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INTERNATIONAL EXAMINATIONS

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JUNE 2003

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 40

SYLLABUS/COMPONENT: 9701/01

CHEMISTRY
Paper 1 (Multiple Choice)

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

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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 different numbers of neutrons (1)
- (b) (i) ^{35}Cl (1)
(ii) H^{37}Cl (1) [2]
- (c) H Cl line at 36 has rel. abundance of $\left. \begin{array}{l} 90 \\ 38 \end{array} \right\}$ (1)
 $\left. \begin{array}{l} 30 \\ 30 \end{array} \right\}$ (1)
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) $r = \underline{0.192}$ nm (1) Assume most candidates will work in dm^3
 $v = \frac{4}{3} \times 3.14 \times (1.92 \times 10^{-9})^3 = 2.96 \times 10^{-26} \text{ dm}^3 (2.96 \times 10^{-29} \text{ m}^3)$ (1)
- (ii) $2.96 \times 10^{-26} \times \underline{6.02 \times 10^{23}}$ (1) = $1.78 \times 10^{-2} \text{ dm}^3 (1.78 \times 10^{-5} \text{ m}^3)$ (1)
- (iii) $24 \text{ dm}^3 (0.024 \text{ m}^3)$ (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]

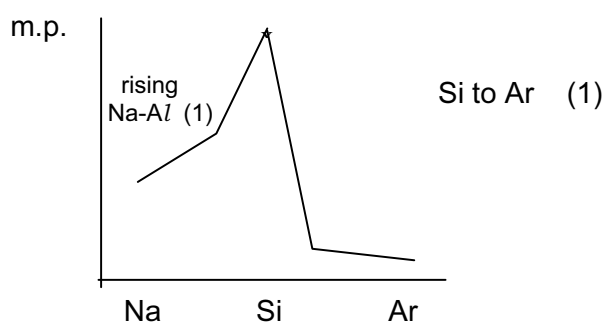
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- 3 (a) $N_2 + 3H_2 \rightleftharpoons 2NH_3$ (1) exothermic (1)
- (b) Pr. 50 atm upwards; Temp 400-600°C; catalyst of iron
(1 each, conditions stated) [3]
- (c) Too high a temp and equilibrium favours LHS, less ammonia at equilibrium (1)
Too low a temp, rate too slow/not enough molecules have E_{act} (1) [2]
- (d) (i) $K_p = \frac{PNH_3^2}{PN_2 \times PH_2^3}$ (1)
- (ii) $K_p = \frac{37.2^2}{44.8 \times 105.6^3}$ (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 eutrophication (1) any 3

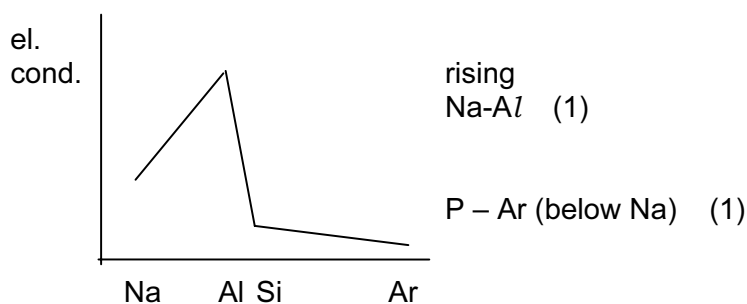
[Total: 13]

4 (a) (i)

