OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry

Advanced GCE **A2 7882**

Advanced Subsidiary GCE **AS 3882**

Mark Schemes for the Units

June 2006

3882/7882/MS/R/06

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Advanced GCE Chemistry (7882)

Advanced Subsidiary GCE Chemistry (3882)

MARK SCHEME ON THE UNITS

Mark Scheme 2811
June 2006

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
1 (a) (i)	(atoms of) same element/same atomic number/number of protons with different numbers of neutrons/diff masses ✓	**[1]**
(ii)	proton neutron electron relative mass 1 1 $\frac{1}{1840}$ / negligible ✓ relative charge +1 0 –1 ✓ *i.e. 1 mark for each correct row* *for electron, accept 1/1500 – 1/2000* *for charges, accept +; 0; –*	**[2]**
(b) (i)	average **atomic** mass/weighted mean/average mass ✓ compared with carbon-12 ✓ 1/12th of mass of carbon-12/on a scale where carbon-12 is 12 ✓	
	OR	
(ii)	The mass of 1 mole of **atoms** of an element ✓ compared with 12 g ✓ of carbon-12 ✓	**[3]**
	$A_r = \frac{(121 \times 57.21) + (123 \times 42.79)}{100}$ / 121.8558 ✓ = 121.9 ✓	**[2]**
(c) (i)	107° ✓ (accept any angle in the range 108° ⟶ 91°)	**[1]**
(ii)	electron pairs repel electron pairs/bonds go as far apart as possible✓ lone pairs repel more ✓	**[2]**
(d) (i)	Mass Sb_2S_3 in stibnite = 5% of 500 kg = 25.0 kg ✓ Moles $Sb_2S_3 = \frac{25.0 \times 10^3}{340}$ / 73.5/ 73.529 /73.53/ 74 mol ✓ (calculator value: 73.52941176) If 5% is not used, 1471 mol; ecf for 2nd mark (calculator value: 1470.588235) If 5% is used 2nd, 73.6 mol: OK for both marks	**[2]**
(ii)	moles Sb = 2 x 73.5 mol ✓ *ecf ans from (i) x 2* mass Sb = 2 x 73.5 x 122 g = 17.9 kg ✓ *ecf ans above x 2* If the 2 isn't used, answer = 73.5 x 122 = 8.95 ✓ OR % Sb = 244/340 = 71.7% ✓ mass Sb = 25.0 x 71.7/100 = 17.9 kg ✓ (ecf as above)	**[2]**
		Total: 15

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Question			**Expected Answers**	**Marks**
2	**(a)**	**(i)**	hydrogen / H_2 ✓	**[1]**
		(ii)	$Sr + 2H_2O \longrightarrow Sr(OH)_2 + H_2$ ✓	**[1]**
		(iii)	different numbers of moles/atoms/ different A_r values✓ so different number of moles of H_2 /more moles of Ca✓ *(i.e. an attempt to quantify difference)*	**[2]**
		(iv)	8–14 ✓	**[1]**
	(b)	**(i)**	$Ca^+(g) \longrightarrow Ca^{2+}(g) + e^-$ Equation with correct charges and 1 electron lost ✓ state symbols ✓ '–' not required on 'e'	**[2]**
		(ii)	same number of protons or same nuclear charge attracting less electrons/ electron removed from an ion/ less electron-electron repulsion (**not** less shielding)/ ion is smaller✓	**[1]**
		(iii)	atomic radii of Sr > atomic radii of Ca/ Sr has electrons in shell further from nucleus than Ca/ Sr has electrons in a higher energy level/ Sr has more shells ✓ Therefore less attraction ✓ Sr has **more** shielding than Ca ✓ (***'more'*** *is essential)* increased nuclear charge is outweighed / despite increased nuclear charge …..by at least one of the factors above ✓	**[3 max]**
				Total: 11

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Question	**Expected Answers**			**Marks**
3 **(a)**	attraction between oppositely charged ions/ oppositely charged atoms ✓			**[1]**
(b)	For CaO: correct dot and cross ✓; correct charges ✓ For CO_2: correct dot and cross ✓			**[3]**
(c)	$1s^2 2s^2 2p^6 3s^2 3p^6$ ✓			**[1]**
(d) **(i)**	Molar mass CaO = 56.1 (g mol^{-1}) ✓ (anywhere) moles CaO = $\frac{1.50}{56.1}$ = 0.0267/0.027 ✓ calc: 0.0267379 Allow 56 which gives 0.0268			**[2]**
(ii)	moles HNO_3 = 2 x 0.0267 = 0.0534 or 0.0535 /0.053 mol ✓ *(i.e. answer to (i) x 2)* volume of HNO_3 = $\frac{0.0534 \text{ (or 5)} \times 1000}{2.50}$ = 21.4 cm^3 ✓ calc from value above = 21.3903743 If 0.053 mol, answer is 21 cm^3 but accept 21.2 cm^3 If 0.054 mol, answer is 22 cm^3 but accept 21.6 cm^3			**[2]**
(e) **(i)**	dative covalent, bonded pair comes from same atom/ electron pair is donated from one atom/ both electrons are from the same atom ✓			**[1]**
(ii)	$Ca(NO_3)_2 \longrightarrow CaO + 2NO_2 + ½O_2$ ✓ *or double equation with 2/2/4/1*			**[1]**
				Total: 11

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Question	**Expected Answers**	**Marks**
4 (a) (i)	203.3 g mol^{-1} ✓ Accept 203	**[1]**
(ii)	white precipitate / goes white ✓	**[1]**
(iii)	$Ag^+(aq) + Cl^-(aq) \longrightarrow AgCl(s)$ equation ✓ state symbols ✓	**[2]**
(iv)	AgCl dissolves in $NH_3(aq)$ ✓ AgBr dissolves in **conc** $NH_3(aq)$/ partially soluble in $NH_3(aq)$ ✓ AgI insoluble in $NH_3(aq)$ ✓	**[3]**
(b)	Cl_2: 0 ✓ HOCl +1 ✓ HCl −1 ✓	**[3]**
(c)	Tap water contains chloride ions ✓	**[1]**
		Total: 11

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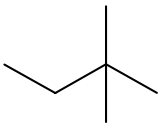
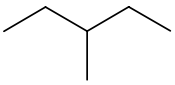
Question	**Expected Answers**	**Marks**
5	High boiling point **or** difficult to break linked to strong bonds in the right context within Li **or** C ✓	**[1]**
	Li conducts by delocalised/free/mobile electrons ✓ structure: giant ✓metallic ✓ or '+ ions with a sea of electrons' for giant mark'	**[3]**
	C conducts by delocalised/free/mobile electrons ✓ structure: giant ✓covalent ✓ with layers ✓	**[4]**
	N No mobile charge carriers/electrons/ions to conduct electricity ✓ simple molecular structure/made of N_2 molecules✓ low boiling point **or** easily broken due to intermolecular forces/ van der Waals' forces ✓	**[3]** **Sub-Total: [11]**
	QWC: At least 2 complete sentences in which the meaning is clear. ✓	**[1]**
		Total: 12

Mark Scheme 2812
June 2006

1(a) octane, 400 +/- 5 ✓
hexadecane. 545 +/- 5 ✓
if ^{o}C penalise once.

(b) fractional distillation ✓

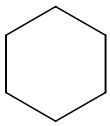
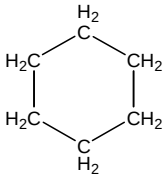
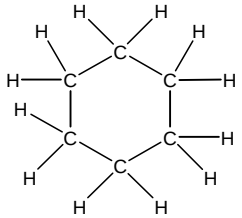
(c) (i)  ✓  ✓

(ii) 2-methylpentane ✓

(iii) **C**, **B** and **A** ✓

(iv) the more branching/the shorter the chain… the lower the boiling point/less energy needed to separate the molecules ✓

long chain have greater surface area/surface interactions/more VdW forces or converse argument about short/branched chains. ✓

(d) (i) not just C_6H_{12}  or  or 

(ii) $C_6H_{14} \longrightarrow C_6H_{12} + H_2$ ✓

(iii) <u>better</u> fuels/<u>more</u> volatile/<u>lower</u> boiling point/reduces knocking/increases octane rating/used as (petrol) additives ✓

(e) (i) M_r of $(CH_3)_3COH = 74$ ✓

% oxygen = (16/74) x 100 = 21.6 % ✓

(ii) $(CH_3)_3COH + 6O_2 \longrightarrow 4CO_2 + 5H_2O$ ✓✓
1 mark for CO_2 and H_2O only

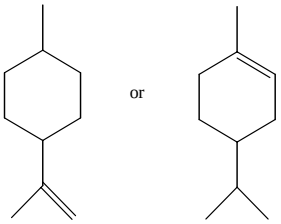
[Total: 16]

2(a) (i) C_5H_8 ✓

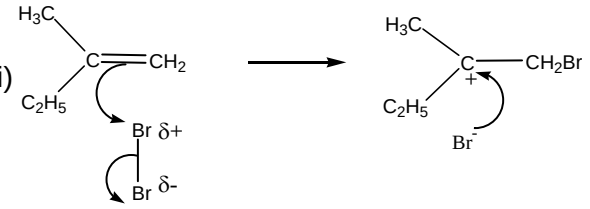
(ii) C_5H_8 ✓

(b) (i) Ni/Pt/Pd ✓

(ii) 1 mark for C_5H_{12} ✓
1 mark for correct balancing ✓

(iii)  ✓

(c) (i) electron/lone pair acceptor ✓

(ii) 

curly arrow from π-bond to $Br^{\delta+}$ ✓

dipoles on the Br–Br bond
and ✓
curly arrow from Br–Br bond to $Br^{\delta-}$

curly arrow from Br^- to C^+ ✓

[Total: 10]

