

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.



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)



| | | | |
|---------------|------------------------------|-----------------|--------------|
| Page 1 | Mark Scheme | Syllabus | Paper |
| | CHEMISTRY – JUNE 2004 | 9701 | 1 |

| <i>Question Number</i> | | <i>Question Number</i> | <i>Key</i> |
|------------------------|----------|------------------------|------------|
| 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

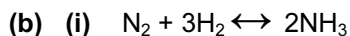
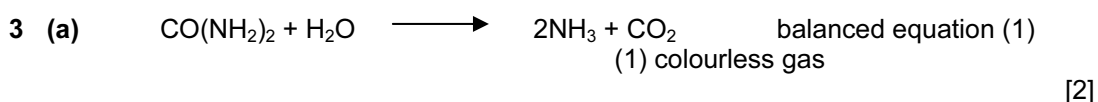
CHEMISTRY
Theory 1 (Structured Questions)



| Page 1 | Mark Scheme | Syllabus | Paper |
|--------|-----------------------|----------|-------|
| | CHEMISTRY – JUNE 2004 | 9701 | 2 |

- 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 elastic. Any two. [2]
- (b) (i) The pressure of / exerted by the gas. [1]
Pa / Nm⁻² [1]
- (ii) The volume of the containing vessel [1]
m³ / dm³ / cm³ [1]
- (iii) The absolute temperature [1]
In K or 273 + °C [1]
- (c) (i) pV ≈ w/m x RT
m = (0.103 x 8.31 x 297) / (99.5 x 10³ x 63.8 x 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 N₂ and Ar molecules (1)
Ammonia is polar / has a dipole (1)
(Any two) [2]
- Total = [13]**
- 2 (a) 1s² 2s² 2p⁶ 3s² 3p³ [1]
- (b) 5 or V [1]
- (c) (i) 3NaOH + H₃PO₄ → Na₃PO₄ + 3H₂O [1]
- (ii) (50 x 0.5) / 1000 = 0.025 (moles) [1]
- (iii) conseq. on (i) 3 x .025 = 0.075 (moles) [1]
- (d) (i) P₄S₃ + 8O₂ → P₄O₁₀ + 3SO₂ balanced = 2 marks
(or 2P₂O₅)
- OR + 6O₂ → P₄O₆ + 3SO₂ unbalanced = 1 mark
(or 2P₂O₃) [2]
- (ii) P₄O₁₀ + 6H₂O → 4H₃PO₄ [1]
- OR P₄O₆ + 6H₂O → 4H₃PO₃
- SO₂ + H₂O → H₂SO₃ [1]
- (if SO₃ then e.c.f.) **Total = [9]**

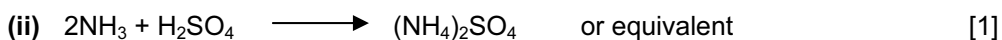
| Page 2 | Mark Scheme | Syllabus | Paper |
|--------|-----------------------|----------|-------|
| | CHEMISTRY – JUNE 2004 | 9701 | 2 |



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

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

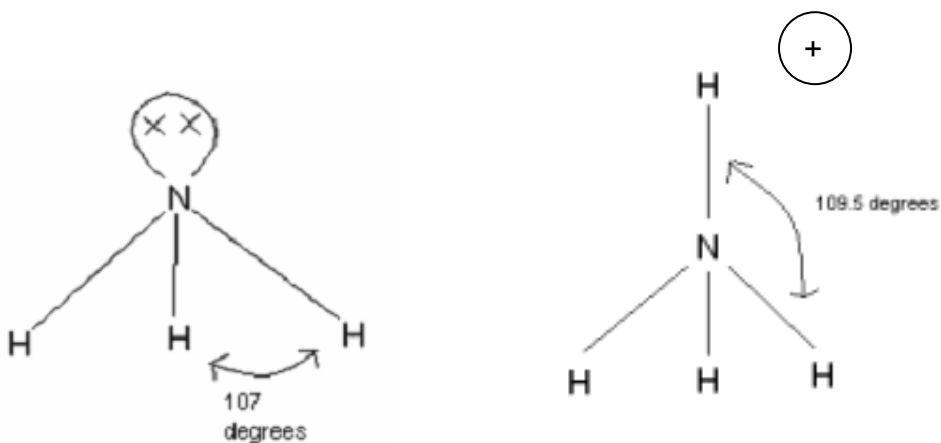
(c) (i) $(1.2) / (2.4) = 1/20$ or 0.05 moles [1]



(iii) 0.025 mols of H_2SO_4 are required

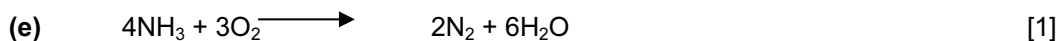
Vol. of 0.50 mol dm^{-3} H_2SO_4 required = $(0.025 \times 1000) / 0.5 = 50\text{cm}^3$ [1]

(d)



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

[4]



