (a-d) may be awarded from the Table(s) of Results or from the Processing of Results

Processing of Results Marks

Marks in the final section (e-g) may be found in and awarded from the Planning Section

Marks for the Table of Results

The three marks in this section **can <u>only</u> be awarded** in the Table of Results Section



Total for Question 2	**10**
Total for Paper	**30**

CAMBRIDGE
INTERNATIONAL EXAMINATIONS

JUNE 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 consist of biological catalysts (1)

They have an active site, into which the substrate fits (1)

Idea of 'lock and key' mechanism (1)

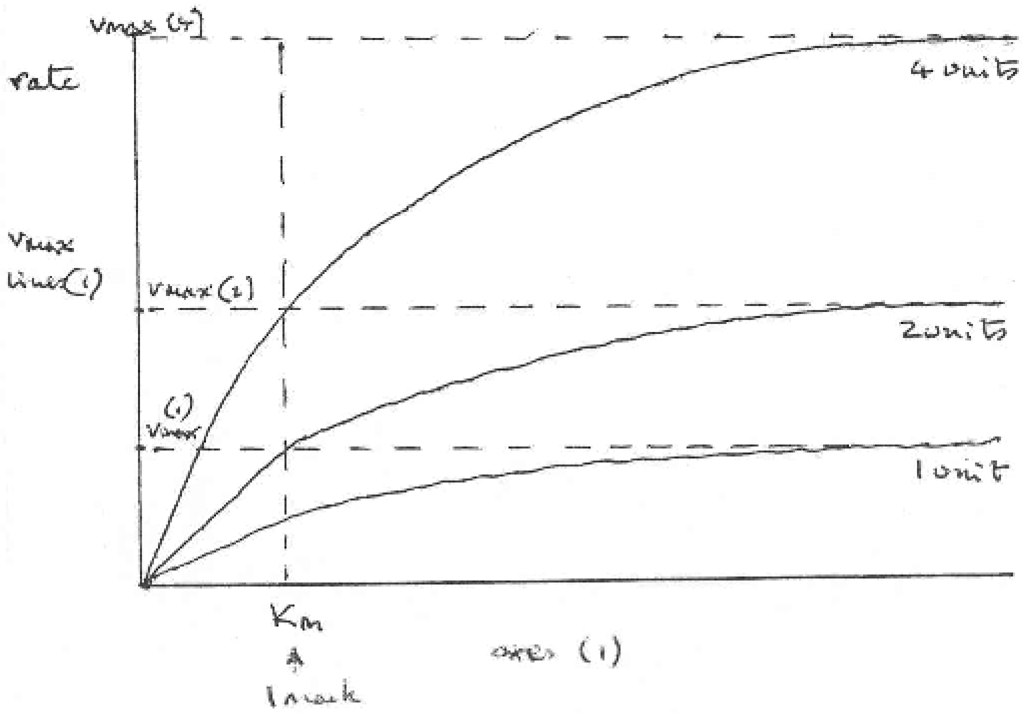
Bond(s) in substrate are weakened (1)

They are specific for a substrate (1)

E + S → ES → E + products (1)

[max 5]

(b)



Axes (1)

1 correct graph (1)

3 correct graphs (2)

Graphs to show V_{max} is proportional to enzyme units, and (1)

K_m is constant (1)

[5]

2. **A** is ATP/adenosine triphosphate/adenine ribose triphosphate (1)

It is associated with energy changes (1)

B is an amino acid/glutamic acid NOT aspartic acid (1)

It is found in proteins (1)

C is a phospholipid/phosphoglyceride (1)

It is found in bilayers/membranes/stabilises colloidal systems (1)

D is deoxyribose (1)

It is found in DNA (1)

E is glucose-6-phosphate (1)

It is formed in glycolysis/at the start of the Krebs cycle/in metabolism/ activates glucose/inhibitor for glycolysis (1)

[5 x 2]