3(a) (i) M_r of 2-methylpropan-1-ol = 74 ✓

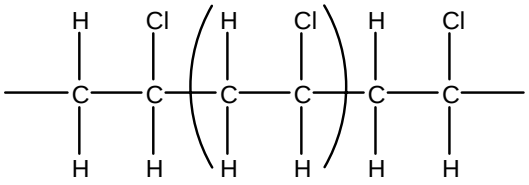
moles = 4.44/74 = 0.06 ✓

(ii) moles = 5.48/137 = 0.04 ✓

(iii) 66.7% ✓

(b) (i) correctly shows three repeat units with 'end bonds' ✓

correctly identifies the repeat unit ✓



(ii) harmful/toxic fumes are produced ✓

(iii) recycle/remove HCl by using gas scrubbers or wtte/crack polymers/used as feedstock/ source of fuel (in an incinerator)/developing biodegradable alternatives. ✓✓

(c) The C–Halogen bond most likely to be broken is **C–Br** because it is the weakest bond ✓

[Total: 10]

4(a) (i) $Cl_2 \longrightarrow 2Cl\bullet$ ✓

(ii) uv (light)/high temperature/min of 400 ^{o}C/sunlight ✓

(iii) $Cl\bullet + C_6H_{12} \longrightarrow C_6H_{11}\bullet + HCl$ ✓

$C_6H_{11}\bullet + Cl_2 \longrightarrow C_6H_{11}Cl + Cl\bullet$ ✓

(iv) react with each other/suitable equation ✓

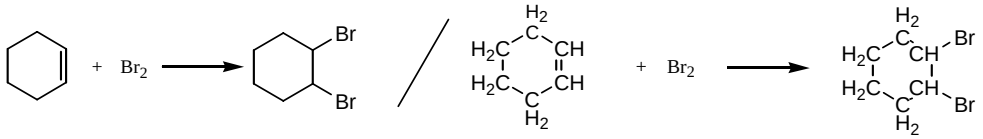
solvent **W** = water/aqueous/aqueous ethanol ✓

solvent **X** = ethanol/alcohol ✓

(c) (i) <u>continuous</u> evaporation & condensation/ heating without loss of volatile components ✓

(ii) there is **<u>not</u>** a absorption between 3230–3550 (cm^{-1}) ✓
don't allow 2500–3300 cm^{-1}

(iii) Br_2 and decolourised/not clear/not discoloured ✓



✓

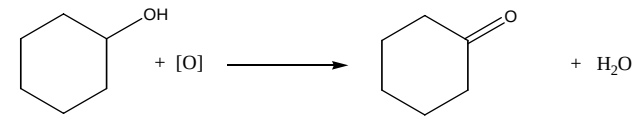
$C_6H_{10} + Br_2 \longrightarrow C_6H_{10}Br_2$

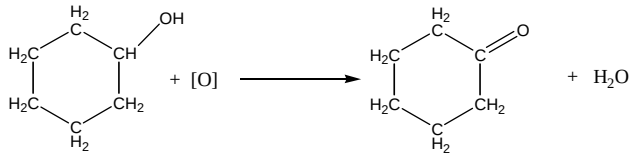
(d) (i) H_2SO_4 – any mention of (aq) loses the mark ✓

(ii) any correct formula/structure or name for benzoic acid ✓

(e) (i) dichromate/$Cr_2O_7^{2-}$/permanganate ✓

(ii)





✓

$C_6H_{12}O + [O] \longrightarrow C_6H_{10}O + H_2O$

[Total: 13]

5. Structural/chain/positional isomers have the same molecular formula, different structure ✓

but-1-ene/ but-2-ene/ methylpropene / cyclobutane/ methylcyclopropane
(any three or two with correct structures and names) ✓✓✓

4 marks for structural isomerism

Cis-trans /geometric isomerism ✓

cis & *trans* but-2-ene clearly identified ✓

C=C prevents rotation ✓

each C in the C=C double bond must be bonded to two different atoms or groups ✓

4 marks for cis-trans isomerism

QWC: Well organised answer making use of correct terminology to include any **three** from: structural, geometric, *cis-trans*, molecular formula, restricted, rotation, stereoisomerism, stereoisomers, chain isomerism, positional isomerism, if all isomers are correctly named ✓

[Total: 9]

Mark Scheme 2813/01
June 2006

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Question	**Expected Answers**			**Marks**
1(a)	CO from incomplete combustion/ insufficient oxygen ✓ NO from nitrogen and oxygen in **the air** ✓			**2**
(b)(i)	ClO + **O** → Cl + O_2 ✓			**1**
(ii)	O_3 + O → $2O_2$ ✓			**1**
(iii)	effect of uv radiation/ homolytic fission/ effect of sunlight ✓ on CFCs/ on chlorocarbons ✓			**2**
(iv)	increase (skin cancer) ✓			**1**
				Total: 7

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Question	**Expected Answers**	**Marks**
2(a)(i)	to break a bond energy has to be put in/ ✓ breaking bonds is endothermic	**1**
(ii)	energy needed to break 1 mole **of bonds** ✓ in the **substance** in the gaseous state ✓	**2**
(iii)	bonds broken: 3(C–H) + (C–O) + (O–H) + 1½ (O=O) = 2781 kJ ✓ bonds made: 2(C=O) + 4(O–H) = 3470 kJ ✓ ΔH_c = – 689 ✓ (kJ mol^{-1})	**3**
(iv)	actual bond enthalpies may be different from average values ✓ conditions are not standard / methanol/ water is a liquid under standard conditions ✓	**2**
(b)(i)	more CO and H_2/ less CH_3OH/ moves to LHS ✓ reaction is exothermic/ ora ✓ (moves in endothermic direction scores 1) less CO and H_2/ more CH_3OH/ moves to RHS ✓ more mole/molecules/particles on LHS/ ora ✓	**4**
(ii)	more particles per unit volume/ increased concentration/ particles closer together ✓ more collisions **and** increases rate✓	**2**
(iii)	heterogeneous ✓	**1**
(iv)	none ✓ affects forward and reverse reaction the **same** ✓	**2**
		Total: 17

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Question	**Expected Answers**			**Marks**
3(a)	the statement is true because there are more collisions (as temperature increases) ✓ increase in temperature increases the velocity/ energy of particles ✓ rate increases (with increase in temperature) more than can be explained by this/ **but** not all collisions are successful ✓ to be successful collisions must exceed E_a ✓ if temperature increased higher proportion of collisions exceed E_a ✓			**5**
(b)(i)	*y* axis: fraction/ number of particles/ molecules/ atoms ✓ *x* axis: energy/ velocity ✓			**2**
(ii)	line labelled T_2 with higher maximum ✓ maximum to LHS of original line ✓ (must start at 0.0, be below original curve at higher energies, cut the other curve only once and not cross the *x* axis)			**2**
				Total: 9

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Question	**Expected Answers**			**Marks**
4(a)(i)	(enthalpy/ energy change) when 1 mole of substance/compound formed ✓ from its elements ✓ under standard conditions ✓ (if conditions quoted must be correct – 25 ^{o}C/298 K, 1 atm/100 kPa/101 kPa)			**3**
(ii)	$Mg(s) + N_2(g) + 3O_2(g) \rightarrow Mg(NO_3)_2(s)$ balanced species ✓ state symbols ✓			**2**
(iii)	cycle ✓ $x - 791 = -602 - 2(33)$ ✓ $x = 123$ ✓			**3**
(b)(i)	a proton donor ✓			**1**
(ii)	solid disappears/ dissolves / colourless solution forms ✓			**1**
(iii)	$MgO + 2HCl \rightarrow MgCl_2 + H_2O$ ✓			**1**
(iv)	$MgO + 2H^+ \rightarrow Mg^{2+} + H_2O$ ✓			**1**
				Total: 12

Mark Scheme 2813/03
June 2006

PLAN Skill P: 16 marks (out of 19 available)

A Gravimetric method – 6 marks

A1 Known/weighed mass of hydrated sodium carbonate is [heated] in a crucible [1]

A2 Heat gently at first ***and*** reason (to avoid spitting/frothing)
OR heat gently at first ***then*** heat more strongly
OR heat gently to avoid decomposition of residue [1]
No penalty for not removing lid

A3 Allow residue to cool with lid on (*specific statement*) the crucible ***or*** in a desiccator
OR Cool residue before weighing so that convection currents don't affect the reading [1]

A4 Weigh after cooling to obtain mass of anhydrous residue [1]
A4 can only be awarded if the residue is indicated to be the anhydrous salt

A5 Heat to constant mass to ensure complete reaction/dehydration [1]
Reason is required. No detail of constant mass procedure required

A6 Repeat **whole** procedure ***and*** take mean of readings
OR repeat procedure until consistent data is obtained [1]

B Titration – 5 marks

In a description of a back-titration marking points B2 and B4 are NOT available

B1 Known mass of hydrated sodium carbonate used
and solution made up in volumetric flask with distilled water [1]

B2 Titrates with specified acid of stated concentration [1]
Concentration of acid must lie between 0.02 and 0.5 mol dm^{-3}

B3 Pipette alkali into conical flask/beaker ***and*** put acid in burette (***or*** *vice versa*) [1]

B4 Named indicator ***and*** correct final colour [1]
Note: *Phenolphthalein is* ***not*** *suitable*
Methyl orange orange/red/pink (acid in burette) or yellow/orange (alkali in burette)
Screened methyl orange goes light purple/grey (in either direction)
Methyl red goes red (if acid in burette) or orange/yellow (alkali in burette)

B5 Obtains two consistent/concordant/identical readings/within 0.1 cm^3
and Trial/first titration done ***or*** dropwise approach to end point outlined [1]

C Calculations – 4 marks

C1 Equation for reaction of sodium carbonate with chosen acid
$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$
or $Na_2CO_3.xH_2O + 2HCl \rightarrow 2NaCl + CO_2 + (x + 1)H_2O$ [1]
Do NOT award mark C1 if there are any ICT errors (such as HCL or CO2)

C2 Researches the value of ***x*** = 10 and uses M_r approx. 286 in calculation [1]

C3 Specimen calculation of quantities suitable for the titration procedure:
a suitable mass of hydrated Na_2CO_3 to titrate with the acid of concentration specified
or a suitable concentration/volume of acid to react with carbonate [1]

C4 Shows clearly and correctly how ***x*** is calculated from gravimetric data [1]
The specimen calculation must begin with the weighings recorded

S Sources *etc*. – 4 marks

S1 Researches hazard of sodium carbonate ***and*** states a safety precaution [1]
[Solid] sodium carbonate is irritant
Accept routine precautions – safety specs, lab coat, gloves – linked to hazard

S2 Two secondary sources quoted in the text ***or*** as footnotes ***or*** at end of plan. [1]
Book references must have chapter or page numbers
Internet reference must go beyond the first slash of web address
*Accept **one** specific reference to 'Hazcards'*
*Allow one reference to a specific OCR past paper (but **not** to teaching notes etc.)*

S3 **QWC**: text is legible ***and*** spelling, punctuation and grammar are accurate [1]
*Award S3 if there are fewer than **six** errors in legibility, spelling, punctuation or grammar.*
Penalise a repeated error only once: mis-spelling of the same word is one error.

