UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the June 2004 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 discussion or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the June 2004 question papers for most IGCSE and GCE Advanced Level syllabuses.

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Grade thresholds taken for Syllabus 9701 (Chemistry) in the June 2004 examination.

	maximum mark available	minimum mark required for grade:		
		A	B	E
Component 1	40	31	28	18
Component 2	60	47	41	27
Component 3	25	19	17	10
Component 4	60	46	41	24
Component 5	30	23	21	15
Component 6	40	27	24	15

The thresholds (minimum marks) for Grades C and D are normally set by dividing the mark range between the B and the E thresholds into three. For example, if the difference between the B and the E threshold is 24 marks, the C threshold is set 8 marks below the B threshold and the D threshold is set another 8 marks down. If dividing the interval by three results in a fraction of a mark, then the threshold is normally rounded down.

JUNE 2004

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 40

SYLLABUS/COMPONENT: 9701/01

CHEMISTRY
Paper 1 (Multiple Choice)

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

TOTAL 40

JUNE 2004

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) The volume of the gas molecules / atoms / particles is insignificant compared with the volume of the vessel.
There are no forces of attraction between the gas molecules.
All collisions by the gas molecules are perfectly elastics. Any <u>two</u>. [2]

(b) (i) The pressure of / exerted <u>by the gas</u>. [1]
Pa / Nm^{-2} [1]

(ii) The volume of the containing vessel [1]
m^3 / dm^3 / cm^3 [1]

(iii) The absolute temperature [1]
In K <u>or</u> 273 + °C [1]

(c) (i) $pV \approx w/m \times RT$

$m = (0.103 \times 8.31 \times 297) / (99.5 \times 10^3 \times 63.8 \times 10^{-6})$ [1]
$= 40.0$ [1]

The gas is argon [1]

(ii) The hydrogen bonds between ammonia molecules (1)
are stronger than the Van De Waals' forces between N_2 and Ar molecules (1)

Ammonia is polar / has a dipole (1)

(Any two) [2]

Total = [13]

2 (a) $1s^2$ $2s^2\,2p^6$ $3s^2\,3p^3$ [1]

(b) 5 or V [1]

(c) (i) $3NaOH + H_3PO_4 \longrightarrow Na_3PO_4 + 3H_2O$ [1]

(ii) (50 x 0.5) / 1000 = 0.025 (moles) [1]

(iii) conseq. on **(i)** 3 x .025 = 0.075 (moles) [1]

(d) (i) $P_4S_3 + 8O_2 \longrightarrow P_4O_{10} + 3SO_2$ (or $2P_2O_5$) balanced = 2 marks

OR $+ 6O_2 \longrightarrow P_4O_6 + 3SO_2$ (or $2P_2O_3$) unbalanced = 1 mark

[2]

(ii) $P_4O_{10} + 6H_2O \longrightarrow 4H_3PO_4$ [1]

OR $P_4O_6 + 6H_2O \longrightarrow 4H_3PO_3$

$SO_2 + H_2O \longrightarrow H_2SO_3$ [1]

(if SO_3 then e.c.f.) **Total = [9]**

3 (a) $CO(NH_2)_2 + H_2O \longrightarrow 2NH_3 + CO_2$ balanced equation (1)
(1) colourless gas
[2]

(b) (i) $N_2 + 3H_2 \leftrightarrow 2NH_3$

(ii) 100 ATMs or over
400 - 500°C
iron catalyst

(iii) Fertiliser, making nitric acid, explosives etc. 1 mark for each
[4]

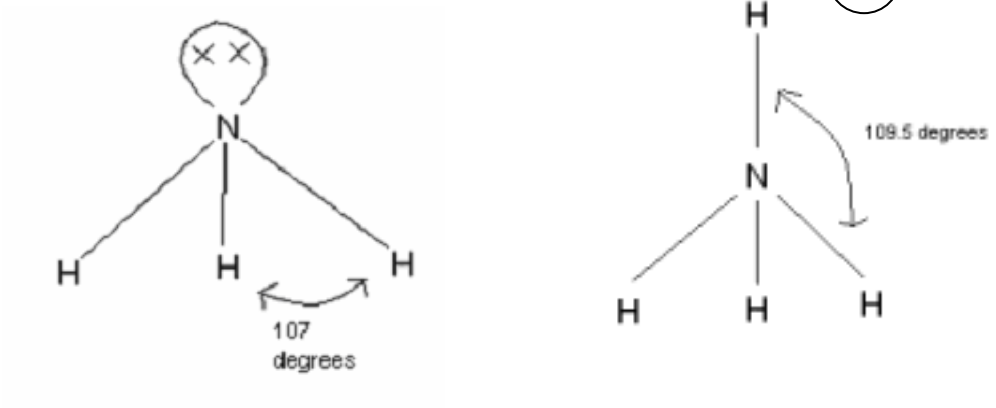
(c) (i) (1.2) / (2.4) = 1/20 or 0.05 moles [1]

(ii) $2NH_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4$ or equivalent [1]

(iii) 0.025 mols of H_2SO_4 are required

Vol. of 0.50 mol dm^{-3} H_2SO_4 required = (0.025 x 1000) / 0.5 = $50cm^3$ [1]

(d)



1 mark for each diagram, 1 mark for each correct bond angle
If not 3-dimensional diagram – 1 penalty.
[4]

(e) $4NH_3 + 3O_2 \longrightarrow 2N_2 + 6H_2O$ [1]

N goes from -3 to 0 ⟶ oxidation [1]
O goes from 0 to -2 ⟶ reduction [1]

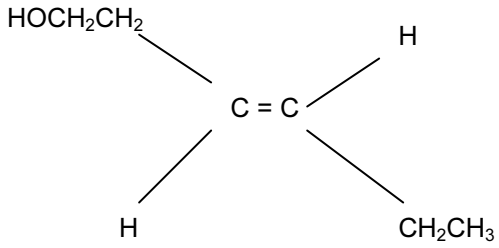
Total = [16]

4 (a) (i) Acid or base, heating / reflux / warm [1]

(ii) $CH_3(CH_2)_2CO_2CH_3 + H_2O \longrightarrow CH_3(CH_2)_2CO_2H + CH_3OH$ [1]