N goes from -3 to 0 \longrightarrow oxidation [1]

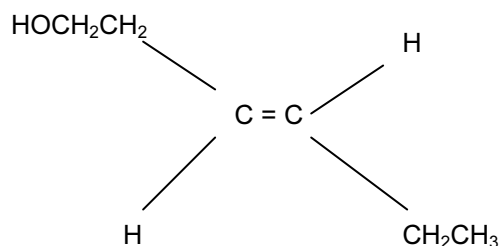
O goes from 0 to -2 \longrightarrow reduction [1]

Total = [16]

| Page 3 | Mark Scheme | Syllabus | Paper |
|--------|-----------------------|----------|-------|
| | CHEMISTRY – JUNE 2004 | 9701 | 2 |

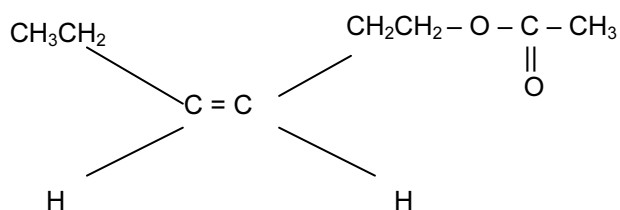
- 4 (a) (i) Acid or base, heating / reflux / warm [1]
- (ii) $\text{CH}_3(\text{CH}_2)_2\text{CO}_2\text{CH}_3 + \text{H}_2\text{O} \longrightarrow \text{CH}_3(\text{CH}_2)_2\text{CO}_2\text{H} + \text{CH}_3\text{OH}$ [1]
- (iii) Solvents (polyesters not in AS syllabus, but allow as plastics, textiles) [1]

(b) (i)



1 mark for this diagram

(ii)



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

[3]

- (c) (i) $\text{C}_6\text{H}_{12}\text{O}$ $72 + 12 + 16$ $M_r = 100$ [1]
- $\text{CH}_2 = \text{CH} - \text{CH} = \text{CH} - \text{CH}_2\text{CH}_3$ [1]
- dehydration / elimination [1]

| Page 4 | Mark Scheme | Syllabus | Paper |
|--------|-----------------------|----------|-------|
| | CHEMISTRY – JUNE 2004 | 9701 | 2 |

- (d) A test for an alcohol (both alcohol and the product are alkenes)
- e.g. sodium bubbles of gas
 PCl_5 misty fumes
 $\text{H}^+ / \text{Cr}_2\text{O}_7^{2-}$ orange turned green
 conc. H_2SO_4 + carboxylic acid ester smell
- NOT Br_2 or $\text{H}^+ / \text{MnO}_4^-$ 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 deodorants, 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**



| | | | |
|--------|-----------------------|----------|-------|
| Page 1 | Mark Scheme | Syllabus | Paper |
| | CHEMISTRY – JUNE 2004 | 9701 | 3 |

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 cm³) are given (initial or final readings).

Give **one mark** if there are two titres within 0.10 cm³ 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:

$$\frac{\text{Supervisor's mass of Na}_2\text{CO}_3}{\text{Candidate's mass of Na}_2\text{CO}_3 \text{ (corrected if necessary)}} \times \text{Candidate's Titre (corrected if necessary)}$$

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

| | | | |
|---------------|------------------------------|-----------------|--------------|
| Page 2 | Mark Scheme | Syllabus | Paper |
| | CHEMISTRY – JUNE 2004 | 9701 | 3 |

| 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 $\text{Na}_2\text{CO}_3 = 106$
 and **one mark** for $\frac{\text{candidate's mass of Na}_2\text{CO}_3}{\text{a calculated } M_r \text{ for Na}_2\text{CO}_3} \times 4$

[2]

- (d) Give **one mark** for $\text{ans (c)} \times \frac{25}{1000}$ **OR**
 $\frac{\text{candidate's mass of Na}_2\text{CO}_3}{\text{a calculated } M_r \text{ for Na}_2\text{CO}_3} \times \frac{1}{10}$

[1]

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

| | | | |
|--------|-----------------------|----------|-------|
| Page 3 | Mark Scheme | Syllabus | Paper |
| | CHEMISTRY – JUNE 2004 | 9701 | 3 |

[1]

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

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: $1.887 \times \frac{\text{candidate's mass of sodium carbonate}}{\text{candidate's titre}}$

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]

| | | | |
|--------|-----------------------|----------|-------|
| Page 4 | Mark Scheme | Syllabus | Paper |
| | CHEMISTRY – JUNE 2004 | 9701 | 3 |

- 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 <i>Accept white solution if a precipitate of unspecified colour has also formed (no contrary colours permitted)</i> | |
| followed by 2 cm depth of dilute hydrochloric acid | Precipitate dissolves/disappears or colourless/clear/transparent solution <i>Ignore any reference to slight white "haziness" left in the solution or to evolution of gas.</i> 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 <i>Do not penalise green precipitates</i> | [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) <i>A suitable test must be described:</i> 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] |

| | | | |
|---------------|------------------------------|-----------------|--------------|
| Page 5 | Mark Scheme | Syllabus | Paper |
| | CHEMISTRY – JUNE 2004 | 9701 | 3 |