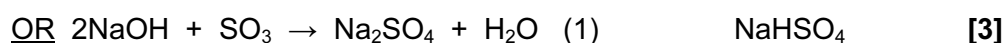
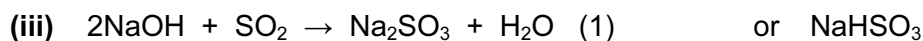
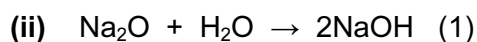
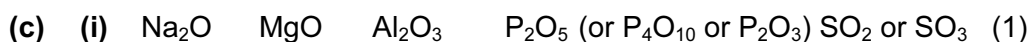
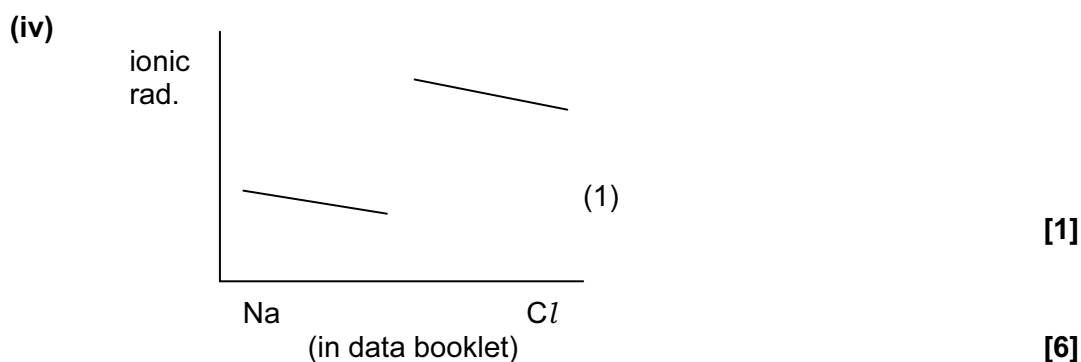
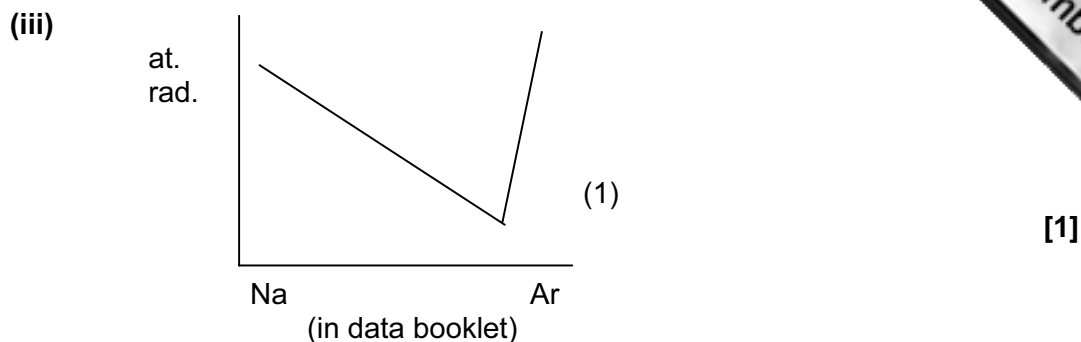


[2]

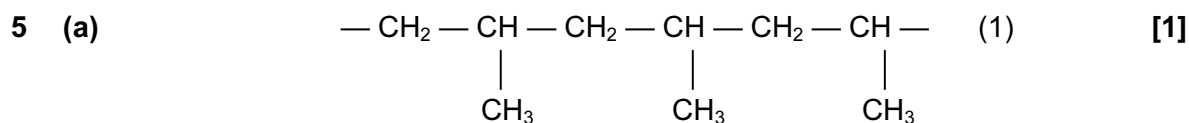
(ii)



[2]



[Total: 9]



(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]

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- (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.
 $CH_3CO_2C_3H_7$ $CH_3CO_2CH(CH_3)_2$ $CH_3CH_2CO_2C_2H_5$ $H-CO_2C_4H_9$
 $C_3H_7CO_2CH_3$ + 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) * volatile, or liquids (1) immiscible, with water (1) smell (1)
 and (ii) 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]

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GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 25

SYLLABUS/COMPONENT: 9701/03

CHEMISTRY
Practical 1

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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** to the nearest second 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. $\left. \begin{array}{l} 1800 \\ 1760 \\ 1590 \end{array} \right\}$ **Closest pair - 2 within 10%**

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.