S4 **QWC**: information is organised clearly and coherently [1]
Can you say 'yes' to all three of the following questions?
- *Is a word count given and within the limits 450–850 words?*
- *Is scientific language used correctly – allow one error without penalty.*
  Is there a terminology error – e.g. 'burn' for 'heat'
  Is there an incorrect chemical formula in the text (e.g. $NaCO_3$)?
  If units are quoted are they [normally] correct? (e.g. mol dm^3)
- *Are the descriptions of both procedures presented logically?*

TEST

Page 3: Part 1 (7 marks)

Table drawn showing all pairs of four readings [1]
Table must have some grid lines, and suitable labelling in words

Two sets of temperature readings clearly shown ***and*** unit shown at least once [1]
*All four temperatures must be recorded to **one** decimal place*

Two pairs of mass readings, to at least 0.01 g, recorded, with unit shown at least once [1]

Mean temperature rise ***and*** mean mass worked out correctly [1]
Mean mass must be recorded to 2 decimal places (or as for masses in the table)

Accuracy of candidate's mean temperature rise [3]
Accuracy marks awarded by comparison with the supervisor's mean temp. rise

- ***Give 3** marks if candidate's mean is within 1.0 ^{o}C of supervisor's mean temp. rise*
- ***Give 2** marks if candidate's mean is within 1.5 ^{o}C of supervisor's temp. rise*
- ***Give 1** mark if candidate's mean is within 2.5 ^{o}C of supervisor's temp. rise*

Page 4 (4 marks)

(a)(i) Heat produced = mass of water x shc x <u>temperature rise/change</u> [1]

(a)(ii) Heat produced correctly calculated [1]
Sig. fig. errors in calculations are penalised once only in Part One

(b) M_r of sodium carbonate = 106 [1]

n(sodium carbonate) = $^{\text{mass used}}/_{106}$ [1]
Answer should be to 3 sig fig.

Page 5 (4 marks)

(c)(i) $Na_2SO_4 + CO_2 + H_2O$ shown [1]

State symbols: (aq), (g) and (l) given in equation. [1]
State symbols mark is conditional on formulae being correct

(c)(ii) Method of calculating enthalpy:
divide by 1000 ***and*** divide by number of moles of carbonate from (b) [1]
This is a 'method' mark.

Enthalpy change correctly calculated with <u>negative</u> sign ***and*** to 2 or 3 sig. fig. [1]
Apply ecf between parts of all calculations.

Page 6: Part 2 (6 marks)

Two initial and final temperatures shown, labelled clearly, with unit, at least once
and subtractions ***and*** mean are both correct [1]
Do not penalise absence of unit if this has already been penalised in part 1

Two initial and final masses shown, to 2 (or more) decimal places, labelled clearly with unit
and subtractions correct ***and*** mean is correct [1]
Do not penalise absence of unit if this has already been done in part 1

Both of the candidate's correct temperature drops are within 0.5 ^{o}C of each other [1]

Accuracy of candidate's mean temperature drop [3]

- *Give **3** marks if candidate's mean is within 0.8 ^{o}C of supervisor's mean*
- *Give **2** marks if candidate's mean is within 1.3 ^{o}C of supervisor's mean*
- *Give **1** mark if candidate's mean is within 1.8 ^{o}C of supervisor's mean*

If candidate did only one reading use it to assess the accuracy mark.

Page 7 (4 marks)

(a) Correct answer scores the mark [1]

(b) n(hydrated sodium carbonate) = $^{mass}/_{286}$ [1]
*This is a **method** mark for calculating the number of moles*

Correct numerical value for ΔH calculated by candidate [1]

ΔH quoted <u>without</u> a negative sign ***and*** to 2 or 3 sig. fig. [1]
This mark is dependent on award of the previous one

Page 8: Part 3 (5 marks)

(a) Two <u>downward</u> arrows linking top boxes with products [1]

Left downward arrow labelled with ΔH(anhydrous) from Part 1 (or –20.6)
and right downward arrow labelled with ΔH(hydrated) from Part 2 (or +27.5) [1]
Mark is for correct labelling of arrows, in the direction drawn by the candidate.

(b) Enthalpy change for hydration = ΔH(part 1) – ΔH(part 2) [1]
If the arrows on Hess diagram are wrong, mark ecf to the diagram
Negative sign (if appropriate) must be included

(c) The acid is corrosive *or* causes burns/blisters [1]

Wash with <u>plenty</u> of water ***or*** wash under tap for several seconds [1]
Idea of lots of/running water is required.

Page 9: Part 4 **(14 marks, maximum)**

When awarding a mark, put the code letter in the margin
Write the page total (unringed) at the foot of each page

(a) **4 marks available**

Ground-up solid has larger surface area [1]

Frequency of collisions [between acid and solid] will increase [1]

Rate of reaction will increase [1]

Faster rate means less opportunity for heat gain/exchange
or faster rate means that reaction will froth too much/cause too much spray [1]
A4 is for stating the advantage or disadvantage of having a faster rate

(b) **9 mark**s

*Mark the candidate's **best three** strands (from the five suggested below)*

1 Heat losses/gains [1]

Conduction *or* convection *or* evaporation of water/acid [1]

Remedy: use a lid ***or*** use a thermos/ Dewar/ vacuum flask [1]
Also accept a clear reference to plotting a cooling curve

2 Loss of [acid] spray during reaction [1]

Use a lid ***or*** use a larger container [1]

A valid method of slowing the reaction down [1]

3 Do extra/further repeats [1]

Obtain a consistent temperature change *or* ignore anomalous results [1]
or a comment that readings obtained were consistent *(if true!)*

Consistent readings are evidence of reliability [1]

4 Thermometer is inaccurate ***or*** should be more accurate ***or*** only calibrated to 1 ^{o}C [1]

High percentage error in readings [1]

Use a thermometer that is more accurately calibrated/ calibrated to 0.1or 0.2 ^{o}C [1]

5 Mixture still fizzing when maximum/minimum temperature recorded [1]

Shows that reaction was still taking place
or shows that more heat was being produced/absorbed [1]

Use [a greater] excess of acid
or use [the same volume of] more concentrated acid [1]

(c) **1 mark**

Heat loss ***or*** inaccuracy in thermometer is main error [1]
Answer must relate to strands 1 or 4

(d) **4 marks, maximum**

The product of the reaction is a solid [if correct amount of water is used] [1]

So, there would be no liquid water to dip the thermometer in [1]

Direct hydration reaction is very exothermic ***or*** a lot of heat is produced [1]

This might cause some water to evaporate/steam to be released [1]

Some of the product would dissolve in the water [if too much H_2O was used] [1]

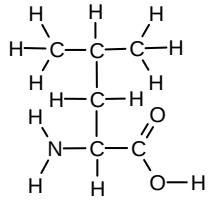
Then the heat change measured would not correspond to formation of solid product [1]

You cannot easily tell if the reaction is complete
or water may not completely hydrate the anhydrous solid [1]

Mark Scheme 2814
June 2006

1 (a)(i) *$RCH(NH_2)COOH$* ✓ — *allow groups R, CH, NH_2, COOH in any order* **[1]**

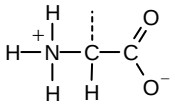
(ii) *any unambiguous structure, e.g.:*



✓ **[1]**

(b)(i) *molecule/ion/'it' has both + and – charges* **[1]**

(ii) *description or diagram to show proton/H⁺ transfer from COOH to NH_2* ✓ — ***NOT*** *just 'hydrogen' transfer*



✓ **[2]**

(c)(i) *heat/warm/reflux* ✓

named strong acid/base
an enzyme (which need not be named) ✓ — ***NOT*** *conc HNO_3 or conc H_2SO_4* **[2]**

(ii) *hydrolysis* ✓ **[1]**

(d)(i) *(ethanolic) ammonia* ✓ **[1]**

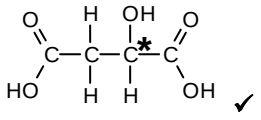
(ii) *any mention of chiral / optical isomers* ✓

leucine synthesied in the laboratory
contains a mixture of (two optical) isomers ✓

leucine from meat/natural source
contains only one (optical) isomer ✓ **[3]**

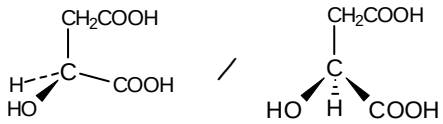
[Total: 12]

2 (a)(i)



✓ **[1]**

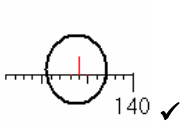
(ii) *structure with correct use of at least two 3-D bonds ✓ – e.g.*