Environmental Chemistry

3. **(a)** The high positive charge of the aluminium ions (1)

causes the coordinated water molecules to lose a hydrogen ion to the soil solution/polarises H-O bond. (1)

Diagram or formula of aluminium ion produced (1)
Accept $[Al(H_2O)_5OH]^{2+}$ or $[Al(H_2O)_4OH]^{+}$

[3]

(b) **(i)** anaerobic (reducing) (1)

(ii) hydrogen ions are required to remove the oxide ions from the sulphate ions or (1)

$S^{2-} + H_2O = HS^{-} + OH^{-}$

hence the water becomes more alkaline*

(iii) aluminium hydroxide is precipitated (1)
accept equation + state symbol
thereby leaving the water more acidic*
(*1 mark for both of these stated)

(iv) $CaCO_3 + 2H^{+} \rightarrow Ca^{2+} + CO_2 + H_2O$ (1)
Allow $CO_3^{2-} + 2H^{+} = CO_2 + H_2O$
or $CO_3^{2-} + H^{+} = HCO_3^{-}$

[5]

(c) Organic matter from the wetlands will utilise dissolved oxygen to form carbon dioxide (1)

This means that the water is making heavy demands on the available oxygen and the water can then be said to have a high BOD (1)

[2]

4 **(a)** $O_2(g) \rightarrow O(g) + O^*(g)$ (1)

$O^*(g) + O_2(g) + M(g) \rightarrow O_3(g) + M^*(g)$ (1)

M is an inert third body such as $N_2(g)$ (1)

$O_3(g) \rightarrow O(g) + O_2(g)$ (1)

$O_3(g) + O(g) \rightarrow 2O_2(g)$ (1)

An equilibrium is therefore established which is $2O_3(g) \rightarrow 3O_2(g)$ (1)

[5 max]

(b) $Cl_2(g) \rightarrow 2Cl\bullet(g)$ (1)

$Cl\bullet + O_3(g) \rightarrow ClO\bullet(g) + O_2(g)$ (1)

$ClO\bullet(g) + O(g) \rightarrow Cl\bullet(g) + O_2(g)$ (1)

$Cl\bullet$ is therefore a catalyst (1)

[3 max]

(c) $NO_2(g)$ can react with the $ClO\bullet(g)$ to form $ClONO_2$ and will therefore break the propagation cycle above. (1)

This means $Cl\bullet(g)$ is no longer regenerated and less ozone is destroyed (1)

[2]

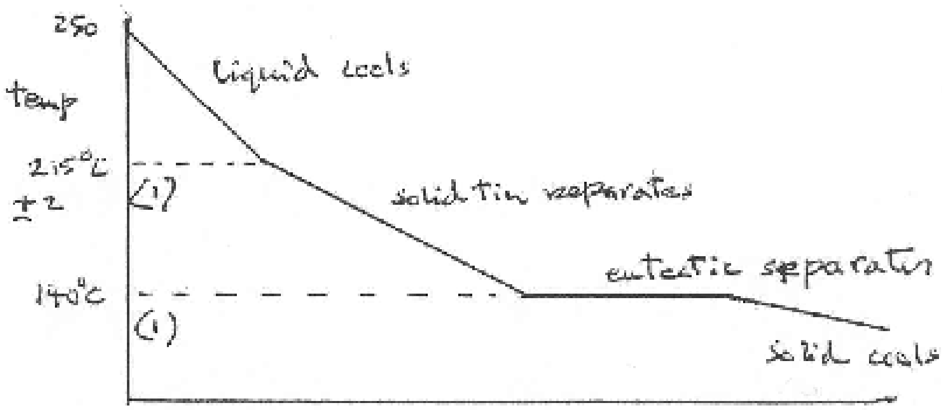
Phase Equilibria

5. **(a)** **(i)** Graph plotted and lines drawn
Axes labelled (1)
Areas – two metal + liquid areas (1)
– liquid + solid areas (1)