Give **one mark** for identifying the anion as sulphite/SO₃²⁻

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. (Beware of contrary statements)

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]

| | | | |
|--------|-----------------------|----------|-------|
| Page 6 | Mark Scheme | Syllabus | Paper |
| | CHEMISTRY – JUNE 2004 | 9701 | 3 |

Tests on Residue

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

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

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)



| Page 1 | Mark Scheme | Syllabus | Paper |
|--------|-----------------------|----------|-------|
| | CHEMISTRY – JUNE 2004 | 9701 | 4 |

- 1 (a) $\text{Mg}^{2+} + 2\text{e}^{-} \longrightarrow \text{Mg}$ [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) $\text{Mg}^{2+}(\text{g}) + 2\text{Cl}^{-}(\text{g}) \longrightarrow \text{MgCl}_2(\text{s})$ [1]
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) $\text{LE} = 349 - 122 - 494 - 107 - 411$
 $= -785 \text{ (kJ mol}^{-1}\text{)}$ [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]

| Page 2 | Mark Scheme | Syllabus | Paper |
|--------|-----------------------|----------|-------|
| | CHEMISTRY – JUNE 2004 | 9701 | 4 |

- 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 $\pm 1^\circ$) [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 = $250 \times 2 \times 65.4/28.1$
 = **1164** (g) (actually 1163.7 – but allow 1160) [2]

allow e.c.f from the stoichiometry of the candidate's equation e.g. allow 582g 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.

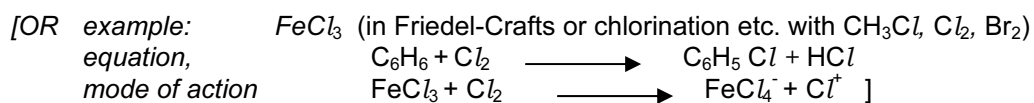
correct answer = [2], with – [1] for one error. OR marks as follows:
use of 2:1 ration [1]
correct use of A_r data for Si and Zn [1]

Total = [12]

| Page 3 | Mark Scheme | Syllabus | Paper |
|--------|-----------------------|----------|-------|
| | CHEMISTRY – JUNE 2004 | 9701 | 4 |

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. $\text{N}_2 + 3\text{H}_2 \longrightarrow 2\text{NH}_3$
- example of homogeneous, e.g. Fe^{3+} (in $\text{S}_2\text{O}_8^{2-} + \text{I}^-$)
- equation, e.g. $\text{S}_2\text{O}_8^{2-} + 2\text{I}^- \longrightarrow 2\text{SO}_4^{2-} + \text{I}_2$
- how catalyst works, e.g. $\text{Fe}^{3+} + \text{I}^- \longrightarrow \text{Fe}^{2+} + \frac{1}{2}\text{I}_2$



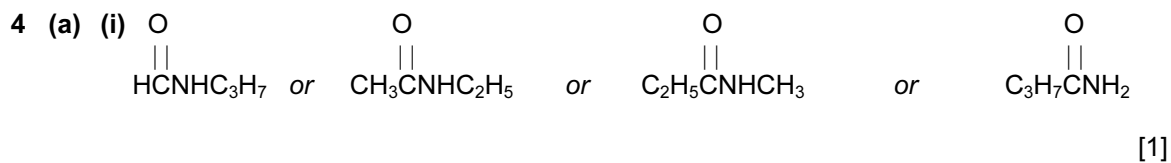
Total = [8]

[space for writing other examples **using iron or its compounds** you may come across. If in doubt consult your TL.
Mark as follows:

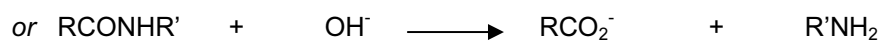
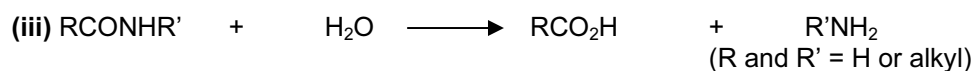
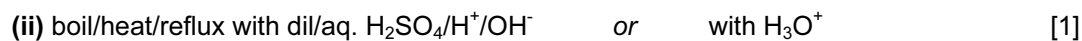
| | | | |
|--------------------|--------------|------------------|--------------------|
| For heterogeneous: | example [1] | for homogeneous: | example [1] |
| | equation [1] | | equation [1] |
| | | | mode of action [1] |

candidates should include **one** example of **each** mode of catalysis]