*allow ecf if lactic acid is labelled in **(i)***

***NOT** if all four bond angles at 90°* **[1]**

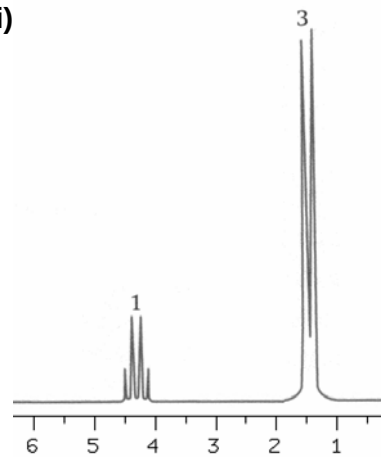
(b)(i)



✓ **[1]**

(ii) *90 ✓* **[1]**

(c)(i)



splitting:
doublet ✓
quartet ✓

position:
doublet peak is at ~1.4 and quartet peak is at ~4.3 ✓

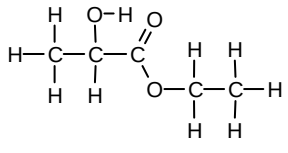
areas:
1 and 3 on the correct peaks (or either way round as ecf if any errors above) ✓

ignore any other peaks

*allow ecf from **one** incorrect splitting pattern*

(ii) *4 ✓*
OH/labile protons now visible **AW** ✓ **[2]**

(d)(i)



✓ **[1]**

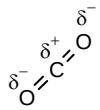
(ii) *any sensible change in flavour linked to the presence of the ester or loss of the acid ✓ – e.g.*
'more fruity due to the ester'
'less sour as acids get used up' **[1]**

[Total: 12]

3 (a)(i) *NaOH / Na* ✓ **[1]**

(ii) $C_6H_5OH + NaOH \longrightarrow C_6H_5O^-Na^+ + H_2O$ /
$C_6H_5OH + Na \longrightarrow C_6H_5O^-Na^+ + \frac{1}{2}H_2$ ✓ **[1]**

(b)(i)

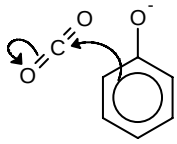


✓

allow a dipole on just one C=O bond

[1]

(ii)



✓✓ **[2]**

(iii) *lone/electron pair from oxygen is delocalised into the ring /interacts with π-electrons* ✓

increases π-electron density / negative charge (around the ring) ✓

attracts electrophiles more ✓ **[3]**

(c) M_r *salicylic acid = 138* ✓

moles (in 1:1 reaction) = 3500 x 10^6 /138 = 2.536 x 10^7 ✓

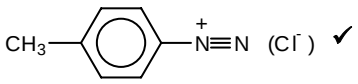
mass of phenol needed = 2.536 x 10^7 x 94 = 2384 tonnes ✓

allowing for 45% yield = 2384 x $^{100}/_{45}$ = ***5298/5300*** *(tonnes)* ✓ *allow 5297.5–5300*

allow ecf throughout **[4]**

[Total: 12]

4 (a)(i) *nitrous acid / HNO_2* **[1]**

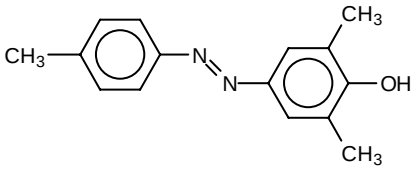
(ii)  ✓

[1]

(iii) *diazonium (ion /salt)* ✓ **[1]**

(iv) *to prevent decomposition / it reacting (diazonium ion) is unstable* **AW** **[1]**

(v) *structure showing the amine coupled to the phenol or its salt – e.g.*



–N=N– ✓ *rest of structure (joined by two nitrogens)* ✓ **[2]**

(b) methylation stage (can come anywhere)
CH_3Cl / CH_3Br ✓
$AlCl_3$ / $FeBr_3$ etc. ✓
equation – e.g. $C_6H_6 + CH_3Cl \longrightarrow C_6H_5CH_3 + HCl$ ✓
intermediate name or unambiguous structure ✓
4 marks

intermediates and equations will vary if methylation is done after nitration or reduction

nitration stage
(conc) H_2SO_4 ✓
(conc) HNO_3 ✓
equation – e.g.: $C_6H_5CH_3 + HNO_3 \longrightarrow C_6H_4(CH_3)NO_2 + H_2O$ ✓
intermediate – name or unambiguous structure ✓
4 marks

reduction stage
tin/iron ✓
HCl ✓
equation – e.g.: $C_6H_4(CH_3)NO_2 + 6[H] \longrightarrow C_6H_4(CH_3)NH_2 + 2H_2O$
or with H^+ *also on left to give* $C_6H_4(CH_3)NH_3^+$ ✓
3 marks

allow other suitable reducing agents:

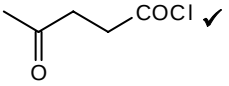
Quality of Written Communication *mark for a well organised answer with the three stages clearly distinguished and sequenced* ✓
1 mark

[12]

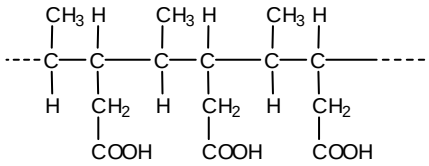
[Total: 18]

5 (a)(i) *$NaBH_4$* ✓ **[1]**

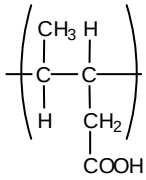
(ii) *4-hydroxypentanoic acid* ✓ **[1]**

(iii) *any correct structure – e.g.*  ✓ **[1]**

(b)(i) *section of the polymer* ✓ *– e.g.*

 **[1]**

(ii) *a correct repeat shown* ✓ *– e.g.*



allow ecf from ***(i)*** *only if the repeat is every 2 carbons along the chain and has a COOH*

[1]

(c)(i) *$C_7H_{12}O_3$* ✓ **[1]**

(ii) *$C_7H_{12}O_3$ + **$8\frac{1}{2}O_2$** ⟶ **$7CO_2$** + **$6H_2O$** or ecf from* ***(i)***)
formulae ✓
balancing ✓ **[2]**

(iii) *idea of providing oxygen /*
reducing incomplete combustion **AW** ✓ **[1]**

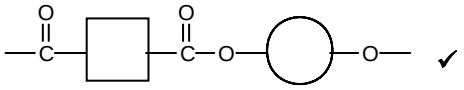
(d)(i) *heat/warm/reflux* ✓
NaOH / KOH(aq) ✓ **[2]**

(ii) ***G*** *is an ester / sensible argument based on polarity* ✓ **[1]**

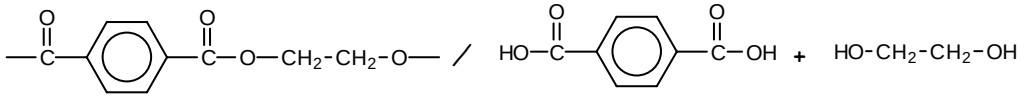
[Total: 12]

6 (a)(i) *(question wording unclear – ignore response and credit the mark)* **[1]**

(ii) *attempt at a polymer containing an ester link* ✓

correct repeat of any polyester of the form:  ✓

repeat unit ***or*** *monomers are correct for Terylene* ✓ *– i.e.*



(allow correct names of the monomers) **[3]**

(b) **polymer P**
contains C=O ✓
is Terylene ✓

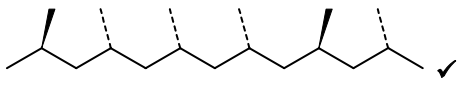
ignore the C–O bond range for ***P***

polymer R
has no O–H / peak at 3230–3550 /
has no C–O / peak at 1000–1300 ✓
is a hydrocarbon ✓
any 3 out of 4 marks **[3]**

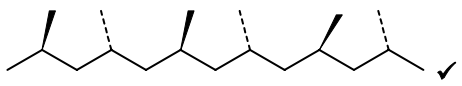
(c) *poly(phenylethene) / polystyrene* ✓ **[1]**

(d) ***atactic*** *= random (or shown by diagram)* ✓
syndiotactic *= alternating (or shown by diagram)* ✓

correct diagram of poly(propene) showing side chains randomly arranged along the chain – e.g.

 ✓

correct diagram of poly(propene) showing side chains alternating along the chain – e.g.

 ✓

correct use of 3-D bonds (on at least one diagram) ✓

allow formulae also showing H atoms (but then needs two 3-D bonds on each carbon for the last mark)

[5]

[Total: 13]

7 **π-bonding in the carbonyl group**

overlap of p-orbitals (or shown in diagram) ✓

description of π-bond above and below C–O /shown in diagram – e.g.  ✓

2 marks

reactivity with electrophiles and nucleophiles

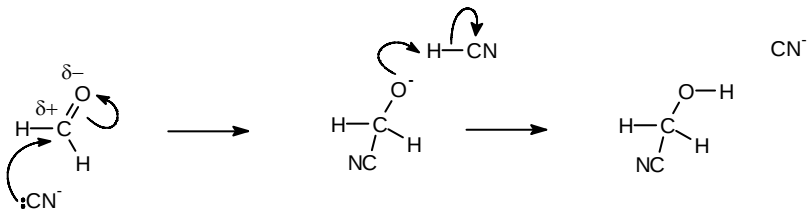
C is δ^+ / description of polarisation of C=O ✓

electrophiles will be repelled / nucleophiles will be attracted by the $C^{\delta+}$ **AW**
or
idea that π-bond electrons are unavailable (due to the polarisation) ✓
2 marks

[4]

mechanism

CN^- or other suitable nucleophile chosen (allow H^-, OH^-, NH_3, H_2O etc.) ✓
– e.g.



curly arrow from correct atom of nucleophile to carbonyl C ✓
polarisation of $C^{\delta+}=O^{\delta-}$ ***and*** *curly arrow from π-bond to O* ✓

structure of the correct intermediate (from methanal) ✓
curly arrow from O^- to H^+ (or the H of H–CN or other suitable donor – e.g. H_2O) ✓

correct organic product (or ecf if a carbonyl other than methanal) ✓
6 marks

[6]

Quality of Written Communication *mark for at least two legible sentences with correct spg that attempt to answer the question* ✓