$$\frac{210}{1800} \times 100 = 11.7\% \quad \mathbf{1 \text{ within } 20\%}$$

e.g. 2 $\left. \begin{array}{l} 1400 \\ 1290 \\ 1250 \end{array} \right\}$ **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.

$$\frac{150}{1290} \times 100 = 11.6\% \quad \mathbf{1 \text{ within } 20\%}$$

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Award marks:

<u>Mark</u>	<u>volume of FA 1 x Time</u>
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 \leq 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 \leq 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 \leq 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 \leq 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 \leq 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 \leq 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 \leq 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 \leq 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 \leq 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 \leq 80% of the larger of the closest pair

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- 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 within 15% 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
$$\text{Rate} \propto \frac{1}{\text{time}}$$

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 $\frac{1}{2}$ 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 $\frac{1}{2}$ 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

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- (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** Na₂S₂O₃ only variable

1

Total for Question 1 15

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- 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 CO_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)

<p>(a) To 2 cm depth of the filtrate in a boiling-tube, add 2 cm depth of aqueous sodium hydroxide</p> <p>then carefully warm the solution.</p>	<p>No reaction, no change, stays colourless or no precipitate one mark</p> <p>Ammonia or gas turning (red) litmus blue etc. one mark</p> <p style="text-align: right;">2</p>
<p>(b) To 1 cm depth of the filtrate in a test-tube, add 1 cm depth of aqueous lead nitrate.</p>	<p>Yellow precipitate one mark (Ignore solubility of ppt or subsequent change in colour)</p> <p style="text-align: right;">1</p>
<p>(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.</p>	<p>Yellow-brown, orange-brown, red-brown, brown solution or Grey or black ppt or Iodine (formed/liberated) one mark</p> <p style="text-align: right;">1</p>

Tests on the Residue (FA 5)

<p>(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.</p> <p>Divide the solution into two parts and use one part for each of the following tests.</p>	<p>Effervescence, fizzing, carbon dioxide or gas turning lime water milky one mark</p> <p style="text-align: right;">1</p>
<p>To one part add aqueous sodium hydroxide.</p>	<p>White precipitate, insoluble in excess one mark</p> <p style="text-align: right;">1</p>
<p>To the other part add dilute aqueous ammonia.</p>	<p>White precipitate, insoluble in excess one mark</p> <p style="text-align: right;">1</p>

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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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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) $E_{\text{left}} = E_{\text{right}} - E_{\text{cell}} = 0.34 - 0.76 = -0.42 \text{ (V)}$ [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]



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



6

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

electrolyte is $\text{Cu}^{2+}(\text{aq})/\text{CuSO}_4/\text{CuCl}_2/\text{Cu}(\text{NO}_3)_2$ etc. *or* name [1]

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

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

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

time = $1520/0.5 = 5034 \text{ seconds} = 50.7 \text{ min}$ [1]
ecf in coulombs

5

Total 13

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- 2 (a) (i) $K_{sp} = [\text{Ba}^{2+}][\text{SO}_4^{2-}]$ [1] units: $\text{mol}^2\text{dm}^{-6}$ [1] ecf
- (ii) $[\text{Ba}^{2+}] = \sqrt{(1.3 \times 10^{-10})} = 1.14 \times 10^{-5} \text{ (mol dm}^{-3}\text{)}$ [1]
- (iii) BaCO_3 can react with/dissolve in the acid/HCl in the stomach [1]
 (or unbalanced equation showing, e.g. $\text{BaCO}_3 + \text{HCl} \rightarrow$)
- 4**
- (b) (i) $K_{sp} = [\text{Mg}^{2+}][\text{OH}^-]^2$ [1] units: $\text{mol}^3\text{dm}^{-9}$ [1] ecf
- (ii) calling $[\text{Mg}^{2+}] = x$, then $K_{sp} = x(2x)^2 = 4x^3 \Rightarrow x = \sqrt[3]{(K_{sp}/4)}$ [1]
 $\therefore [\text{Mg}^{2+}] = \sqrt[3]{(2 \times 10^{-11}/4)} = 1.7 \times 10^{-4} \text{ (mol dm}^{-3}\text{)}$ [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) $\Delta H_r = \Delta H_f^\ominus(\text{Mg}^{2+}) + 2\Delta H_f^\ominus(\text{Cl}^-) - \Delta H_f^\ominus(\text{MgCl}_2)$
 $= -467 + 2(-167) - (-641)$
 $= -160 \text{ (kJ mol}^{-1}\text{)}$ [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