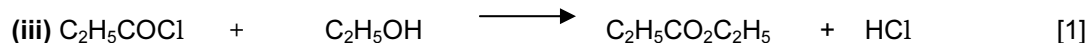
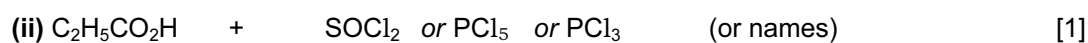
| Page 4 | Mark Scheme | Syllabus | Paper |
|--------|-----------------------|----------|-------|
| | CHEMISTRY – JUNE 2004 | 9701 | 4 |



[for propyl groups allow C_3H_7 or $\text{CH}_3\text{CH}_2\text{CH}_2$ or $(\text{CH}_3)_2\text{CH}$]



[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 $-\text{CONH}- \rightarrow -\text{CO}_2\text{H} + \text{NH}_2-$
[1] for all four R groups consistent with (i)]

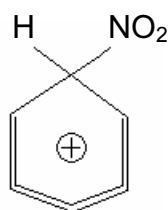


Total = [7]

| Page 5 | Mark Scheme | Syllabus | Paper |
|--------|-----------------------|----------|-------|
| | CHEMISTRY – JUNE 2004 | 9701 | 4 |

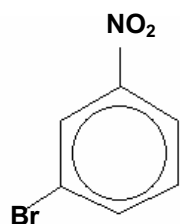
- 5 (a) (i) $\text{Cl}_2 + \text{AlCl}_3$ etc. (UV or aq negates) [1]
(ii) $\text{Br}_2 + \text{AlCl}_3$ or AlBr_3 etc. [1]
(iii) $\text{HNO}_3 + \text{H}_2\text{SO}_4$ [1]
conc. + $50^\circ < T < 60^\circ$ [1]

- (b) (i) $\text{A}^+ = \text{NO}_2^+$ or nitronium ion [1]
(ii) B is

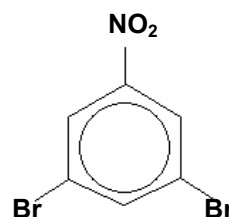


[1]

- (c) (i)

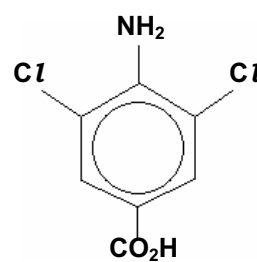
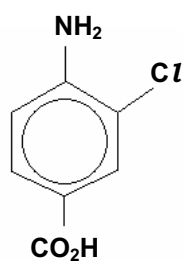


or



[1]

- (ii)



[1]

Total = [8]

| Page 6 | Mark Scheme | Syllabus | Paper |
|--------|-----------------------|----------|-------|
| | CHEMISTRY – JUNE 2004 | 9701 | 4 |

- 6 (a) (i) $\text{NH}_3^+\text{CH}_2\text{CO}_2^-$ [1]
- (b) (i) $\text{NH}_2\text{CH}(\text{CH}_3)\text{CO}_2\text{H} + \text{HCl} \longrightarrow \text{ClNH}_3\text{CH}(\text{CH}_3)\text{CO}_2\text{H}$ [1]
- (ii) $\text{NH}_2\text{CH}(\text{CH}_2\text{OH})\text{CO}_2\text{H} + \text{NaOH} \longrightarrow \text{NH}_2\text{CH}(\text{CH}_2\text{OH})\text{CO}_2\text{Na} + \text{H}_2\text{O}$ [1]

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

- (c)
- $$\begin{array}{ccccccc} & & \text{O} & & \text{O} & & \text{O} \\ & & || & & || & & || \\ \text{---NHCH}_2\text{C} & \text{---NHCH}(\text{CH}_3)\text{C} & \text{---NHCH}(\text{CH}_2\text{OH})\text{C} & \text{---} & \text{---} & \text{---} & \text{---} \\ & \text{PB} & \text{PB} & & & & \end{array}$$
- 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**



| | | | |
|--------|-----------------------|----------|-------|
| Page 1 | Mark Scheme | Syllabus | Paper |
| | CHEMISTRY – JUNE 2004 | 9701 | 5 |

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, Δt , 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

| | | | |
|---------------|------------------------------|-----------------|--------------|
| Page 2 | Mark Scheme | Syllabus | Paper |
| | CHEMISTRY – JUNE 2004 | 9701 | 5 |

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]

| | | | |
|--------|-----------------------|----------|-------|
| Page 3 | Mark Scheme | Syllabus | Paper |
| | CHEMISTRY – JUNE 2004 | 9701 | 5 |

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).*

| | | | |
|--------|-----------------------|----------|-------|
| Page 4 | Mark Scheme | Syllabus | Paper |
| | CHEMISTRY – JUNE 2004 | 9701 | 5 |

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
$$\frac{\text{mass of zinc}}{65.4}$$

[1]

- (g) Give **one mark** for
$$\frac{25}{1000} \times 0.80 \quad \text{or} \quad 2.0 \times 10^{-2}$$

[1]

- (h) Give **one mark** for

$25 \times 4.3 \times \text{Temperature rise calculated in (e)}$ (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