[1]

[Total: 11]

Mark Scheme 2815/01
June 2006

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument		
Question	**Expected Answers**	**Marks**	**Additional guidance**
1 (a)	Atomisation of Na = (+)218 / 2 × (+) 109 (1); Ionisation of Na = (+)990 / 2 × (+)495 (1); Any other two correct enthalpy changes (1); Last two correct enthalpy change (1)	4	
(b)	–791 + 141 – 247 – 990 – 218 – 416 (1); –2521 (1)	2	**Allow** ecf from part (a) *e.g.* –2026 if only 1 mole of Na → Na^+ –2412 if only 1 mole of Na (s) → Na (g) –1917 if only 1 mole of Na throughout **Allow** full marks for –2521 with no working out
(c)	Calcium chloride (1) And Br^- has larger ionic radius than Cl^- / Br^- has lower charge density than Cl^- / ora (1); K^+ has a lower charge than Ca^{2+} / K^+ has lower charge density than Ca^{2+} / K^+ has a larger ionic radius than Ca^{2+} / ora (1); Strongest attraction between ions (when smallest radius and highest charge) / strongest attraction between ions (with the highest charge density) / ora (1)	4	If wrong salt chosen **maximum of 2 marks** (the comparison of the ions) **Not** Br has larger radius **Not** K has lower charge **Not** K^+ has larger atomic radius **Penalise** use of atoms rather than ions just once in this question
		Total = 10	

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Question	**Expected Answers**	**Marks**	**Additional guidance**
2 (a)	Zn^{2+} is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$ and Cu^{2+} is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$ (1); Copper has at least one ion with an incomplete filled d-orbital (zinc does not) / copper(II) ion has an incomplete set of d electrons (zinc ion does not) / copper(II) ion has an incomplete d sub-shell (zinc ion does not) / ora (1)	2	**Allow** Zn^{2+} $[Ar]3d^{10}$ and $Cu^{2}{}_{+}$ $[Ar]3d^9$
(b)	Cu^{2+} compounds are coloured but Zn^{2+} compounds are not (1); Cu^{2+} compounds may be catalytic but Zn^{2+} compounds are not (1)	2	**Allow** Cu^{2+} forms complexes but Zn^{2+} does not **Allow** correct chemistry of Cu^{2+} compared to Zn^{2+} *e.g.* Cu^{2+} and NaOH gives blue ppt but Zn^{2+} gives white ppt (that redissolves in excess)
(c)	Moles of hydrogen = 3.17×10^{-3} / moles of zinc = 3.17×10^{-3} (1); Mass of zinc = 0.207 g / moles of zinc × 65.4 (1); Percentage of copper = 83.2 (1)	3	**Not** 3×10^{-3} **Not** 0.2 **Allow** ecf Final answer must be to **3 or 4 sig figs** **Penalise** significant figures just **once** **Allow** values between 82.9–83.2
		Total = 7	

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument		
Question	**Expected answers**	**Marks**	**Additional guidance**
3 (a) (i)	$Cu \rightarrow Cu^{2+} + 2e^-$ / $Cu - 2e^- \rightarrow Cu^{2+}$ (1)	**1**	
(ii)	$2Cu + O_2 + 4H^+ \rightarrow 2Cu^{2+} + 2H_2O$ (1)	**1**	**Allow** any correct multiple **Allow** ecf from (a) (i)
(b)	M_r of $[Cu(CH_3COO)_2]_2.Cu(OH)_2$ = 460.5 (1) Molar ratio $[Cu(CH_3COO)_2]_2.Cu(OH)_2 : H_2O$ is 0.182 : 0.906 (1) x = 5 (1)	**3**	**Allow** ecf from wrong M_r **Not** full marks for 5 with no working out
		Total = 5	

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument		
Question	**Expected Answers**	**Marks**	**Additional guidance**
4 (a)	2 sodium ions with either 0 electrons or 8 electrons in the outer shell and oxide ion with 8 electrons in the outer shell (1); Correct charge on ions Na^+ and O^{2-} (1)	2	**Ignore** inner electrons Sodium electrons must **not** be shown twice
(b) (i)	MgO has (electrostatic) attraction between ions (1) This attraction is very strong – dependant on the correct force of attraction in MgO (1)	2	**Allow** strong ionic bonds / giant ionic (1)
(ii)	Magnesium hydroxide **with** pH 8–13 (1)	1	**Allow** milk of magnesia
(iii)	$2H^+(aq) + MgO(s) \rightarrow H_2O(l) + Mg^{2+}(aq)$ Balancing (1); Correct state symbols (1)	2	State symbols mark **dependant** on the correct formulae Spectator ions should only be **penalised once** *i.e*. allow state symbol marks
(c)	$2Al + 1½O_2 \rightarrow Al_2O_3$ (1)	1	**Allow** any correct multiple of the equation **Ignore** state symbols
(d)	**Any two from** Does not conduct electricity (when molten) (1) Insoluble in water (1) High melting point / high boiling point (1) (Extremely) hard (1)	2	**Ignore** transparent **Ignore** strong
(e)	Reacts with alkalis / reacts with water to give an acid / $Cl_2O_7 + H_2O \rightarrow 2HClO_4$ / strong oxidant (1)	1	**Allow** an acidic oxide **Not** is an acid / is acidic
(f)	Products sodium hydroxide, magnesium hydroxide and hydrogen (1); Reaction with sodium much faster / aw / sodium moves on top of water but magnesium sinks to bottom (1)	2	**Allow** NaOH and $Mg(OH)_2$
		Total = 13	

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Question	**Expected answers**	**Marks**	**Additional guidance**
5	**Ligand substitution** Suitable example *e.g.* reaction of thiocyanate ions with hexaaquairon(III) to give $[Fe(H_2O)_5(CNS)]^{2+}$ (1); Observations *e.g*. formation of a blood-red colour (1) Suitable equation *e.g*. $[Fe(H_2O)_6]^{3+} + CNS^- \rightarrow [Fe(H_2O)_5(CNS)]^{2+} + H_2O$ (1) **Precipitation** Suitable example *e.g*. reaction between (aqueous) iron(II) chloride with (aqueous) sodium hydroxide (1); Observations *e.g*. formation of a green precipitate / formation of a green solid (1) Suitable equation *e.g*. $Fe^{2+}(aq) + 2OH^-(aq) \rightarrow Fe(OH)_2(s)$ (1) **Redox** Suitable example *e.g*. oxidation of iron(II) chloride by chlorine to make iron(III) chloride (1) Observation *e.g*. green solution becomes yellow / rust solution (1) Suitable equation e.g. $2FeCl_2 + Cl_2 \rightarrow 2FeCl_3$ (1) **And QWC** One mark for correct spelling, punctuation and grammar in at least two sentences (1)	10	Suitable example can be awarded from an equation Equations do not need state symbols Precipitate can be awarded state symbol in equation Other examples could include iron and chlorine to make iron(III) chloride / iron and HCl to make $FeCl_2$ / MnO_4^- and Fe^{2+} to make Fe^{3+} Answer must address the question
		Total = 10	

Mark Scheme 2815/02
June 2006

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1(a)(i)	Any one between N–H and O=C on separate chains.✓ The link may be a solid line.	**1**
(ii)	(Alpha) helix ✓ and (beta) pleated sheet✓.	**1**
(b)(i)	Any two of disulphide bridges Ionic attraction ✓✓ van der Waals/IDID (not hydrophobic) Dipole–dipole Accept a diagram if given.	**2**
(ii)	Between like charges(*e.g*. COO^- and COO^-) ✓. AW	**1**
(iii)	Low pH turns COO^- to COOH✓. High pH turns NH_3^+ to NH_2 ✓. In each case ionic attractions are destroyed✓. If they get the pH the wrong way round then ecf on their second example. If they do not specify pH then max. 1/2.	**3**
(c)	Any four marks from: The enzyme has an active/binding site with a specific shape✓. The substrate fits the site.✓ Accept diagram. The substrate has a complementary/matching shape to that of the site ✓. NOT the same. Mention of involvement of functional/R groups in binding/catalysis ✓. Only one optical isomer will fit/idea of induced fit. NOT lock and key. AW throughout. **QWC** Award the mark for a clearly laid out answer that incorporates the ideas of shape and active site.	**4** **1**
(d)	✓ for basic idea of a dipeptide, including correct amide link H_2N-----CONH----COOH for sidechains CH_3 and CH_2OH accept H/CH_2CH_2OH or OH/ CH_3CH_2 accept any possible structure, correct in bonding terms, based on H_2N–C–CONH–C–COOH. Accept full displayed structures and ionised forms.	**2**
		Total: 15

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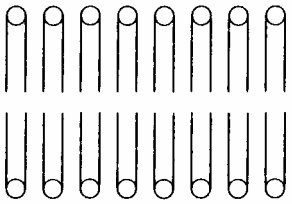
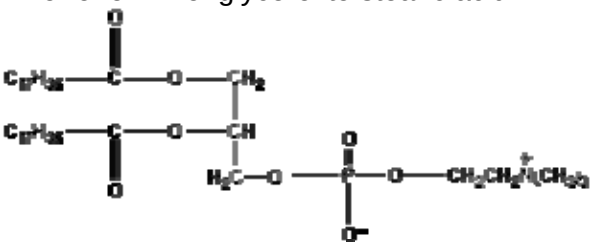
Question	**Expected Answers**	**Marks**
2.(a)	Must be bilayer rather than micelle. For example 	**1**
(b)	✓ for link of phosphate to choline ✓ for link of phosphate to glycerol ✓ for one link of glycerol to stearic acid  Or similar. Allow phosphate on C2. Full marks can be achieved if the three links are correct even when there is a minor mistake with the detail of the structure.	**3**
(c)	Five marks from: • (Part of) the inhibitor has similar shape ✓ to that of the substrate. Allow the same. • Both have the $-N(CH_3)^{3+}$ group✓ . • The inhibitor competes for the active site✓. Accept blocks active site/ binds instead of substrate for competes✓. • Inhibitor binding is reversible✓. • Graph showing lowering of rate✓ , • and then return to normal max. rate✓ with increasing acetylcholine/substrate concentration. The graph must show both curves to score. Only 1 mark if axes are omitted or incorrect. Last 2 marks may be scored without a graph.	**5**
(d)	van der Waals attraction ✓ between long hydrocarbon chains/fatty acid tails AW and solvent molecules✓ allows solution to form. Accept answer based on breaking of van der Waals in fatty acid tails requiring energy✓, which is supplied by the formation of new van der Waals with non-polar solvent molecules✓.	**2**
		Total: 11