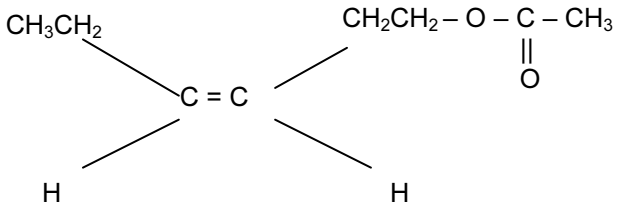
(iii) Solvents (polyesters not in AS syllabus, but allow as plastics, textiles) [1]

(b) (i)



1 mark for this diagram

(ii)



1 mark for ester link, 1 mark for rest of molecule

[3]

(c) (i) $C_6H_{12}O$ 72 + 12 + 16 $M_r = 100$ [1]

$CH_2 = CH – CH = CH – CH_2CH_3$ [1]

dehydration / elimination [1]

(d) A test for an alcohol (both alcohol and the product are alkenes)

e.g. sodium bubbles of gas
PCl_5 misty fumes
$H^+/ Cr_2O_7^{2-}$ orange turned green
conc. H_2SO_4 + carbonylic acid ester smell

NOT Br_2 or H^+/MnO_4^- as it tests positive for both

1 mark for specified test
1 mark for the relevant observation

[2]

Total = [11]

5 (a) Example (1) reason (1) MUST BE ORGANIC

e.g.
PVC (1) used in food packaging (& needs to be inert) (1)
Teflon / PTFE (1) used in non-stick kitchenware (1)
Freons (1) used as deoderants, anaesthetics etc. (1)
CCl_4 etc (1) solvent (1)

3 x 2 [6]

(b) (i) U.V. radiation [1]
Breaks C-Cl bond OR giving Cl free radicals [1]
These react with ozone [1]

(ii) e.g polypropene for PVC
alkanes e.g. butane for aerosols

OR equivalent answers need not be organic
e.g. N_2O as anaesthetic

[2]

Total = [11]

JUNE 2004

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 25

SYLLABUS/COMPONENT: 9701/03

CHEMISTRY
Practical 1

UNIVERSITY of CAMBRIDGE
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Question 1

(a) Table 1.1

Give **one mark** if both weighings are to 2 dp or better, in the correct places in the table, and there is no error in subtraction.

Centres were instructed to provide between 1.70 g and 2.00 g of **FA 1**. *If a candidate's mass is clearly a value in this range* ***x10 or x 0.1*** *the mark for Table 1.1 will not be awarded but the "correct" value will be used in assessing the accuracy ratio*.

[1]

(b) Titration Table 1.1

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" burette readings (e.g. 23.47 cm^3) are given (initial or final readings).

Give **one mark** if there are two titres within 0.10 cm^3 and a "correct" average has been calculated.
See instructions in (f) and examples in (g) of Standing Instructions.
The subtraction of a Rough value need only be checked when the Rough value has been included in the selection for calculating the average.
Do not give this mark if there is an error in subtraction or there is no indication of the titres used to calculate the average (ticks/calculation).

[2]

Accuracy

Check and correct if necessary the subtraction in Table 1.1 for the Supervisor. Use the rules in Standing Instructions to obtain a titration value for the Supervisor.

Calculate, correct to 2 decimal places, for each candidate:

$$\frac{\textbf{Supervisor's mass of } Na_2CO_3}{\textbf{Candidate's mass of } Na_2CO_3 \textbf{ (corrected if necessary)}} \times \textbf{Candidate's Titre (corrected if necessary)}$$

Compare the calculated value with the Titre value obtained by the Supervisor.
Assign accuracy marks as follows:
The spread penalty referred to in (g) may have to be applied using the table below

Accuracy marks	
Mark	Difference from Supervisor
6	up to 0.20
5	0.20+ to 0.40
4	0.40+ to 0.60
3	0.60+ to 0.80
2	0.80+ 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

[6]

In all calculations, ignore evaluation errors if working is shown

(c) Give **one mark** for M_r **of** $Na_2CO_3 = 106$

and **one mark** for $\frac{\text{candidate's mass of } Na_2CO_3}{\text{a calculated } M_r \text{ for } Na_2CO_3}$ **x 4**

[2]

(d) Give **one mark** for **ans (c)** **x** $\frac{25}{1000}$ **OR**

$\frac{\text{candidate's mass of } Na_2CO_3}{\text{a calculated } M_r \text{ for } Na_2CO_3}$ **x** $\frac{1}{10}$

[1]

(e) Give **one mark** for **answer to (d) x 2**

[1]

(f) Give **one mark** for **answer to (e)** **x** $\frac{\textbf{1000}}{\textbf{candidate's titre}}$

and **one further mark** for a **FULLY CORRECT** answer to within 1% of the value calculated by the examiner **using the titre/mass used by the candidate**.

A candidate with an incorrect sub-section, who correctly starts a subsequent sub-section from first principles can gain the evaluation mark.

The correct value is given by: **1.887** **x** $\frac{\textbf{candidate's mass of sodium carbonate}}{\textbf{candidate's titre}}$

Do not award this evaluation mark if there are cancelling chemical errors or an M_r other than 106 is used in the calculation.
Ignore rounding to less than 3 significant figures providing evaluation has been shown to 3 significant figures or better.

Examiners should calculate the value, correct to 3 significant figures, and record it in a ring close to the candidate's value.

[2]

Total for Question 1 [15]

2 **FA 4** is a mixture of: **FA 5** (Na_2SO_3 which is soluble in water) and
FA 6 ($CaCO_3$ which is insoluble in water)

Tests on Filtrate

	Test	*Observations*	
(a)	To 1 cm depth of the filtrate in a test-tube, add 1 cm depth of aqueous barium chloride;	White precipitate *Accept white solution if a precipitate of unspecified colour has also formed (no contrary colours permitted)*	
	followed by 2 cm depth of dilute hydrochloric acid	Precipitate dissolves/disappears **or** colourless/clear/transparent solution *Ignore any reference to slight white "haziness" left in the solution or to evolution of gas.* Both parts of the observation are needed for the **one mark** to be awarded.	**[1]**
(b)	To 1 cm depth of the filtrate in a test-tube, add 1 cm depth of acidified aqueous potassium dichromate(VI).	(Solution turns) green **not** blue/green **one mark** *Do not penalise green precipitates*	**[1]**
(c)	To 1 cm depth of the filtrate in a test-tube, add 2 cm depth of dilute hydrochloric acid. Warm the solution and identify the gas given off. Empty and wash away the contents of the tube at the end of this test.	(Gas with reducing properties) *A suitable test must be described:* turns chromate/dichromate green (blue/green is acceptable here) or decolourises manganate(VII) **or** (Acidic gas) turns a named indicator an appropriate colour **one mark** ***(Allow this mark on addition of HCl in test (a) if not given in (c))*** ***Ignore any lime-water test or reference to CO_2*** *(some $CaCO_3$ may pass through the filter paper)*	**[1]**
(d)	To 1 cm depth of the filtrate in a test-tube, add 2 cm depth of aqueous iodine.	(Iodine) decolourised **or** colourless solution **or** stated diminishing colour (eg. brown to yellow) **one mark**	**[1]**