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

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]

| | | | |
|--------|-----------------------|----------|-------|
| Page 5 | Mark Scheme | Syllabus | Paper |
| | CHEMISTRY – JUNE 2004 | 9701 | 5 |

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 $\frac{100}{24000}$ mole of hydrogen (4.17×10^{-3})
 Give **one mark** for (mole of hydrogen) x 2 (8.34×10^{-3})
 Give **one mark** for $\frac{0.0583}{8.34 \times 10^{-3}} = 6.99599\dots\dots$

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]

| | | | |
|--------|-----------------------|----------|-------|
| Page 6 | Mark Scheme | Syllabus | Paper |
| | CHEMISTRY – JUNE 2004 | 9701 | 5 |

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

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

Give **one mark** for **Moles of Li** = $\frac{0.0583}{A_r}$

Give **one mark** for **Moles of H₂** = $\frac{0.0583}{2A_r}$

Give **one mark** for equating to 100 cm³ of gas and evaluating the answer:

$$\frac{0.0583}{2A_r} = \frac{100}{24000}$$

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 ≡ 1H₂), 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 dm³ 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

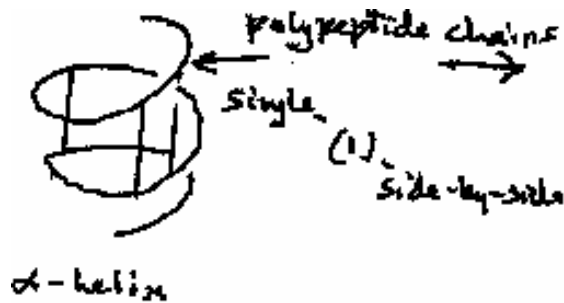
**CHEMISTRY
Options**



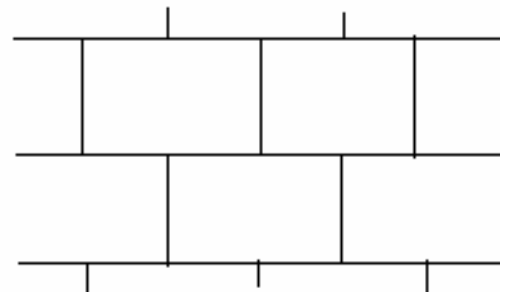
| Page 1 | Mark Scheme | Syllabus | Paper |
|--------|-----------------------|----------|-------|
| | CHEMISTRY – JUNE 2004 | 9701 | 6 |

Biochemistry

1. (a)



(1)



β – pleated sheet

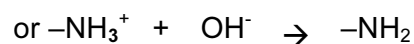
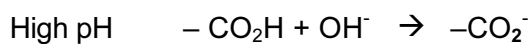
(1)

Stabilising bonds are $C=O \parallel \parallel \parallel \parallel H-N$

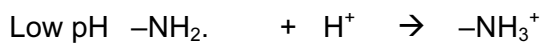
(1)

[4]

(b) (i) pH changes affect R groups



(1)

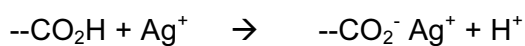


(1)

Change in pH breaks hydrogen bonds between groups

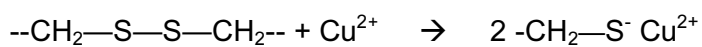
(1)

Heavy metals form salts



(1)

and break disulphide links



(1)

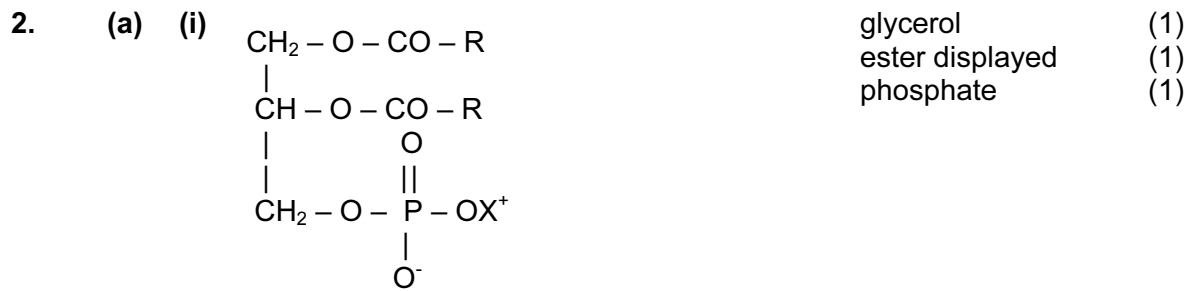
[5]