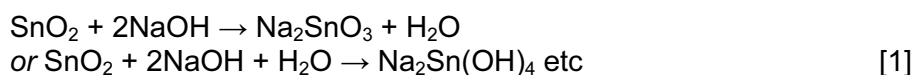
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- 3 (a) (i) simple/discrete covalent/molecular [1]
(ii) giant/macro covalent/molecular (NOT atomic) [1]
(iii) (giant) ionic [1]
a general statement that strong attraction means high m.pt.
and weak means low [1]

4

- (b) (i) $\text{CO}_2 + 2\text{NaOH} \rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O}$
or $\text{CO}_2 + \text{NaOH} \rightarrow \text{NaHCO}_3$ [1]
(this mark is negated if candidate states that SiO_2 dissolves/reacts)



(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]



4

- (c) $\text{PbO}_2 + 4\text{HCl} \rightarrow \text{PbCl}_2 + 2\text{H}_2\text{O} + \text{Cl}_2$ [1]

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

or

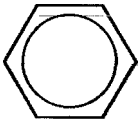


$E_{\text{cell}} = 1.69 - 1.36$
= **0.33** (V) [for 1 M HCl] [1]

2

Total: 10, max 9

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- 4 (a) $\text{Cl}_2 + \text{light/heat}$ (aq negates) [1]
- (b) $\text{Cl}_2 + \text{AlCl}_3/\text{FeCl}_3/\text{Fe}$ etc. (aq negates) [1]
- (c)
-  CO_2H [1]
- (d) $\text{NaOH} + \text{I}_2(+ \text{aq})$ (or $\text{I}^- + \text{OCl}^- + \text{aq}$) [1]
- C: (pale) yellow ppt.
D: no reaction (both) [1]
- (e) mass of CN needed = $0.03 \times 60 = 1.8\text{g}$ [1]
 $M_r = 154.5, \therefore \text{amount} = 1.8/154.5 = \mathbf{0.0117}$ (mol) (allow **0.012**) ecf [1]
- (f) (i) increasing ease: $\text{H} < \text{D} < \text{G}$ [1]
- (ii) chlorine on the aryl ring is very inert or strong C-Cl bond or overlap between Cl 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 Cl (OWTTE) [1]
- 3**
- Total 10**

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- 5 (a) (i) $\text{SOCl}_2/\text{PCl}_5/\text{PCl}_3/\text{P} + \text{Cl}_2$ (aq negates) [1]
(ii) $\text{C}_6\text{H}_5\text{OH} + \text{NaOH} \rightarrow \text{C}_6\text{H}_5\text{O}^- \text{Na}^+$ (or $\text{C}_6\text{H}_5\text{ONa}$) + H_2O [1]
(iii) J = $\text{C}_6\text{H}_5\text{OCOCH}_3$ [1]
K = CH_3CONH_2 [1]

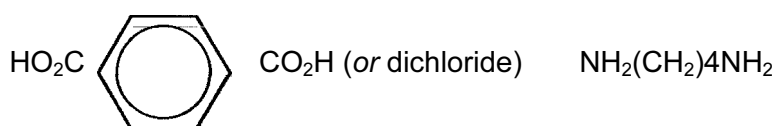
4

- (b) (i) condensation [1]
(ii) $\text{ClCOCH}_2\text{CH}_2\text{COCl} + 2\text{HOCH}_2\text{CH}_2\text{OH} \rightarrow$ [1]
 $\text{HOCH}_2\text{CH}_2\text{OCOCH}_2\text{CH}_2\text{CO}_2\text{CH}_2\text{CH}_2\text{OH} (+ \text{H}_2\text{O})$ [1]