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3.(a)(i)	RNA. The sugar is ribose✓. The base uracil is only found in RNA✓. Accept uridine.			**2**
(ii)	The H attached to N on the pyrimidine ring✓. One of the two C=O oxygens for the second mark✓. NH and both C=O/ Both C=O alone scores 1. Allow whole of NH or C=O ringed.			**2**
(b)(i)	3'- TCGCGTCTGGGA-5' ✓ Numbering to be ignored unless sequence is reversed when it must be correct.			**1**
(ii)	GAC✓			**1**
(iii)	Hydrogen bonding links the bases/triplets of tRNA and mRNA✓. Then any three marks from: Each t-RNA carries an amino acid and a base triplet✓. Each molecule of t-RNA carries the amino acid at one end corresponding ✓ to the base triplet at the other. This base triplet is complementary to the triplet on m-RNA that codes for the amino acid✓. They may use codon-anticodon here only. t-RNA brings the amino acid to be joined onto the growing polypeptide chain/ the t-RNA triplets are UCG CGU CUG and GGA ✓. The marks may be found on a clear labelled diagram. AW throughout.			**4**
				Total: 10

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4(a)	Identifying the positions as 1,4 (once) and 1,6✓. To score the mark they must make it clear which C atoms on the structure they mean. Identifying the stereochemistry as α for both a 1,4 and the 1,6 links✓.			**2**
(b)	Both acid and enzyme hydrolysis✓.			**1**
(c)	Each example must have property tied to function. Insoluble in water so cannot move out of cells/ minimises effect on osmotic pressure or water potential in cells of large amounts of glucose✓. Easily hydrolysed by enzymes to glucose when needed/branching makes hydrolysis easier✓. Compact, not taking up much space✓. AW throughout.			**3**
(d)(i) **(ii)**	Glucose has many OH groups✓ <u>which can hydrogen</u> <u>bond to water</u>. No diagram required but if one is given it must be correct. The word many is not necessary if they have OH group<u>s</u>. Some OH groups from each glucose are tied up in glycosidic links ✓. AW Many of remaining OH groups will be hydrogen bonded to each other / some OH groups hidden within structure✓. AW			**1** **2**
				Total: 9

Mark Scheme 2815/03
June 2006

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1(a)	Carbon dioxide by respiration /combustion AW ✓. Dioxin by incineration (of plastics such as PVC) at too low a temperature/incorrect temperature✓. Methane by anaerobic respiration of organic waste✓. AW			**3**
(b)	Its ability to absorb infrared radiation✓. Its concentration (in the troposphere)✓. Instead of one of these marks accept Either Its residence time/stability (in the troposphere) ✓ Or reference to one of reference to number of bonds, charge separation in the bonds, symmetry. AW			**2**
(c)(i)	Toxic✓. Do not accept harmful/dangerous *etc*.			**1**
(ii)	van der Waals/ dipole–dipole attraction✓. Accept clear diagram to that effect. Not hydrogen bonding.			**1**
(iii)	Photosynthesis (by the tomato plants). Accept production of carbohydrate. AW			**1**
				Total: 8

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Question	**Expected Answers**			**Marks**
2(a)(i)	CFCs absorb UV radiation ✓ to release chlorine atoms/radicals equation✓ Equation *e.g.* $CCl_2F_2 \longrightarrow CClF_2 + Cl$ Accept dotted versions of free radicals. Chlorine atoms react with ozone to produce ClO and oxygen /equation $Cl + O_3 \longrightarrow ClO + O_2$ ✓ Cl is regenerated by reaction of ClO with O atoms, /equation $ClO + O \longrightarrow Cl + O_2$ ✓ O atoms are produced by photolysis of O_2 / O_3 /NO_2 or an appropriate equation *e.g.* $O_3 \longrightarrow O_2 + O$ ✓ The chain reaction ✓ means that a higher proportion of ozone is broken down than would be normally in the absence of CFCs.✓ Find 6 marks from the above. Give the QWC mark for a clearly laid out answer that shows understanding of the terms free radical/ chain reaction and one correct equation.			**6** **1**
(ii)	HCFCs are broken down in the troposphere ✓ because they contain C–H bonds✓. AW			**2**
(b)(i)	By direct combination during lightning/in car or aircraft engines. AW✓ NOT simply car exhausts.			**1**
(ii)	$2NO + O_2 \rightarrow 2NO_2$ ✓			**1**
(iii)	+2 ✓			**1**
(c)	(Photochemical) smog/formation of ozone in troposphere✓ NOT global warming. Destruction of ozone in stratosphere✓. Not acid rain.			**2**
				Total: 14

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3(a)(i)	$Ca^{2+} + CO_3^{2-} \rightarrow CaCO_3$ ✓			**1**
(ii)	$Ca(HCO_3)_2 \rightarrow CaCO_3 + CO_2 + H_2O$ ✓			**1**
(b)	The aqueous calcium/magnesium ions in the water attach themselves to the ion-exchange resin in exchange for the sodium/hydrogen ions ✓ already there. In this way the calcium/magnesium ions are removed from the solution ✓ and the water is softened. The explanation should include a diagram or mention of the equilibrium involved, or an equation such as $2\ R^-Na^+ + Ca^{2+} \longrightarrow R_2Ca + 2Na^+$			**3**
(c)	Either Al^{3+} ions form a precipitate (of aluminium hydroxide)✓ which absorbs (other ions and) fine solids✓. Or Al^{3+} ions neutralise the negative charge on the surface of colloidal particles✓ causing them to coagulate/form a solid floc✓. Chlorine kills bacteria✓.			**3**
(d)	Acid rain has low pH/pH about 4✓. The concentration of HCO_3^- ions in solution will be lowered.✓ Calcium carbonate will precipitate if the concentration of carbonate ions is high enough✓; this is more likely to be the case at high rather than low pH✓. AW. Reference to K_s accepted as part of explanation for first mark.			**4**
				Total: 12

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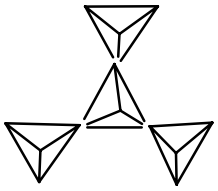
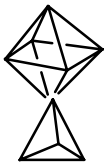
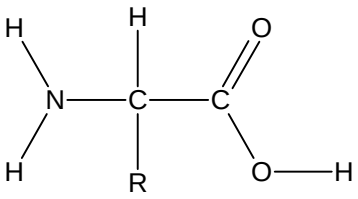
4(a)	 Diagram should show sharing of oxygen atoms or corners between adjacent tetrahedral units ✓. Three oxygen atoms/corners ✓on each tetrahedral unit are shared in this way within a silicate sheet.	**2**
(b)	 By sharing ✓ of oxygen atoms ✓between silicate sheet and aluminate sheets✓(simply sharing corners earns 1 mark only). Si–O–Al earns both ✓✓	**2**
(c)	The layers in a 1 : 1 clay are linked by hydrogen bonding ✓ between hydroxyl/OH groups on aluminate sheets and (spare) oxygen atoms on the silicate sheets✓. No room for water or cations✓ Accept reference to layers all binding tightly for the last mark.	**3**
(d)	Negative charge on surface attracts cations✓. Negative charge increased by substitution of Al^{3+} for Si^{4+} (or Mg^{2+} for Al^{3+})✓. or The hydrogen atoms in the OH groups on the outside ✓ can dissociate as H^+ ions, being replaced by metal cations ✓. An equation can earn both marks *e.g.* $ROH + K^+ \rightleftharpoons ROK + H^+$	**2**
(e)	$CaAl_2Si_2O_8 + 2CO_2 + 3H_2O \longrightarrow Al_2Si_2O_5(OH)_4$ $+ Ca(HCO_3)_2$ ✓ balance ✓ Allow 1 mark ecf if they use $CaCO_3$ and then balance correctly ($1CO_2 + 2H_2O$).	**2**
		Total: 11

Mark Scheme 2815/04
June 2006

Question	Expected Answers	Marks
1(a)(i)	Has no overall charge (at pH 7) /it is a zwitterion	1
(ii)	Has an overall positive charge	1
(iii)	A has lower mass / higher charge than B It is a smaller molecule	1
(b)	Mark for structure Acid or zwitterion  Decrease pH (at which electrophoresis is carried out) / Increase $[H^+]$ This will cause COO– or NH_2 group in zwitterion to be protonated resulting in uncancelled positve charge (therefore migrates towards negative electrode)	1 1 1 1
		Total: 7

Question	Expected Answers	Marks
2 (a) (i)	electrons excited / gain energy / jump up an energy level	1
	electrons emit energy / light as electrons return / fall down to ground state / original energy level/shell	1
(ii)	The higher energy electron shells/energy levels are closer together	1
(iii)	$E = hf$ /= $6.63 \times 10^{-34} \times 5.9 \times 10^{15}$	1
	multiply by L to get energy in J mol^{-1}	1
	$= 6.63 \times 10^{-34} \times 5.9 \times 10^{15} \times 6.02 \times 10^{23}$	
	$= 2\ 350\ 000$ J mol^{-1}	1
	= 2 350 kJ mol^{-1} (2 355/2354 kJ mol^{-1}) **to 3 sig. fig.**	1
(b)(i)	electronic = UV/visible (spectroscopy)	1
	nuclear spin (in an external magnetic field) = nmr	1
	vibrational = infrared / ir	1
(ii)	energy (states) are quantised / there are discrete energy levels/ there are r particular bonds/parts of molecules	1
	only the frequency that corresponds to the energy difference between states will be absorbed	1
		Total: 12