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

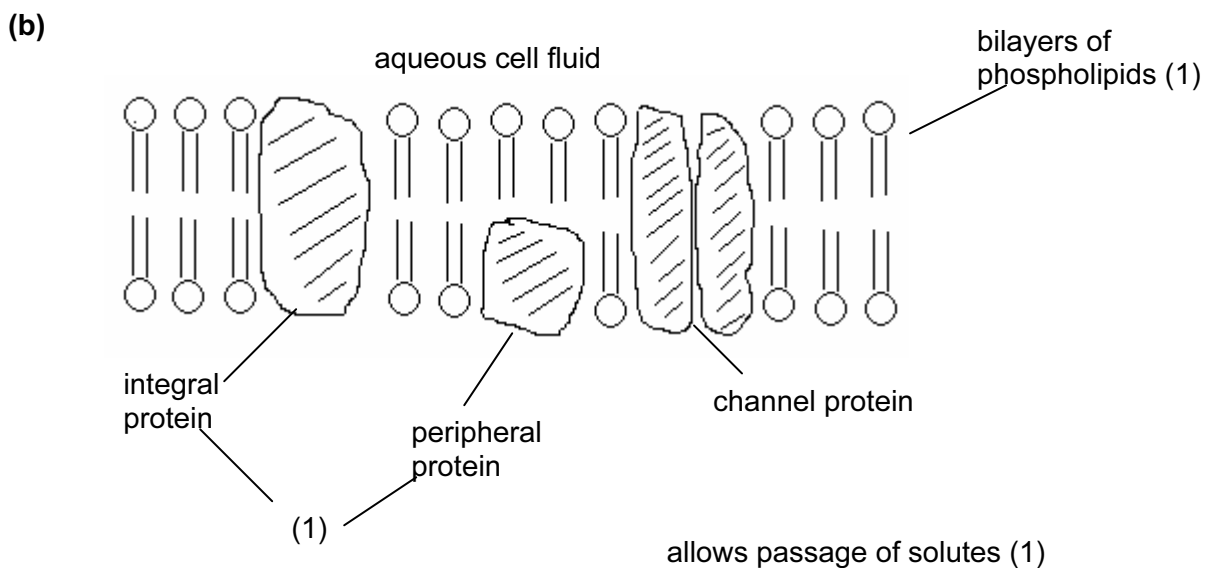
Or The solidifying of milk by bacteria in cheese/yoghurt - pH is changed

[1]

| Page 2 | Mark Scheme | Syllabus | Paper |
|--------|-----------------------|----------|-------|
| | CHEMISTRY – JUNE 2004 | 9701 | 6 |



(ii) Phosphate has a negative charge on $-\text{P}-\text{O}$, positive on X (1)
 [4]



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]

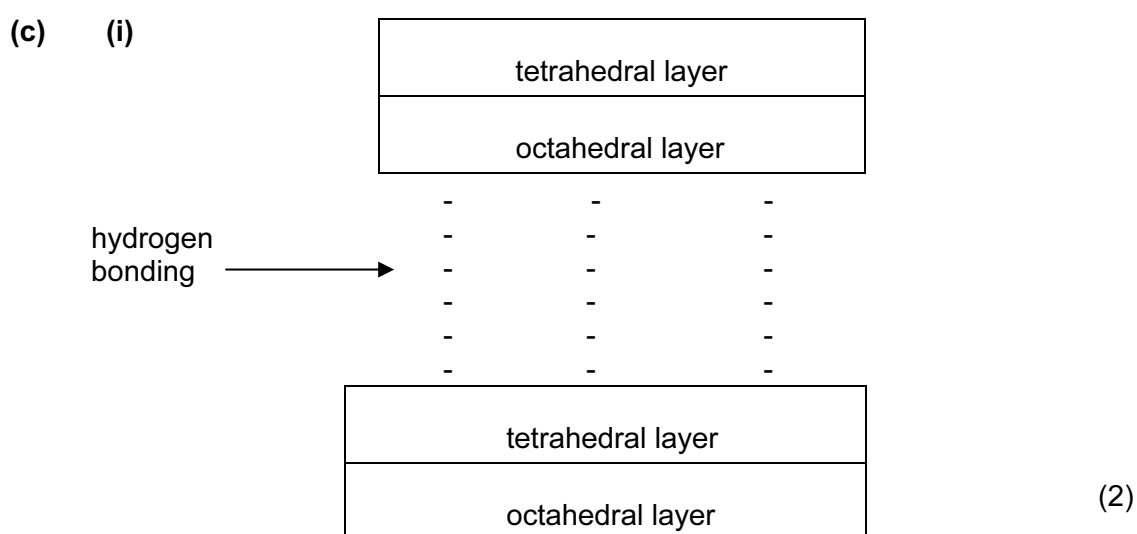
| | | | |
|---------------|------------------------------|-----------------|--------------|
| Page 3 | Mark Scheme | Syllabus | Paper |
| | CHEMISTRY – JUNE 2004 | 9701 | 6 |