3

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

(ii)



[1] + [1]

3

Total 10

- 6 (a) (i) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$ or $[\text{Ar}] 4s^2 3d^2$ (or vice versa) [1]
(ii) two of TiCl_2 , TiCl_3 , TiCl_4 [1]

2

- (b) (i) blue solution is formed [1]
containing $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ [1]
(ii) NH_3 replaces H_2O ligands or forms $[\text{Cu}(\text{NH}_3)_4]^{2+}$ [1]
(or $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$) [1]
which is deep blue/purple [1]

4

Total 6

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JUNE 2003

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 30

SYLLABUS/COMPONENT: 9701/05

CHEMISTRY
Practical 2

Page 1	Mark Scheme	Syllabus
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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 cm³ and 45.50 cm³ has been diluted.

Titration Table 1.2

Give **one mark** if

Two (uncorrected) titres are within 0.10 cm³

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**,

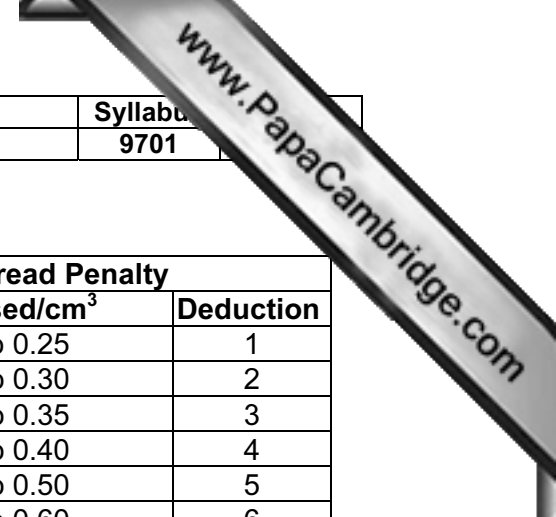
$$\frac{\text{Volume of FB 1 diluted}}{45.00} \times \text{Titre}$$

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

$$\frac{100.0}{248.2} \quad \text{or} \quad 0.403 \quad \text{or} \quad 0.4029$$

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 volume of FB 1 diluted

$$250$$

1

(e) Give two marks for Answer to (d) x titre (1) x $\frac{1}{2}$ (1)

$$1000$$

2

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

$$1000$$

1

(g) Give one mark for answer to (e)
answer to (f)

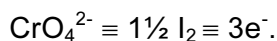
1

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- (h) Give **one mark** for correctly calculating the oxidation numbers of
- | | |
|---------------------------------|------|
| Chromium in CrO_4^{2-} | (+)6 |
| Iodine in I^- | -1 |
| Iodine in I_2 | 0 |

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



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	Titrate 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

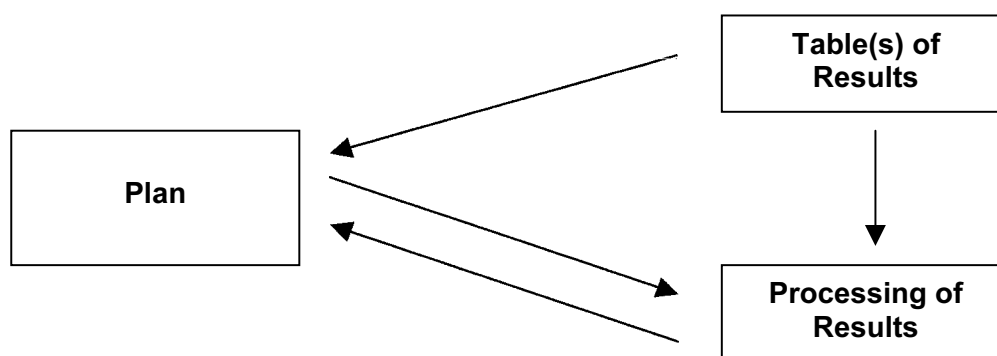
Marks for the Plan (a-d) may be awarded from the Table(s) of Results or from the Processing of Results