Give **one mark** for identifying the anion as sulphite/SO_3^{2-}

providing two pieces of evidence are given in the conclusion that refer to correct observations or there is equivalent unambiguous reference to tests in the table.

i. white precipitate with barium chloride
ii dichromate(VI) turns green in test (b)
iii iodine decolourised
one from
iv acid/base indicator colour change in (c)
v dichromate(VI) turns green in (c)

[1]

Observation marks may be awarded in the supporting evidence section where the candidate refers back to a specified test. (<u>Beware of contrary statements</u>)

Give **one mark** for stating that the anion behaves in **(b)** and **(d)** as a:
reductant / reducing agent / reducer / oxidisable species (providing a mark has been given in **(b)** or **(d)**).

[1]

Tests on Residue

	Test	*Observations*	
(e)	Add 2 cm depth of hydrochloric acid to the residue (FA 6) in the boiling-tube. Use the solution formed in the following tests (f) and (g).	(Gas evolved:) *A suitable test must be described:* turning lime water milky/cloudy/turbid/chalky **one mark**	**[1]**
(f)	To 1 cm depth of the solution remaining after test (e) add aqueous sodium hydroxide.	White precipitate, insoluble in excess *Both parts of observation needed* **one mark**	**[1]**
(g)	To 1 cm depth of the solution remaining after test (e) add aqueous ammonia.	No precipitate / no reaction / solution remains colourless / clear solution (remains **but not formed**) **One mark**	**[1]**

Observation marks may again be awarded in the supporting evidence section where the candidate refers back to a specified test. (<u>Beware of contrary statements</u>)

Give **one mark** if the cation and the anion match the results in tests **(e)**, **(f)** and **(g)**. **and** there is supporting evidence in the conclusion for each ion.

The **anion** is CO_3^{2-} *Allow carbonate from effervescence, fizzing or rapid evolution of gas*

The **cation** is Ca^{2+}

Matched observations:

Test (f)	*Test (g)*	*Allowable deduction*
Unqualified White ppt *Do not allow if the ppt was soluble in excess NaOH*	No ppt	Ca^{2+}
White ppt insol in excess	White ppt insol in excess	Mg^{2+}
White ppt insol in excess	White ppt sol in excess	No cation matches
White ppt sol in excess	White ppt insol in excess	Al^{3+} or Pb^{2+}
White ppt sol in excess	White ppt sol in excess	Zn^{2+}
No ppt	White ppt insol in excess	No cation matches
No ppt	White ppt sol in excess	No cation matches
No ppt	No ppt	Ba^{2+}

[1]

Total for Question 2 = [10]

Total for Paper = [25]

JUNE 2004

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) $Mg^{2+} + 2e^- \longrightarrow Mg$ [1]

(b) chlorine/Cl_2 [1]

(c) smaller A_r [1]
larger (atomic/ionic) radius/size [1]

(d) **(i)** the energy change when **1 mol** of solid compound [1]
is formed from its **gaseous ions** [1]

(ii) $Mg^{2+}(g) + 2Cl^-(g) \longrightarrow MgCl_2(s)$ *charges + balancing* [1]
state symbols [1]

(e) **(i)** LE ($MgCl_2$) is greater than LE (NaCl) [1]
(because) Mg^{2+} has higher charge / smaller radius than Na^+ [1]

(ii) LE ($MgCl_2$) is greater than LE ($CaCl_2$) [1]
(because) Mg^{2+} is smaller than Ca^{2+} [1]

(f) LE = 349 – 122 – 494 – 107 – 411

= **-785** (kJ mol^{-1}) [3]

correct answer = [3], with – [1] for one error. OR mark as follows:
use of all 5 ΔH values, with x1 multipliers [1]
correct signs for all ΔH values [1]
negative sign in answer [1]

Total = [15]

2 (a) covalent (*giant* or *macro*) negates, as also does any reference to ionic bonding) [1]
(*simple molecular is not enough – look for covalent*)

tetrahedral [1]

(b) (i) plotting (allow ±1°) [1]
138 – 151°C (stated in numbers, or read from the graph) [1]

(ii) (b. pt. increases due to) larger intermolecular / van der Waals / induced dipole (NOT permanent dipole) / attractions [1]

due to the larger no. **of electrons** *or* more shells **of electrons** (in MX_4) [1]

(c) (i) Si has empty low-lying orbitals *or* empty d-orbitals (C does not) [1]

(ii) $SiCl_4 + 2H_2O \longrightarrow SiO_2 + 4HCl$ [1]

[*or* $SiCl_4 + 4H_2O \longrightarrow Si(OH)_4 + 4HCl$ etc.]

(iii) (yes), because Ge also has empty (low lying d-) orbitals [1]

(d) (i) $SiCl_4 + 2Zn \longrightarrow Si + 2ZnCl_2$ [NOT ionic equation] [1]

(ii) mass = 250 x 2 x 65.4/28.1

= **1164** (g) (actually 1163.7 – but allow 1160) [2]

*allow e.c.f from the stoichiometry of the candidate's equation e.g. allow **582**g for [2] marks if the equation shows the stoichiometry to be 1:1. But if 582g is obtained because the candidate forgot to apply the stoichiometry as given in the equation, award only [1] mark.*

correct answer = [2], with – [1] for one error. OR marks as follows:
use of 2:1 ration [1]
correct use of A_r data for Si and Zn [1]

Total = [12]

3

- heterogeneous: different phases/states *or* homogeneous: same phase/state
- (heterogeneous): adsorption onto the surface
- the correct allocation of the terms *heterogeneous* and *homogeneous* to the two exemplar
- *example of heterogeneous, e.g.* Fe (in the Haber process)
- *equation, e.g.* $N_2 + 3H_2 \longrightarrow 2NH_3$
- *example of homogeneous, e.g.* Fe^{3+} (in $S_2O_8^{2-} + I^-$)
- *equation, e.g.* $S_2O_8^{2-} + 2I^- \longrightarrow 2SO_4^{2-} + I_2$
- *how catalyst works, e.g.* $Fe^{3+} + I^- \longrightarrow Fe^{2+} + \frac{1}{2}I_2$