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 : CH₄ N₂O, O₃, CFCs or H₂O (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) CO₂ dissolves in water and can react to form HCO₃⁻ and CO₃²⁻ ions
CO₂(g) ↔ CO₂(aq) (1)
CO₂(aq) + H₂O ↔ H⁺ + HCO₃⁻ (1)
HCO₃⁻ ↔ H⁺ + CO₃²⁻ (1)
Some dissolved CO₂ is used by plankton in photosynthesis (1)
CO₂ is more soluble under pressure. (1)
CO₃²⁻ ions can react with Ca²⁺ ions and CaCO₃ is precipitated (1)
[max 4]

| | | | |
|---------------|------------------------------|-----------------|--------------|
| Page 4 | Mark Scheme | Syllabus | Paper |
| | CHEMISTRY – JUNE 2004 | 9701 | 6 |

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 CO₂ levels
in large pores (1)
- In clay soils waterlogging produces reducing conditions promoting
Anaerobic decomposition (1)



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

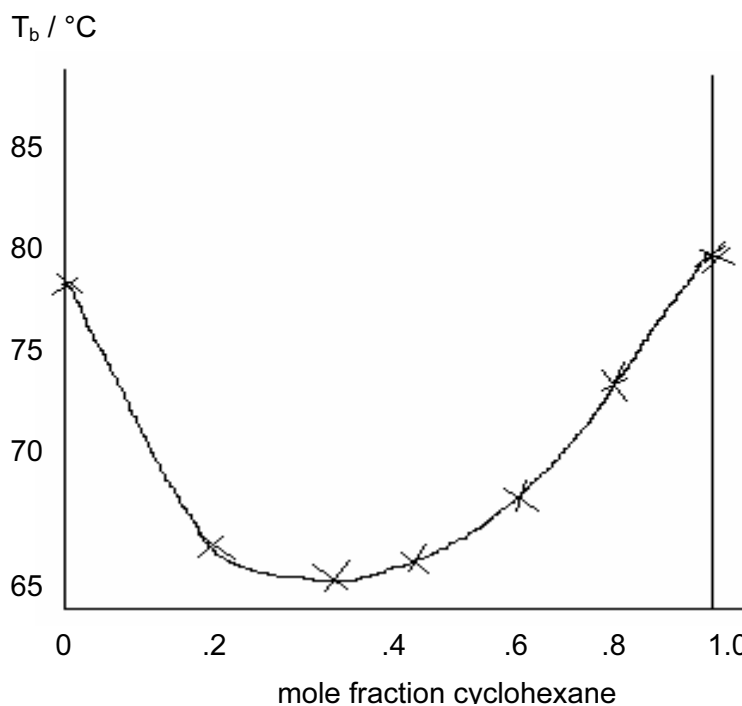
Thus the soil does not expand on wetting or contract on drying out (1)
[4]

- (d) Reduced by increased amount of humus (1)
- Reduced by increased amount of Al³⁺ (1)
- Increased by increased amount of Ca²⁺ (1)
[3]

| | | | |
|--------|-----------------------|----------|-------|
| Page 5 | Mark Scheme | Syllabus | Paper |
| | CHEMISTRY – JUNE 2004 | 9701 | 6 |

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]

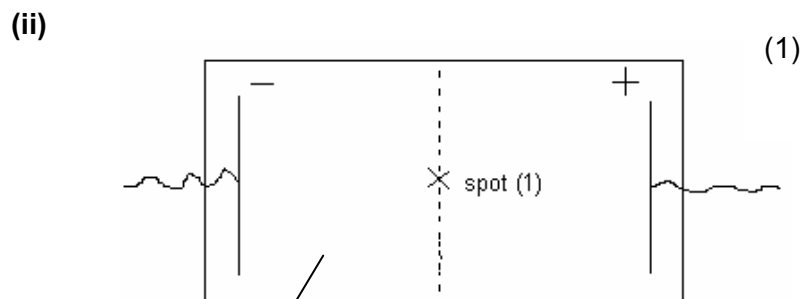


axes (1)
points and plot (1)

- (ii) 66.7°C at 0.3 mole fraction cyclohexane (1)
[3]
- (d) (i) cyclohexane $0.3 \times 35.7 = 10.7$)
ethanol $0.7 \times 83.9 = 58.7$) (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]

| | | | |
|---------------|------------------------------|-----------------|--------------|
| Page 6 | Mark Scheme | Syllabus | Paper |
| | CHEMISTRY – JUNE 2004 | 9701 | 6 |

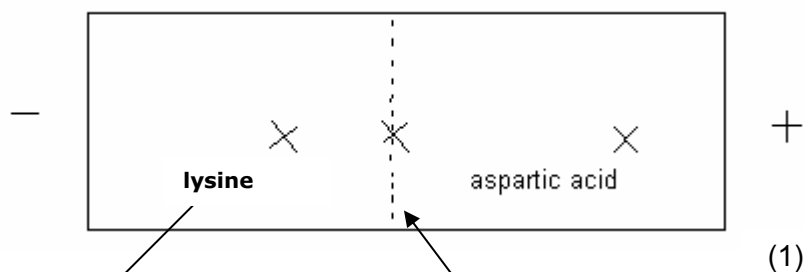
6. (a) (i) Reflux for a long period (6+ hours) with 6M HCl (1)
 Use specified enzymes e.g. trypsin (1)