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 only be awarded** in the Table of Results Section



Total for Question 2 **10**

Total for Paper **30**

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GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 40

SYLLABUS/COMPONENT: 9701/06

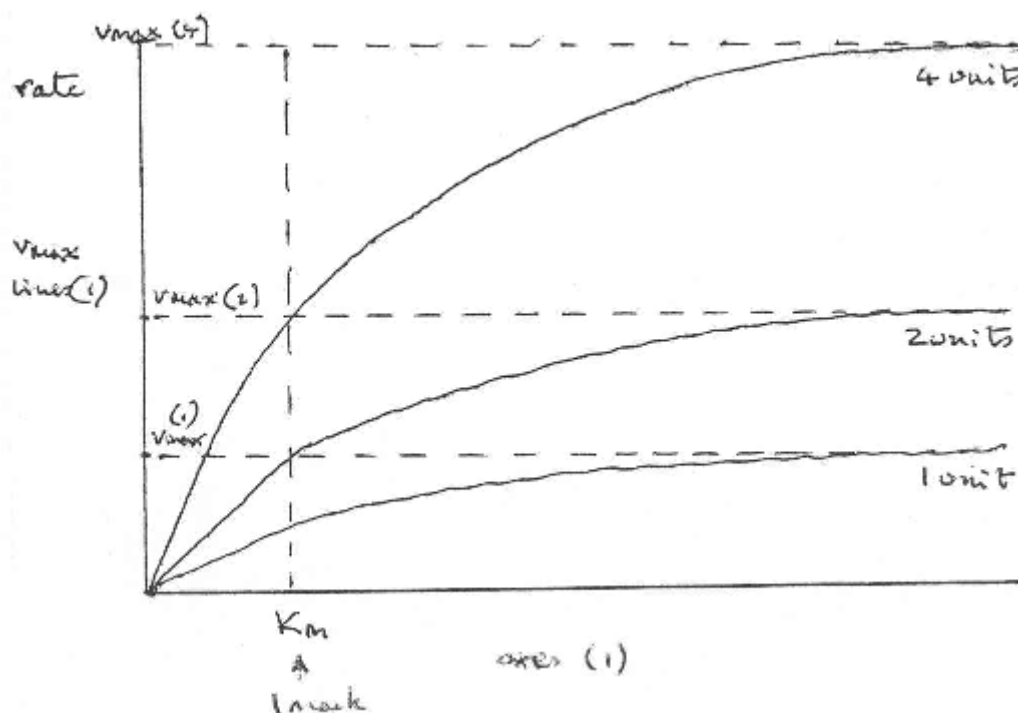
CHEMISTRY
Options

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)
 $E + S \rightarrow ES \rightarrow E + \text{products}$ (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]

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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]

Page 3	Mark Scheme	Syllabus
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Environmental Chemistry

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

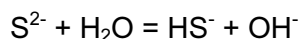
causes the coordinated water molecules to lose a hydrogen ion to the soil solution/polarises H-O bond. (1)

Diagram or formula of aluminium ion produced (1)
Accept $[\text{Al}(\text{H}_2\text{O})_5\text{OH}]^{2+}$ or $[\text{Al}(\text{H}_2\text{O})_4\text{OH}]^+$

[3]

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

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



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) $\text{CaCO}_3 + 2\text{H}^+ \rightarrow \text{Ca}^{2+} + \text{CO}_2 + \text{H}_2\text{O}$ (1)
Allow $\text{CO}_3^{2-} + 2\text{H}^+ = \text{CO}_2 + \text{H}_2\text{O}$
or $\text{CO}_3^{2-} + \text{H}^+ = \text{HCO}_3^-$