[OR example: $FeCl_3$ (in Friedel-Crafts or chlorination etc. with CH_3Cl, Cl_2, Br_2)
equation, $C_6H_6 + Cl_2 \longrightarrow C_6H_5Cl + HCl$
mode of action $FeCl_3 + Cl_2 \longrightarrow FeCl_4^- + Cl^+$]

Total = [8]

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*[space for writing other examples **using iron or its compounds** you may come across. If in doubt consult your TL. Mark as follows:*
For heterogeneous: example [1] equation [1] *for homogeneous: example [1] equation [1] mode of action [1]*
*candidates should include **one** example of **each** mode of catalysis]*

4 (a) (i) $HCNHC_3H_7$ *or* $CH_3CNHC_2H_5$ *or* $C_2H_5CNHCH_3$ *or* $C_3H_7CNH_2$

[1]

[for propyl groups allow C_3H_7 or $CH_3CH_2CH_2$ or $(CH_3)_2CH$]

(ii) boil/heat/reflux with dil/aq. $H_2SO_4/H^+/OH^-$ *or* with H_3O^+ [1]

(iii) $RCONHR' + H_2O \longrightarrow RCO_2H + R'NH_2$
(R and R' = H or alkyl)

or $RCONHR' + OH^- \longrightarrow RCO_2^- + R'NH_2$

or $RCONHR' + H_3O^+ \longrightarrow RCO_2H + R'NH_3^+$

[2]

[award [2] for a balanced equation with the same R groups as in (i).If [2] cannot be awarded, apply the following part-marks: [1] *for –CONH- → $-CO_2H$ + NH_2-*
[1] *for all four R groups consistent with (i)]*

(b) (i) $C_2H_5C(=O)Cl$

[1]

(ii) $C_2H_5CO_2H + SOCl_2$ *or* PCl_5 *or* PCl_3 (or names) [1]

(iii) $C_2H_5COCl + C_2H_5OH \longrightarrow C_2H_5CO_2C_2H_5 + HCl$ [1]

Total = [7]

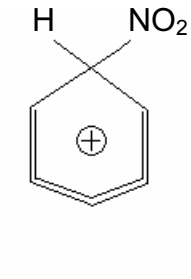
5 (a) (i) Cl_2 + $AlCl_3$ etc. (UV *or* aq negates) [1]

(ii) Br_2 + $AlCl_3$ *or* $AlBr_3$ etc. [1]

(iii) HNO_3 + H_2SO_4 [1]
conc. + 50° < T < 60° [1]

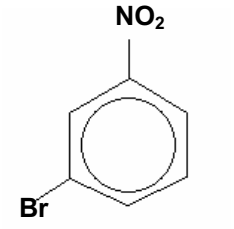
(b) (i) A^+ = NO_2^+ *or* nitronium ion [1]

(ii) B is

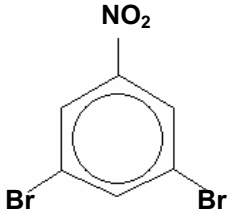


[1]

(c) (i)

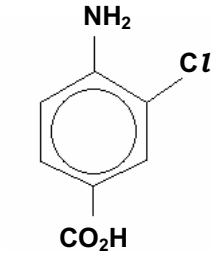


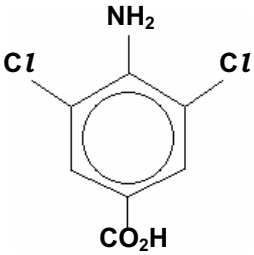
or



[1]

(ii)





[1]

Total = [8]

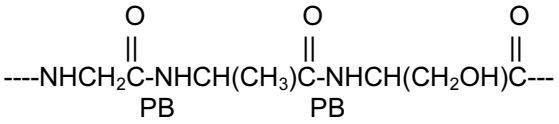
6 (a) (i) $NH_3^+CH_2CO_2^-$ [1]

(b) (i) $NH_2CH(CH_3)CO_2H + HCl \longrightarrow ClNH_3CH(CH_3)CO_2H$ [1]

(ii) $NH_2CH(CH_2OH)CO_2H + NaOH \longrightarrow NH_2CH(CH_2OH)CO_2Na + H_2O$ [1]

N.B. charges not needed, and deduct only [1] for incorrect side chains
Allow ionic equations

(c)



Correct CO-NH bonding (at least one C=O shown) [1]
At least one PB (peptide bond) labeled) [1]
3 residues [1]

(the 3 residues don't all have to be different, but must all be either gly, ala or ser)

(d) condensation *or* polyamide [1]

(e) deducting 18 from each M_r value [1]
*(M_r value of 3-residue fragment = **215** if this has been done; otherwise M_r = 269)*

dividing 600,000 by the M_r value [1]
*(this would give **2791** if 18 had been deducted from each M_r, or 2230 if not)*

multiplying the answer by 3 (since there are 3 amino acids per residue) [1]
*(correct answer is **8732**. If no 18 had been deducted, answer is 6691)*

Possible likely answers:

8732 (±10)	➔	[3]
6691 (±10)	➔	[2]
2791 (±10)	➔	[2]
2230 (±10)	➔	[1]

[if the answer is none of these, you can award part marks, as above.]

Total = [10]

JUNE 2004

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 30

SYLLABUS/COMPONENT: 9701/05

CHEMISTRY
Practical 2

UNIVERSITY of CAMBRIDGE
International Examinations

1 (a) Weighing Table 1.1

Give **one** mark if all **three** weighings are to at least 2 decimal places and in the correct places in the Table.
Give **one** mark for a recorded mass of **FB 1** between **2.80 g and 3.00 g** (both values inclusive)

With-hold one of these marks:
(i) if there is an error in subtraction which should be correct to number of decimal places shown in the weighing table. (Final zeros may be omitted),
(ii) the (mass of tube + residual solid) is less than the mass of the empty tube,
(iii) there is no mass of weighing bottle plus residual zinc

[2]

(b) Temperature Table

Give **one** mark if all **recorded** thermometer readings are to at least 1 decimal place (the table does not have to be complete).
With-hold this mark if all recorded temperatures end with .0(0) or .5(0)

[1]

Accuracy marks

On the Supervisor's script:

Ring the temperature at 2½ minutes (2 minutes, 1½ minutes etc if no temperature recorded at 2½ minutes)

Ring the **highest temperature achieved** when recorded for the first time.
Ignore any temperature recorded at 3 minutes – even if this is the highest temperature recorded.