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)



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

glycine (1)

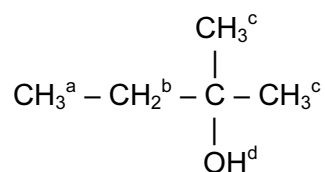
[max 3]

| | | | |
|--------|-----------------------|----------|-------|
| Page 7 | Mark Scheme | Syllabus | Paper |
| | CHEMISTRY – JUNE 2004 | 9701 | 6 |

Spectroscopy

7. (a) Yellow colour of a sunflower is due to the other colours being absorbed (1)
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 D₂O (1)
- D does not absorb (in this part of the spectrum) (1)
- [6]

| | | | |
|---------------|------------------------------|-----------------|--------------|
| Page 8 | Mark Scheme | Syllabus | Paper |
| | CHEMISTRY – JUNE 2004 | 9701 | 6 |

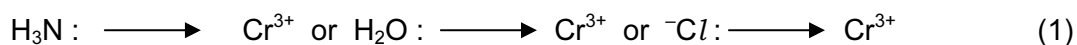
8. (a) C-O is composed of different atoms, which produces a dipole (1)
 When the bond vibrates, the dipole changes, absorbing in the ir (1)
 [2]
- (b) $1740\text{ cm}^{-1} \longrightarrow \text{C}=\text{O}$ (1)
 1050 cm^{-1} **OR** $1240\text{ cm}^{-1} \longrightarrow \text{C}-\text{O}$ (1)
 Functional group is ester (1)
 [max 2]
- (c) $M + 1 \longrightarrow {}^{13}\text{C}$ (1)
 $M + 2 \longrightarrow$ Halogen atom (*Cl* or *Br*) (1)
 $M + 4 \longrightarrow$ Second halogen atom (1)
 $M + 2$ peak approx equal in height to $M + 4 \longrightarrow \text{Br}$ (1)
 [4]
- (d) $m/e\ 29 \longrightarrow \text{C}_2\text{H}_5^+$ (1)
 $m/e\ 43 \longrightarrow \text{C}_3\text{H}_7^+$ or CH_3CO^+ (1)
 [2]

| | | | |
|--------|-----------------------|----------|-------|
| Page 9 | Mark Scheme | Syllabus | Paper |
| | CHEMISTRY – JUNE 2004 | 9701 | 6 |

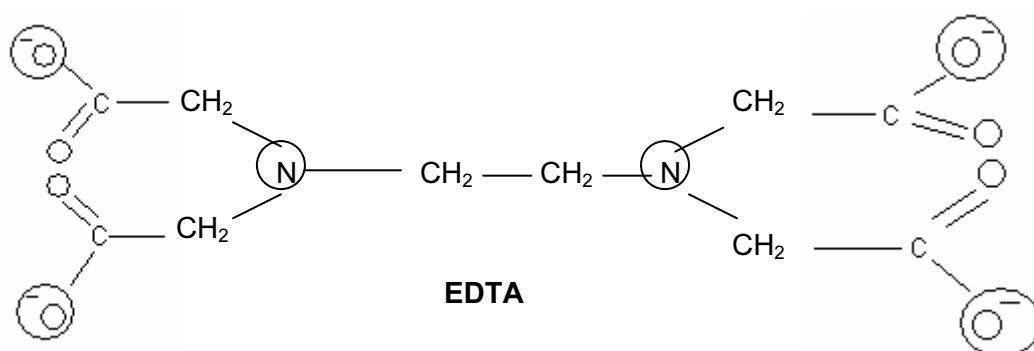
Transition Elements

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

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



- (c) (i)



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]

| | | | |
|---------|-----------------------|----------|-------|
| Page 10 | Mark Scheme | Syllabus | Paper |
| | CHEMISTRY – JUNE 2004 | 9701 | 6 |

10. (a) (i) Green (1)
- (ii) Purple (1)
- (iii) $\text{MnO}_2 + \frac{1}{2} \text{O}_2 + 2\text{OH}^- \rightarrow \text{MnO}_4^{2-} + \text{H}_2\text{O}$ (1)
- (iv) $2\text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{H}_2 + 2\text{OH}^-$ (1)
 ($\text{H}^+ + \text{e}^- \rightarrow \frac{1}{2} \text{H}_2$ scores(1))
- (v) $\text{MnO}_4^{2-} + \text{H}_2\text{O} \rightarrow \text{MnO}_4^- + \frac{1}{2} \text{H}_2 + \text{OH}^-$ (1)
- [5]
- (b) $3\text{MnO}_4^{2-} + 4\text{H}^+ \rightarrow 2\text{MnO}_4^- + \text{MnO}_2 + 2\text{H}_2\text{O}$
- (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)
- $\text{SO}_3^{2-} + \text{MnO}_4^- + 2\text{OH}^- \rightarrow \text{MnO}_4^{3-} + \text{SO}_4^{2-} + \text{H}_2\text{O}$ (1)
- [3]