[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]

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- 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) $Cl_2(g) \rightarrow 2Cl\cdot(g)$ (1)
- $Cl\cdot + O_3(g) \rightarrow ClO\cdot(g) + O_2(g)$ (1)
- $ClO\cdot(g) + O(g) \rightarrow Cl\cdot(g) + O_2(g)$ (1)
- $Cl\cdot$ is therefore a catalyst (1)

[3 max]

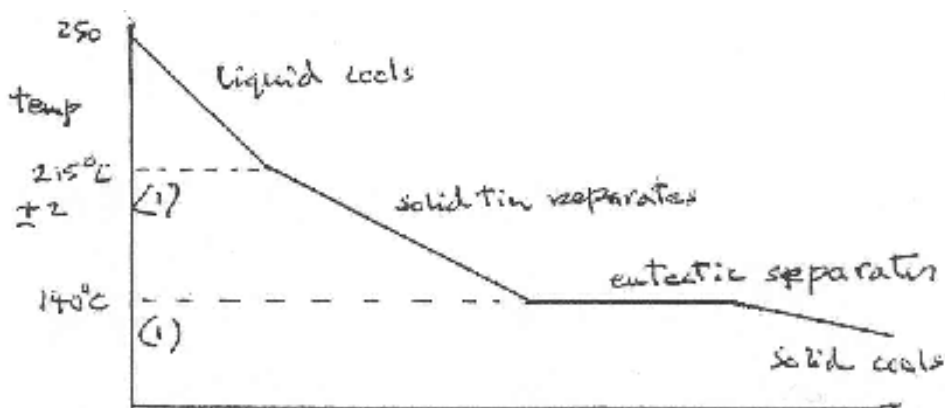
- (c) $NO_2(g)$ can react with the $ClO\cdot(g)$ to form $ClONO_2$ and will therefore break the propagation cycle above. (1)
- This means $Cl\cdot(g)$ is no longer regenerated and less ozone is destroyed (1)

[2]

Phase Equilibria

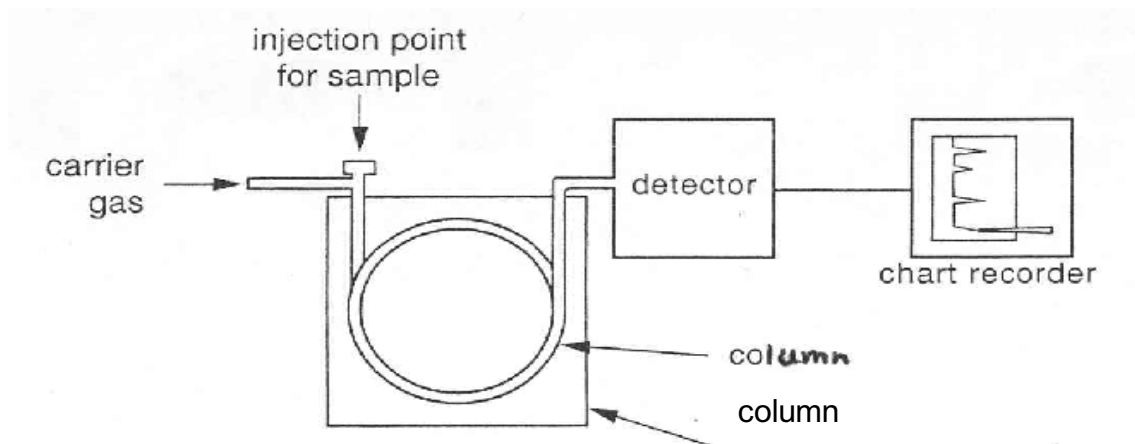
5. (a) (i) Graph plotted and lines drawn (1)
 Axes labelled (1)
 Areas – two metal + liquid areas (1)
 – liquid + solid areas (1)
- (ii) $140 \pm 4 \text{ }^\circ\text{C}$ and $40 \pm 3\%$ tin (2 x 1)
- [5]