(ii) 140 $\pm$ 4 °C and 40 $\pm$ 3% tin (2 x 1)

[5]

(b)



Shape of cooling curve to 140°C (ecf from candidate's graph) (1)

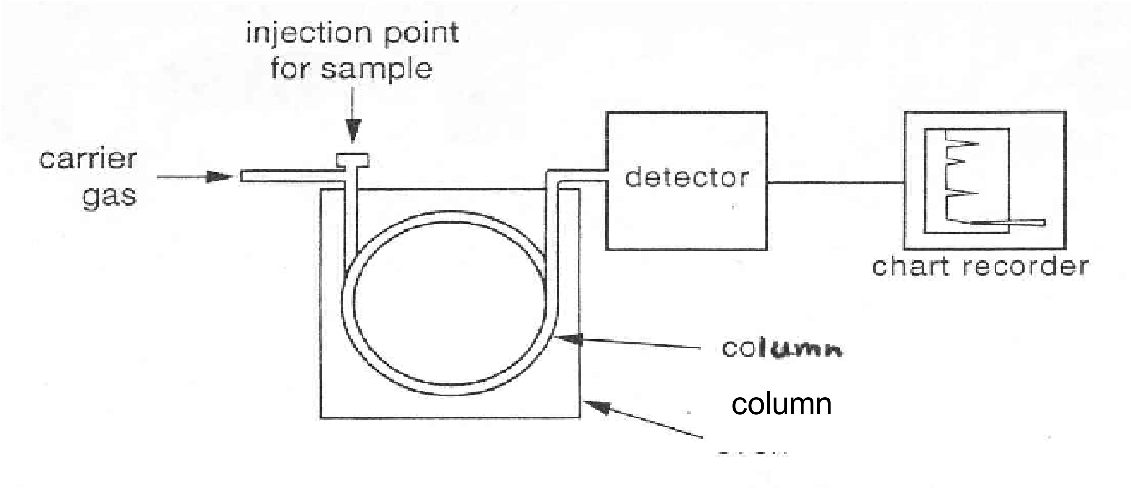
Any two sections labelled correctly (1)

[4]

(c) One of: solder; lead shot; bronzes; aluminobronzes (1)

[1]

6. **(a)** **(i)**



Injection and carrier gas (1)

Column and oven (1)

Detector and recorder (1)

(ii) Adsorption/partition (1)

[4]

(b) **(i)** Propanone, butanone, ethanol, pentan-3-one, propan-2-ol
5 correct $\Rightarrow$ 3 marks; 4 correct $\Rightarrow$ 2 marks; 3 correct $\Rightarrow$ 1 mark
-1 for each of methanol, pentan-2-one or cyclohexanone (max 3)

(ii) 50 - 150°C (1)

(iii) Hydrophilic/polar (1)

Since alcohol OH groups are more strongly adsorbed than ketones (1)

[6]

Spectroscopy

7. **(a)** Colour results from d-electrons absorbing energy as they move from lower to higher energy levels (1)

d-orbitals are split due to repulsion/ligand field argument (1)

by ligands of electrons in $d(x^2-y^2)$ and $d(z^2)$ orbitals (1)

$[Cu(H_2O)_6]^{2+}$ has vacant d-orbitals allowing promotion (1)

$[Zn(H_2O)_6]^{2+}$ has no vacant orbitals (1)

[5]

(b) **(i)** $\pi \rightarrow \pi^*$ (1)
$n \rightarrow \pi^*$ (1)
$n \rightarrow \sigma^*$ (1)

(ii) $n \rightarrow \sigma^*$ (1)

(iii) $\pi \rightarrow \pi^*$ (1)

more than one absorption scores 0

[5]

8. **(a)** ***<u>From mass spectrum</u>***
Ratio of M : M+1 peaks shows no. of carbons is

16.5 : 1.47 = 100 : 1.1 (1)

$n = \dfrac{1.47 \times 100}{16.5 \times 1.1} = 8$ (1)