Calculate the difference between the two ringed temperatures.

Record, in a ring, this temperature rise, Δt, to the left of the temperature table on page 4.

Candidate scripts

Ring the temperature at 2½ minutes and the **highest temperature achieved** when recorded for the first time in the same way as for the Supervisor.
(Again ignore any temperature recorded at 3 minutes – even if this is the highest temperature recorded.)

Calculate the difference between the two ringed temperatures. Record this temperature rise, Δ**t**, to the left of the temperature table on page 4.

Calculate the difference between the Supervisor's and candidate's value for Δt.

Award accuracy marks as shown on the next page

The expected temperature rise is about 30 °C. If the Supervisor records a temperature rise that is substantially below this figure award Accuracy marks on the sliding scale shown in the following table:

Mark	Difference to Supervisor / °C	
	Δt about 30 °C	**Δt about 15 °C**
8	up to 1.00	up to 0.50
7	1.00+ to 1.50	0.50+ to 0.75
6	1.50+ to 2.00	0.75+ to 1.0
5	2.00+ to 2.50	1.0+ to 1.25
4	2.50+ to 3.00	1.25+ to 1.50
3	3.00+ to 5.00	1.50+ to 2.50
2	5.00+ to 7.00	2.50+ to 3.50
1	7.00+ to 10.00	3.50+ to 5.00
0	Greater than 10.00	Greater than 5.00

[8]

1 Graph

(d) Plotting of Points.
It is intended that the Examiner will check the plotting of two temperatures on whole numbers of minutes and one at a ½ minute.

Select and indicate, in the temperature table, the following three temperatures:

i The highest temperature reached, recorded for the first time – the value that has been circled in the temperature table for calculating accuracy marks.

If this initial value falls on a whole number of minutes, select, as the second point to be plotted
ii The first temperature, lower than the highest temperature recorded in the temperature table
If this second temperature also falls on a whole number of minutes, select as the third point to be plotted
iii The next lower temperature that falls on a ½ minute

If this initial value falls on a ½ minute, select, as the second point to be plotted
ii The first temperature, lower than the highest temperature recorded in the temperature table that falls on a whole number of minutes
Select as the third point to be plotted
iii The next lower temperature that also falls on a whole number of minutes

Check the plotting of these three points

Give **one mark** if all three points have been correctly plotted.
The plotted point must be within ¼ small square of the correct position on either axis

If the candidate has not plotted one of the selected points apply similar rules to find the first temperature/plot that can be checked.

*Award **no plotting mark** to a candidate who has plotted no temperatures at ½ minutes.*

*Where a maximum temperature is reached after a considerable time and there is no cooling (remaining temperatures are on a plateau) select the maximum and two appropriate points **before** the maximum is reached (one to be on a ½ minute).*

Give **one mark** if:
an approximately horizontal line has been drawn before the addition of zinc powder,

and

a line or curve of ***"best fit"***, with mainly negative slope, has been drawn after continuous cooling commences

Candidates do not have to link the graphs between 2½ and 3½ minutes.

Give **one mark** if there has been any attempt to extrapolate the cooling curve to 3 minutes.

[3]

(e) If the extrapolation mark has been given in **(d)** give **one** mark if the candidate reads from the graph the extrapolated temperature at 3 minutes. This should be correct to half a small square on either axis.

[1]

(f) Give **one** mark for $\frac{\textbf{mass of zinc}}{\textbf{65.4}}$

[1]

(g) Give **one mark** for $\frac{\textbf{25}}{\textbf{1000}}$ **x 0.80** or **2.0×10^{-2}**

[1]

(h) Give **one** mark for

25 x 4.3 x **Temperature rise calculated in (e)** *(Ignore any sign)*

Correct units, J or kJ, necessary.
With-hold this mark if J/…….. or kJ/…… is shown at this stage.

[1]

(i) Give **one** mark for

$\frac{\textbf{answer to (h)}}{\textbf{smaller of answer to (f) or (g)}}$ *(Ignore moles, /mol, mol^{-1})*

With-hold this mark if the sign **or** units are incorrect.
Do not penalise incorrect units, already penalised in **(h)** ` **[1]**

Total for Question 1 = [19]

2

(a) Give **one mark** if the apparatus drawn is suitable for the reaction of lithium with water and the collection of gas. *Do not allow delivery tubes etc to pass through apparatus.*
In assessing apparatus consider "Could it be set up with real apparatus?" "Would it work?"

Give **one further mark** if the apparatus drawn or named in the diagram is suitable for measuring the volume of gas collected.
An unnamed gas syringe or inverted measuring cylinder must show graduations in the diagram to score this mark.
No graduations need be drawn if the apparatus has been correctly labelled.

[2]

(b) Give **one mark** for an answer that involves one of the following:
(i) the removal of the oil before weighing (wiping or dissolving in suitable non-aqueous solvent)
(ii) removing the oxidised outer layer
(iii) cutting the lithium to expose fresh metal to the water

[1]

(c) Give **one mark** for a suitable safety measure **and** reason:
(i) use of tweezers or similar/gloves to handle lithium as reactive with moisture on skin
(ii) keeping a flame away from the apparatus as hydrogen is flammable
(iii) wearing gloves as lithium hydroxide is corrosive / highly alkaline

***In parts* (b) *and* (c) *ignore* non-scoring suggestions**

[1]

(d) Give **one mark** for $\frac{\mathbf{100}}{\mathbf{24000}}$ **mole of hydrogen** **(4.17×10^{-3})**

Give **one mark** for (**mole of hydrogen) x 2** **(8.34×10^{-3})**

Give **one mark** for $\frac{\mathbf{0.0583}}{\mathbf{8.34 \times 10^{-3}}} = \mathbf{6.99599.....}$

The value evaluated depends on rounding and the stage at which rounding took place.

6.94, 6.99, 6.996, 7.0, 7.02 or 7 are likely to be seen.

[3]

Some candidates may attempt the calculation using $pV = nRT$

or $pV = \frac{m}{M_r}nRT$

Give **one mark** for $\textbf{Moles of Li} = \frac{\textbf{0.0583}}{\textbf{A}_\textbf{r}}$

Give **one mark** for $\textbf{Moles of H}_\textbf{2} = \frac{\textbf{0.0583}}{\textbf{2A}_\textbf{r}}$

Give **one mark** for equating to 100 cm^3 of gas and evaluating the answer:

$$\frac{\textbf{0.0583}}{\textbf{2A}_\textbf{r}} = \frac{\textbf{100}}{\textbf{24000}}$$

Other methods of performing the calculation may be seen and should be fitted into the pattern of the methods above.