(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]

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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)
- $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ has vacant d-orbitals allowing promotion (1)
- $[\text{Zn}(\text{H}_2\text{O})_6]^{2+}$ 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)
- [5]**

} more than one absorption scores 0

Page 8	Mark Scheme	Syllabus
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8. (a) **From mass spectrum**
Ratio of M : M+1 peaks shows no. of carbons is

$$16.5 : 1.47 = 100 : 1.1 \quad (1)$$

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

From ir spectrum

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)

From nmr spectrum

Compound contains 3 proton environments (1)

Peak at 7.4 δ – aromatic ring (1)

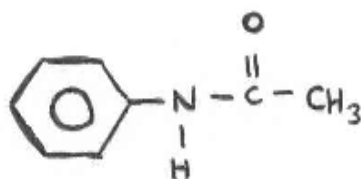
Peak at 2.1 δ – CH₃ (1)

Peak at 3.1 δ which disappears in D₂O – 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]

Page 9	Mark Scheme	Syllabus
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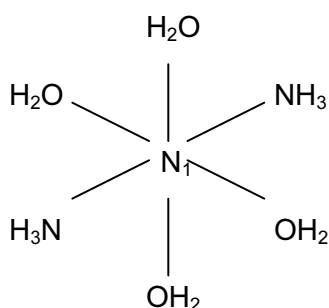
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Transition Elements

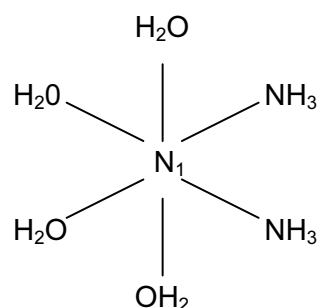
9. (a) $\text{Ni} + 4\text{CO} \rightarrow \text{Ni}(\text{CO})_4$ (1)
 $\text{Ni}(\text{CO})_4$ is a liquid and is purified by distillation (1)
 $\text{Ni}(\text{CO})_4 \rightarrow \text{Ni} + 4\text{CO}$ (1)
CO is recycled (1)
[4]

- (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)



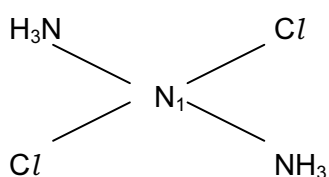
Trans



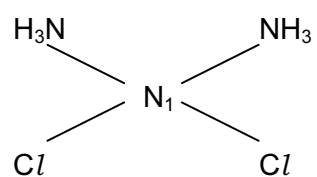
Cis

Octahedral

(2 x 1)



Trans



Cis

Square planar

(2 x 1)

[4]

Page 10	Mark Scheme	Syllabus
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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) $2\text{Cu}^+ \rightarrow \text{Cu}^{2+} + \text{Cu}$ (1)
 $E_{\text{cell}} = 0.52 - 0.15 = 0.37 \text{ V}$ (1)
[3]

- (c) (i) $\text{Cu}^{2+} + 2\text{I}^- \rightarrow \text{CuI} + \frac{1}{2}\text{I}_2$ (1)
white solid brown solution (1)
 $2\text{S}_2\text{O}_3^{2-} + \text{I}_2 \rightarrow \text{S}_4\text{O}_6^{2-} + 2\text{I}^-$ (1)
(ii) $\text{CuCl}_2 + 2\text{HCl} + \text{Cu} \rightarrow 2\text{H}[\text{CuCl}_2]$ (1)
or similar
Blue Cu^{2+} to colourless/white Cu^+ (1)
 $\text{HCuCl}_2 \rightarrow \text{CuCl} + \text{HCl}$ (1)
 $M_r \text{ CuCl} = 99$, hence $\frac{35.5}{99} = 35.9\%$ chlorine (1)
[6]

[10 max]