Question	Expected Answers	Marks
3(a)	(M : M + 1 = 100 : 21.8) No. of carbon atoms = $\frac{21.8 \times 100}{100 \times 1.1}$ = 19.8 therefore 20 carbons confirmed	 1 1
(b)(i)	(group of atoms) that absorb radiation in the UV &/or visible regions of the spectrum	1
(ii)	C=C / double bonds / π-bonds lone/electron pair(s) (on O atom) delocalisation / delocalised system/conjugated system/ alternating double bonds	1 1 1
(c)	the (peak of the) absorption is in the UV region / outside the visible part of the spectrum	 2
(d)(i)	wavelength (of major absorption) increases as length of delocalised / conjugated region in molecule increases region of delocalisation/conjugation between oxygens in rhodonines increases / clear link to rhodonine structure	1 1
(ii)	(some of) the compounds absorb in the visible region of the spectrum absorption at different wavelengths / colours allows all colours/full range of colours to be perceived	1 1
		Total: 12

Question	Expected Answers	Marks
4 (a)	(M_r = 88 – given on mass spectrum) molecular formula = $(C_2H_4O) \times 2 = C_4H_8O_2$ OR $\frac{1.43 \times 100}{32.40 \times 1.1} = 4$	 1
(b)	infrared spectrum: presence of (sharp) peak at approx 1750 cm^{-1} indicates C=O peak at approx. 1200 cm^{-1} consistent with C–O in ester / lack of peak at 2500–3300 cm^{-1} shows no O–H therefore not carboxylic acid nmr: There are 3 proton environments 3 proton peak at δ = approx. 1.2 $R–CH_3$ triplet because next to CH_2 2 proton peak at δ = approx. 2.3 $–OC–CH_2–$ R quartet because next to CH_3 3 proton peak at δ = approx. 3.7 $–O–CH_3$ singlet because not next to carbon bearing hydrogens / next to O This interpretation fits methyl propanoate/diagram of structure Quality of Written Communication mark – look for use of at least **three** terms from peak / triplet / quartet / splitting/environment/integral	 1 1 1 1 1 1 1 1 1 Max. 5 from 7 for nmr 1 1
(c)(i) (ii)	$[C_2H_5CO]^+ = 57$ / $[CH_3O]^+ = 31$ / $[CH_3OCO]^+ = 59$ / $[C_2H_5]^+ = 29$ (m/e values required with each ion]) **1 max** if no positive charges shown Ions can be shown on labelled diagram as long as symbols fully explained Correctly labelled peaks on mass spectrum	1 mark for each ion identified up to 2 max. 2
		Total: 14

Mark Scheme 2815/05
June 2006

Question 1

a) Particles/molecules have mass but **negligible size** (1)
Allow negligible or zero volume
There are no forces between molecules (1)
Collisions between particles are perfectly elastic (1)

b) i) Collisions of the molecules with the walls of its container (1)

ii) Calculation of n = 10.5/42 = 0.25 (1)

$$P = \frac{0.238 \times 8.314 \times 353}{3.5 \times 10^{-3}}$$ (1)

= 209631.57 (ecf on substitution above) Pa (1)
(= 209.6 kPa)
(this last mark is for a number from their calculation with a consistent unit)

c) 1. The intermolecular forces of attraction become significant (can overcome the motion of the particles) (at low temperatures) (1)
2. Molecules are much closer to each other and so intermolecular forces become significant. / the actual size of particles becomes significant (at high pressure when the particles are close together) (1)

[Total 9]

Question 2

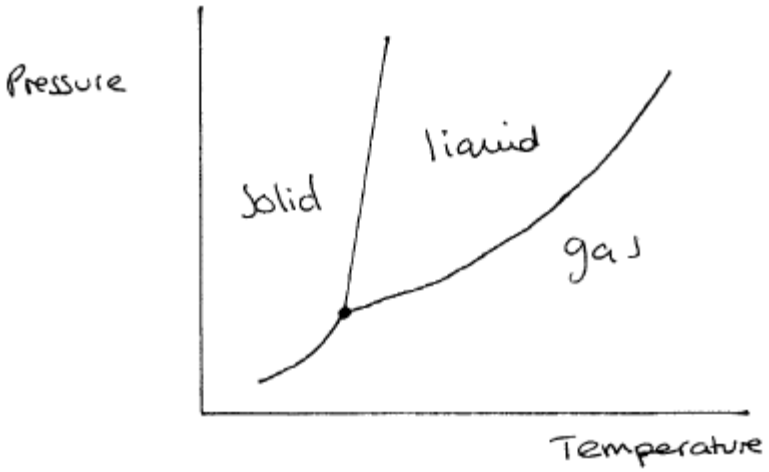
a) Pressure decreases (1)
So the CO_2 is less soluble and some escapes as a gas (1)

b) The concentration of a gas dissolved in a liquid (at a constant temperature) (1)
is proportional to the (partia)l pressure of the gas. (1)

c) $K_h = \frac{[CO_{2(g)}]}{P}$

$= [CO_{2(g)}] = 3.37 \times 10^{-4} \times 100$
$= 3.37 \times 10^{-2}$ mol dm^{-3} (1)
In a 2 litre bottle = $2 \times 3.37 \times 10^{-2}$ (ecf from line above)
$= 6.74 \times 10^{-2}$ moles CO_2 (1)

d)



i) axes labelled (temperature and pressure) (1)
ii) areas labelled (solid, liquid, gas) (1)
iii) The Triple point is where all three phases can co-exist at equilibrium (1)

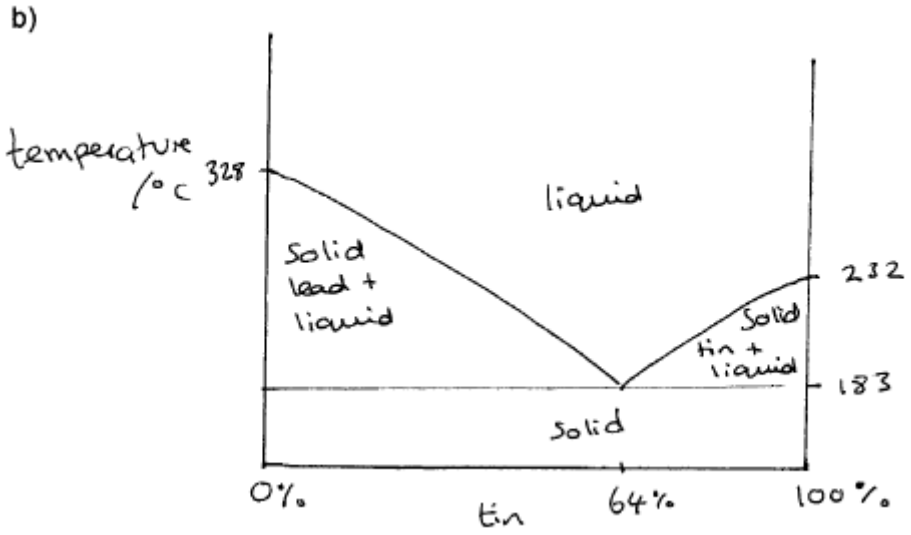
[Total: 9]

Question 3

a) i) 1. Liquid mixture (of tin and lead) cooling / liquid cools (1)
2. Crystals of lead appearing (with liquid mixture) (1)
3. (eutectic/ 64% Sn/ 36% Pb) mixture crystallising (1)
4. solid mixture and lead crystals cooling / solid cools (1)

ii) B = 183 ^{o}C (1)

b)



b) i) V – shape (of equilibrium lines) (1)
The bottom of the 'v' at 64% Sn / 36% Pb (1)
3 of the 4 areas correctly labelled (1)
The temperatures 328 ^{o}C (Pb), 232 ^{o}C (Sn) and 183 ^{o}C (eutectic) marked (1)

ii) Eutectic (1)

[Total:10]

Question 4

a) i) It is a mixture with a range of boiling points (1)

ii) Source of heat / crude oil is pre-heated (1)
Column is cool at the top / hot at the bottom (1)
Vapour goes up / liquid goes down (1)
There is 'intimate' mixing / equilibrium is established (on the plates) (1)
Fractions are tapped off / collected which consist of molecules with similar boiling points (1)

QWC correct use of 3 terms such as fraction, equilibrium, vapour, boiling, boiling range, condensing, condensation and vaporisation. [1]

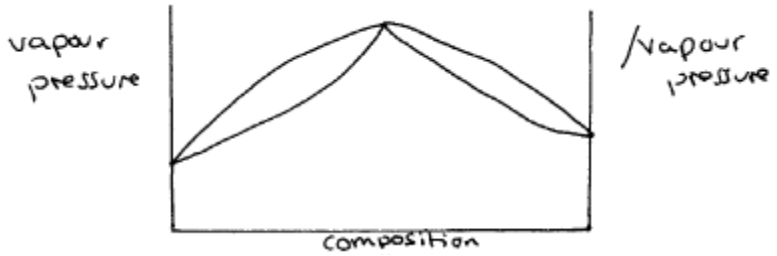
b) i) The vapour pressure of a solvent in a solution is equal to the vapour pressure of the pure solvent (1)
x its mole fraction in the solution. (1)
/ $P_A = N_A \times P^o_A$ if the terms are defined
Allow 1 mark for identifying the correct defined terms

ii) $P_{eth} = 180 \times 0.5 = 90$ kPa

iii)
$P_{H2O} = 70 \times 0.5 = 35$ kPa (1)

So mole fraction of ethanol = 90/125 = **0.72** (1)

c)i) The axes are labelled (composition and vapour pressure) (1)
A v.p – composition curve with a maximum shown (1)



ii) The strength of the hydrogen bonding (1)
between ethanol and water is less than the hydrogen bonding in either pure ethanol or pure water (1)

d) Boiling requires separation of molecules and Hydrogen bonding requires more energy to break than van der Waals' forces. (1)