Examiners should be confident that the use of the mole ratio, ($2Li \equiv 1H_2$), has been applied by the candidate both correctly and confidently.
Guard against the sudden appearance of an unjustified 2 in a muddled calculation.

(e) Give **one mark** for variable conditions (temperature or pressure) / 24 dm^3 is approximate V_m

AND

Give **one further mark** for a 'chemical' **or** 'procedural' reason such as:
(i) lithium is covered with a layer of oxide **or** lithium reacts with "air" / moisture in the air after or during weighing / cutting / transfer
(ii) residual oil on the lithium
(iii) insufficient water for all the lithium to react **or** excess lithium
*do **not** give this mark for - "not all of the Li reacts"*
(iv) loss of gas at start before apparatus is sealed
*do **not** give this mark for general loss of gas or leaking apparatus*

[2]

(f) Give **one mark** for stating that a titration would be used **or** evaporation to dryness of LiOH or a salt prepared from LiOH + weighing the solid remaining after evaporation

[1]

(g) Give **one mark** for reference to one of
(i) standard or standard / standardised acid used in the titration
(ii) obtaining concordant titres
(iii) % error in pipette **and** burette is very small (or equivalent)
(iv) the end-point of a titration is sharp / precise (or equivalent)
(v) balances weigh to 3 decimal places (or better)

The answer to **(g)** must be related to the answer in **(f)**.

[1]

Total for Question 2 = [11]
Total for Paper = [30]

JUNE 2004

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 40

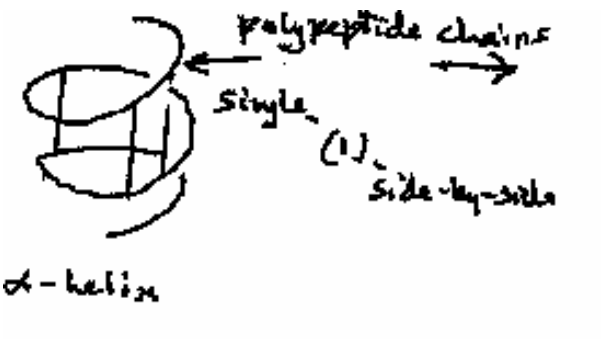
SYLLABUS/COMPONENT: 9701/06

CHEMISTRY
Options

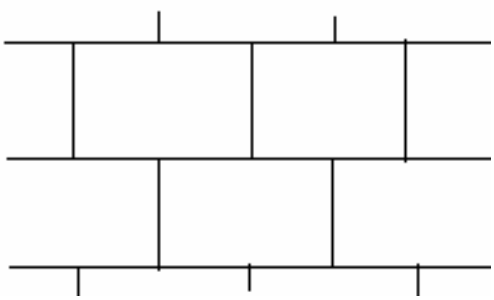
UNIVERSITY of CAMBRIDGE
International Examinations

Biochemistry

1. (a)



(1)



β – pleated sheet (1)

Stabilising bonds are C==O ||||||H—N (1)

[4]

(b) (i) pH changes affect R groups

High pH $– CO_2H + OH^- \rightarrow –CO_2^-$

or $–NH_3^+ + OH^- \rightarrow –NH_2$ (1)

Low pH $–NH_2. + H^+ \rightarrow –NH_3^+$

or $–CO_2^- + H^+ \rightarrow –CO_2H$ (1)

Change in pH breaks hydrogen bonds between groups (1)

Heavy metals form salts

$--CO_2H + Ag^+ \rightarrow --CO_2^- Ag^+ + H^+$ (1)

and break disulphide links

$--CH_2—S—S—CH_2-- + Cu^{2+} \rightarrow 2\ -CH_2—S^- Cu^{2+}$ (1)

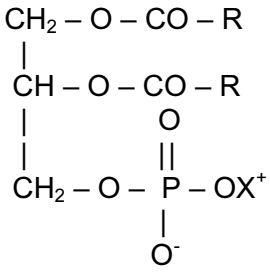
[5]

(c) The cooking of an egg - bonds are broken by heat

Or The solidifying of milk by bacteria in cheese/yoghurt - pH is changed

[1]

2. **(a)** **(i)**

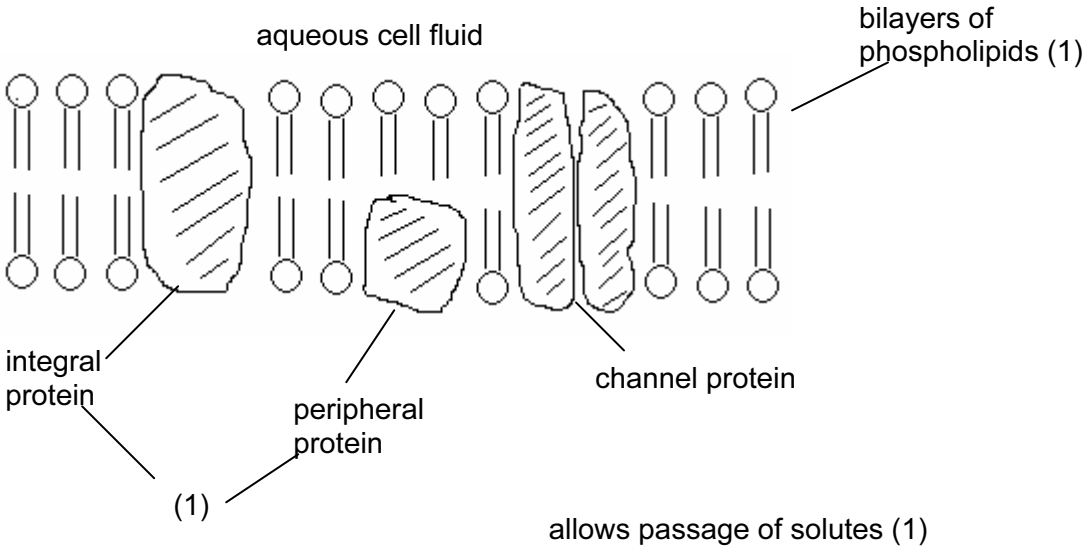


glycerol (1)
ester displayed (1)
phosphate (1)

(ii) Phosphate has a negative charge on –P—O , positive on X (1)

[4]

(b)



allows passage of solutes (1)