<u>From ir spectrum</u>
Peak at 3050 – 3400 cm^{-1} could be OH (or NH) (1)

Not broad or rounded, suggest not OH (1)

Peak at 1600 – 1680 cm^{-1} suggests C=O (1)

<u>From nmr spectrum</u>
Compound contains 3 proton environments (1)

Peak at 7.4 δ – aromatic ring (1)

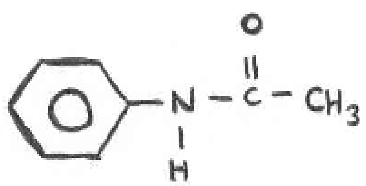
Peak at 2.1 δ – CH_3 (1)

Peak at 3.1 δ which disappears in D_2O – labile H/N-H (1)

[max 8]

(b) Functional groups – amide (C=O, N-H) (1)

Suggests **Q** is (1)



NOT a disubstituted ring

[2]

Transition Elements

9. **(a)** $Ni + 4CO \rightarrow Ni(CO)_4$ (1)

$Ni(CO)_4$ is a liquid and is purified by distillation (1)

$Ni(CO)_4 \rightarrow Ni + 4CO$ (1)

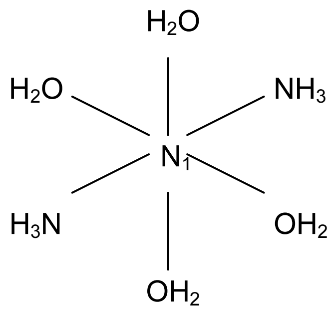
CO is recycled (1)

[4]

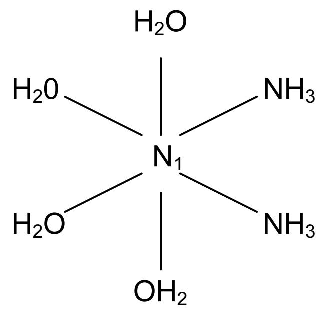
(b) Use: Catalyst in the hydrogenation of vegetable oils to margarine (1)
Reason: Heterogeneous catalyst – uses d-orbitals to complex (1)
Any other viable use accepted, mark independent of property/reason

[2]

(c)

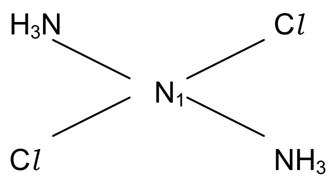


Trans

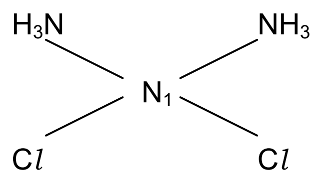


Cis

Octahedral (2 x 1)



Trans



Cis

Square planar (2 x 1)

[4]

10. **(a)** Cu^{I} has d^{10} configuration/no gaps in upper orbitals (1)

Cu^{II} has d^{9} configuration/has space for promotion of an electron (1)

[2]

(b) **(i)** The formation of a higher and a lower oxidation state from an intermediate one/simultaneous oxidation and reduction (1)

(ii) $2Cu^{+} \rightarrow Cu^{2+} + Cu$ (1)

$E_{cell} = 0.52 - 0.15 = 0.37$ V (1)

[3]

(c) **(i)** $Cu^{2+} + 2I^{-} \rightarrow CuI + \frac{1}{2}I_2$ (1)

CuI white solid, $\frac{1}{2}I_2$ brown solution (1)

$2S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^{-}$ (1)

(ii) $CuCl_2 + 2HCl + Cu \rightarrow 2H[CuCl_2]$ (1)
or similar

Blue Cu^{2+} to colourless/white Cu^{+} (1)

$HCuCl_2 \rightarrow CuCl + HCl$ (1)

M_r CuC*l* = 99, hence $\frac{35.5}{99}$ = 35.9% chlorine (1)

[6]

[10 max]