Protein increases the flexibility of the bilayer (1)

van der Waals' forces between the alkyl groups of phospholipids (1)

ionic and H-bonds between phosphate residues / protein and the aqueous cell fluid (1)

[6]

Environmental Chemistry

3. **(a)** (i) At night plant respiration occurs, but negligible photosynthesis (1)

(ii) In winter lower temperatures and less sunlight reduce photosynthesis (1)

[2]

(b) (i) Two of : CH_4 N_2O, O_3, CFCs or H_2O (2 x 1)

(ii) Gases absorb infrared energy by increased bond vibration (1)
Some of this i.e. re-emitted back to Earth (1)

[4]

(c) CO_2 dissolves in water and can react to form HCO_3 and CO_3^- ions

$CO_2(g) \leftrightarrow CO_2(aq)$ (1)

$CO_2(aq) + H_2O \leftrightarrow H^+ + HCO_3^-$ (1)

$HCO_3 \leftrightarrow H^+ + CO_3^{2-}$ (1)

Some dissolved CO_2 is used by plankton in photosynthesis (1)

CO_2 is more soluble under pressure. (1)

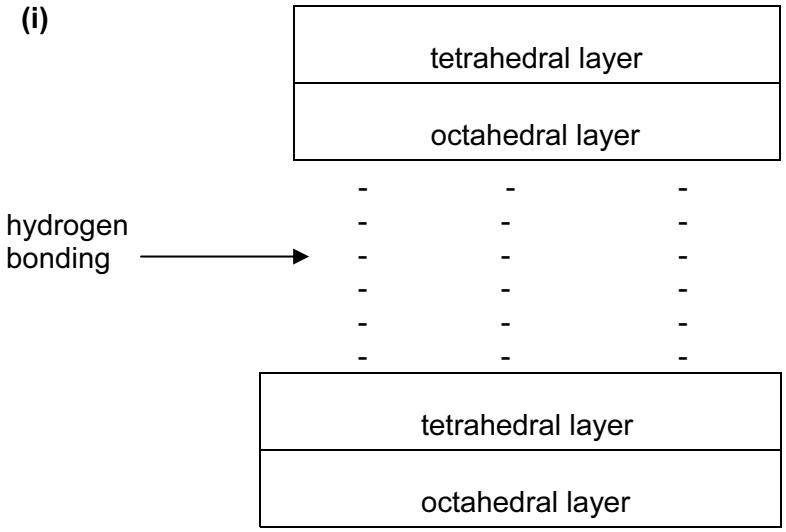
CO_3^{2-} ions can react with Ca^{2+} ions and $CaCO_3$ is precipitated (1)
[max 4]

4. **(a)** Gaps between small particles produce capillary action
or Water binds to minerals (1)

(b) In sandy soils, the decay of organic materials increases CO_2 levels in large pores (1)

In clay soils waterlogging produces reducing conditions promoting Anaerobic decomposition (1)

(c) **(i)**



(2)

(ii) Water cannot enter the gap between the layers due to hydrogen bonding between them (1)

Thus the soil does not expand on wetting or contract on drying out (1)
[4]

(d) Reduced by increased amount of humus (1)
Reduced by increased amount of Al^{3+} (1)

Increased by increased amount of Ca^{2+} (1)
[3]

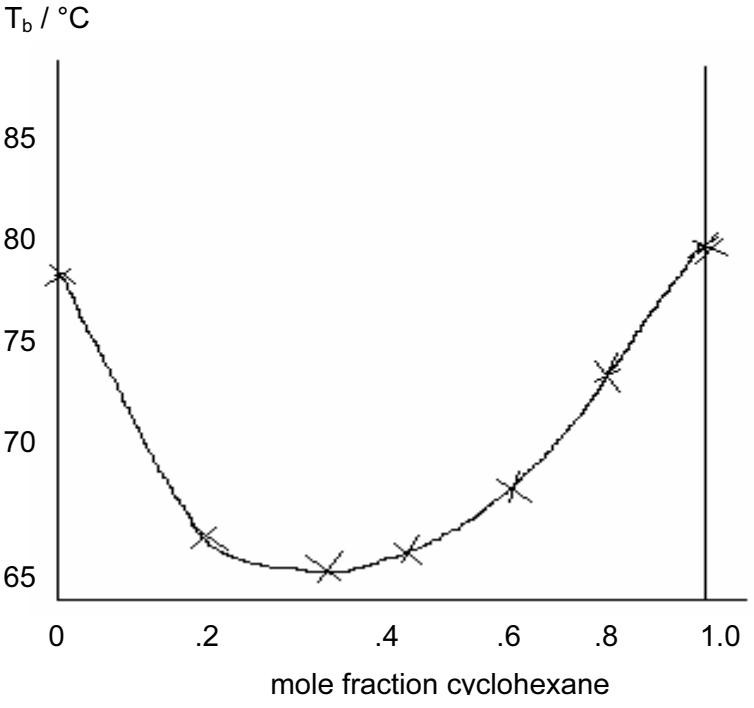
Phase Equilibria

5. **(a)** Enthalpy/energy required to convert one mole of the liquid into the gaseous phase (1)
[1]

(b) One correct observation about the difference in ΔH_{vap} with such different Values of M_r (1)

Cyclohexane — van der Waals' forces only, ethanol — H-bonding (1)

H-bonding stronger than van der Waals' (1)
[max 2]



axes (1)

points and plot (1)

(ii) 66.7°C at 0.3 mole fraction cyclohexane (1)
[3]

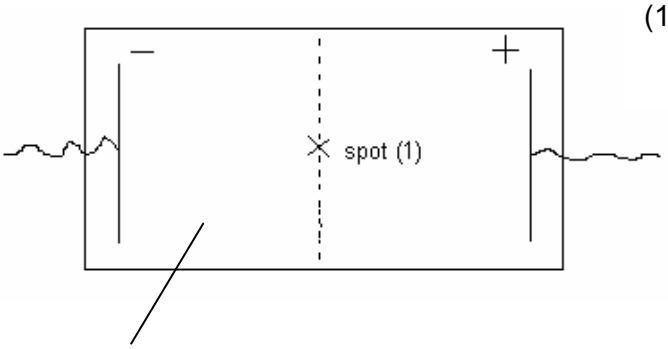
(d) **(i)** cyclohexane 0.3 x 35.7 = 10.7)
ethanol 0.7 x 83.9 = 58.7) (1)

ΔH_{vap} of mixture = 69.4 kJ mol^{-1} (1)

(ii) Mixing the two liquids will break the H-bonds in ethanol (1)
This reduces the ΔH_{vap} (1)
[4]

6. **(a)** **(i)** Reflux for a long period (6+ hours) with 6M HCl (1)
Use specified enzymes e.g. trypsin (1)

(ii) (1)



kept wet in buffer (1)

(iii) From the positions to which they move (1)

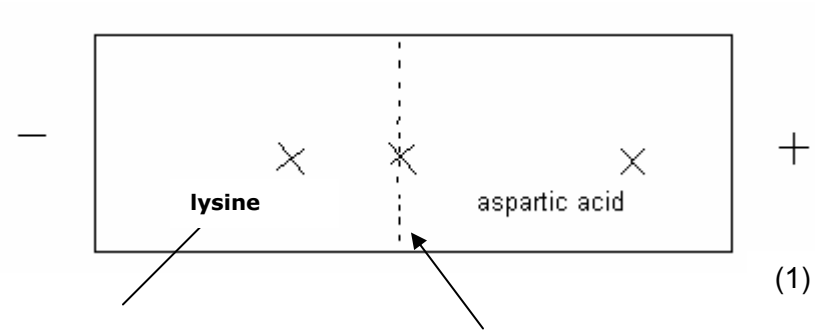
Under standard conditions (and times) (1)

Compare with reference samples (1)

Use of locating agent / ninhydrin / iodine (1)

[max 7]

(b)



(1)

moves to negative (1)
less movement than asp. (1)

glycine (1)

[max 3]

Spectroscopy

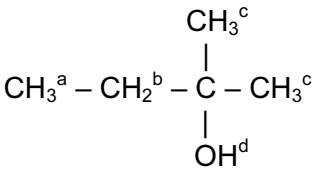
7. **(a)** Yellow colour of a sunflower is due to the other colours being absorbed OR only yellow being reflected (1)

Electrons move from low to higher energy orbitals (1)

Yellow colour of streetlights is due to emission (1)

Excited electrons fall from high to lower energy orbitals (1)
[4]

(b) **(i)**



Peak of height 6 at 1.2 δ is produced by H_c (1)

Peak of height 3 at 0.9 δ is produced by H_a (1)

Peak of height 2 at 1.5 δ is produced by H_b (1)

Peak of height 1 at 3.2 δ is produced by H_d (1)

(ii) Peak at 3.2 δ disappears (1)

-OH proton exchanges with D_2O (1)

D does not absorb (in this part of the spectrum) (1)
[6]

8. **(a)** C-O is composed of different atoms, which produces a dipole (1)

When the bond vibrates, the dipole changes, absorbing in the ir (1)
[2]

(b) 1740 cm^{-1} ⟶ C=O (1)

1050 cm^{-1} **OR** 1240 cm^{-1} ⟶ C—O (1)

Functional group is ester (1)
[max 2]

(c) M + 1 ⟶ ^{13}C (1)

M + 2 ⟶ Halogen atom (C*l* or Br) (1)

M + 4 ⟶ Second halogen atom (1)

M + 2 peak approx equal in height to M + 4 ⟶ Br (1)
[4]

(d) m/e 29 ⟶ $C_2H_5^+$ (1)

m/e 43 ⟶ $C_3H_7^+$ or CH_3CO^+ (1)
[2]

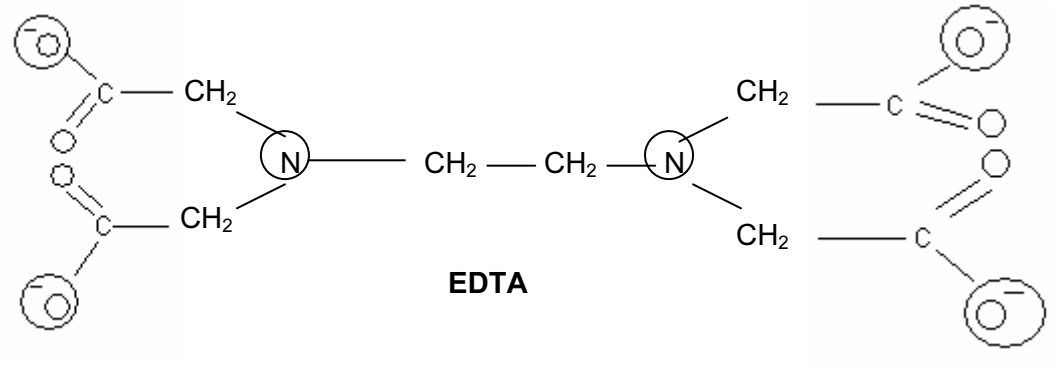
Transition Elements

9. **(a)** An atom, ion or molecule that has a lone pair of electrons (1)
that can form a dative bond to the metail ion (1)
[2]

(b) Examples – NH_3 or H_2O or Cl^- (1)

$H_3N: \longrightarrow Cr^{3+}$ or $H_2O: \longrightarrow Cr^{3+}$ or $^-Cl: \longrightarrow Cr^{3+}$ (1)

(c) **(i)**



EDTA

Oxygens circled (1), nitrogens circled (1)

(ii) K_c for the 2nd equilibrium is very large so well over to the RHS (1)

All Cd^{2+} ions will be complexed and flushed out via the kidneys (1)

Calcium is no problem since K_c is 10^6 smaller (1)

Zinc has a similar K_c to cadmium and will also be flushed out (1)

Solution is to give zinc as dietary supplement (1)
[max 6]

10. **(a)** **(i)** Green (1)

(ii) Purple (1)

(iii) $MnO_2 + ½\ O_2 + 2OH^- \rightarrow MnO_4^{2-} + H_2O$ (1)

(iv) $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$ (1)
($H^+ + e^- \rightarrow ½\ H_2$ scores(1))

(v) $MnO_4^{2-} + H_2O \rightarrow MnO_4^- + ½\ H_2 + OH^-$ (1)

[5]

(b) $3MnO_4^{2-} + 4H^+ \rightarrow 2MnO_4^- + MnO_2 + 2H_2O$

(1) for correct species, (1) for balancing

[2]

(c) SO_3^{2-} requires 2 electrons change to SO_4^{2-}

Therefore Mn^{VII} has been reduced to Mn^{V} (1)

Suggest MnO_4^{3-} (1)

$SO_3^{2-} + MnO_4^- + 2OH^- \rightarrow MnO_4^{3-} + SO_4^{2-} + H_2O$ (1)

[3]