Ethanol has hydrogen bonds between molecules whereas pentane has only van der Waals' forces, and hydrogen bonds are stronger than van der Waals' forces. (1)

[Total: 17]

Mark Scheme 2815/06
June 2006

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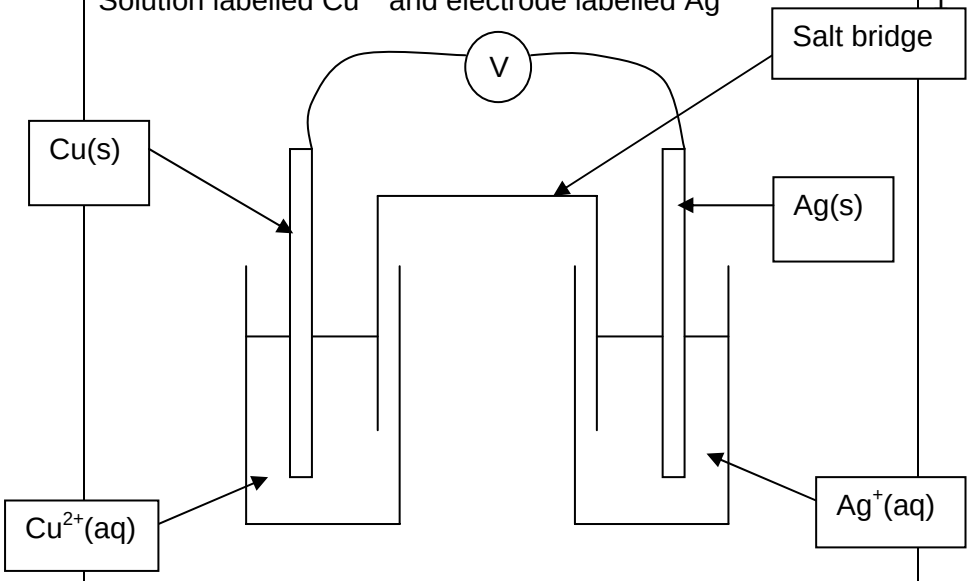
Question	**Expected Answers**			**Marks**
1 (a)	Emf / voltage / potential difference Half cell combined with standard hydrogen electrode Standard conditions 298K, 1 mol dm^{-3}, 1 atm (all 3 required for 1 mark)			1 1 1
(b)(i)	Diagram shows: Voltmeter + salt bridge + complete circuit Solution labelled Cu^{2+} and electrode labelled Ag			1 1
				
(ii)	Direction from Cu(s) to Ag(s) (must be in / close to wire)			1
(iii)	0.80 – 0.34 = 0.46 V			1
(iv)	$Cu + 2Ag^{+} \rightarrow Cu^{2+} + 2Ag$			1
(c)	Standard Electrode Potential for chlorine is more positive than Fe^{3+} therefore it is a better oxidising agent than Fe^{3+} (do not accept $E^{\ominus}$ is larger or smaller) Standard Electrode Potential for iodine is less positive than Fe^{3+} therefore it is a poorer oxidising agent than Fe^{3+} (Accept release of electrons/equilibrium arguments)			1 1
				Total: 10

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Question	**Expected Answers**			**Marks**
2 (a)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^8$ (Do not accept $[Ar]3d^8$)			1
(b)	Blue / violet / indigo / lilac (not purple / magenta / mauve) Because spectrum shows absorbance in yellow / orange / red (allow green if part of a list)			1 1
(c) (i)	Ring around O^- Ring around N (Accept ring around O of C=O as an alternative to O^-)			1 1
(ii)	Lone pair (of electrons) / non-bonding pair			1
				Total: 6

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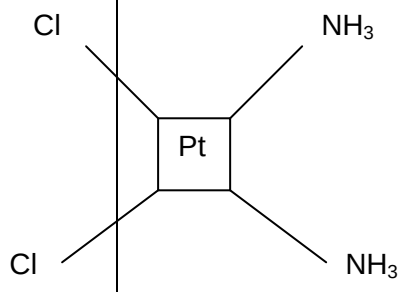
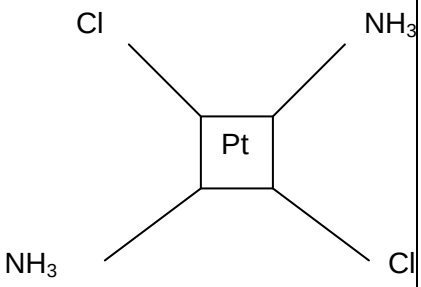
Question	**Expected Answers**			**Marks**
3 (a) (i)	Number of dative bonds / co-ordinate bonds formed with the transition metal (Do not accept number of ligands but allow number of lone pairs bonded to….)			1
(ii)	Square planar			1
(b) (i)	Ligand substitution			1
(ii)	$x = -2$			1
	$y = 0$			1
(i)	*cis* isomer drawn			1
	trans isomer drawn			1
	(ignore any charges)			
				
(ii)	*cis* / *trans* or geometric			1
(iii)	Binds with DNA (not binds with cell)			1
	Prevents replication/prevents cell dividing/prevents tumour growth (do not allow kills cell)			1
				Total: 10

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Question	**Expected Answers**			**Marks**
4 (a)	Yellow → (green)→ blue → green → lilac (violet) VO_3^- (Mix) VO^{2+} V^{3+} V^{2+} 1 mark for VO^{2+} 1 mark for V^{3+} 2 marks for 4 correct colours with correct oxidation state 1 mark for 3 correct colours (First green (mix) can be missed out without penalty)			 1 1 2
(b)	Moles V^{2+} = 25.0 x 0.100 / 1000 = 0.0025 mols Moles MnO_4^- = 30.0 x 0.0500 / 1000 = 0.00150 mols 1 mole of MnO_4^- changes its Oxidation State by 5 to change the Oxidation State of 1.67 moles of V^{2+} Oxidation State of V^{2+} changes by 5 / 1.67 = 3			1 1 1 1
(c)	$3MnO_4^- + 5V^{2+} + 3H_2O \rightarrow 3Mn^{2+} + 5VO_3^- + 6H^+$ (1 mark for correct species, 1 mark for balanced)			 2
				Total: 10

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument			
Question	**Expected Answers**			**Marks**
5	$[Co(H_2O)_6]^{2+}$ is pink / $[Co(NH_3)_6]^{2+}$ is light brown / $[CoCl_4]^{2-}$ is blue			1
	$[Co(H_2O)_6]^{3+}$ is blue / $[Co(NH_3)_6]^{3+}$ is dark brown			1
	Allow 1 mark for a correct +2 oxidation state ion with a correct colour and 1 mark for a correct +3 oxidation state ion with a correct colour			
	Ions can be octahedral *e.g.* $[Co(H_2O)_6]^{2+}$			1
	or tetrahedral *e.g.* $[CoCl_4]^{2-}$ (need example in both cases)			1
	Equation for suitable ligand exchange reaction *e.g.* $[Co(H_2O)_6]^{2+} + 4Cl^- \rightleftharpoons [CoCl_4]^{2-} + 6H_2O$			1
	$[Co(H_2O)_6]^{3+}$ is unstable / powerful oxidising agent and readily decomposes into $[Co(H_2O)_6]^{2+}$			1
	$[Co(NH_3)_6]^{3+}$ is much more stable than $[Co(H_2O)_6]^{3+}$			1
	NH_3 is a stronger ligand than H_2O / forms stronger dative covalent bonds than H_2O			1
	One mark awarded for correct spelling punctuation and grammar in at least two complete sentences			1
				Total: 9

Mark Scheme 2816/01
June 2006

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
1 (a)	The contribution of a gas to the total pressure in a gas mixture / pressure exerted by the gas alone / mole fraction x total pressure / x P ✓	**[1]**
(b)	Mole fraction of Cl (g) 3.0/88.0 or 0.034 ✓ (calc. 0.034090909)	**[1]**
(c) (i)	$K_p = \frac{p\,Cl(g)^2}{p\,Cl_2(g)}$ ✓ state symbols not required	**[1]**
(ii)	$K_p = \frac{3^2}{85}$ = 0.11 / 0.106 ✓ kPa ✓ (calc: 0.1058823529) Could be ecf from incorrect K_p expression. pCl$_2$ / pCl^2, gives 9.4 kPa^{-1}. 2 pCl / pCl$_2$, gives 0.0706 / 0.071 no units. pCl / pCl$_2$, gives 0.0353 / 0.035 no units. no units must be specified.	**[2]**
(d)	Equilibrium moves to the side with fewer molecules which is → left/more Cl_2 / less Cl ✓ relieves the increased pressure/ minimises change/minimises this effect ✓ (*i.e.* attempts to explain in terms of le Chatelier)	**[2]**
(e)	K_p decreases so equilibrium goes to the left/more Cl_2 / less Cl ✓	**[1]**
(f)	Amount Cl_2 produced = 1.6 x 10^{12}/71 or 2.25 x 10^{10} mol ✓ Amount NaCl required = 2 x 2.25 x 10^{10} or 4.5 x 10^{10} mol ✓ ecf moles 2 x Cl_2 Volume brine = 4.5 x 10^{10}/4 = 1.125 x 10^{10} dm^3 ✓ ecf moles Cl_2/4 *i.e.* 1.12 – 1.13 x 10^{10} dm^3	**[3]**
		Total: 11

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
2 (a)	(change in) concentration/mass/volume with time	**[1]**
(b) (i)	O_2: Exp 2 has 4 x $[O_2]$ as Exp. 1: rate increases by 4 ✓, so order = 1 with respect to O_2 ✓ NO: Exp 3 has 3 x [NO] as Exp. 3: rate has increases by 9✓, so order = 2 with respect to NO ✓	**[4]**
(ii)	rate = $k[O_2]\,[NO]^2$ ✓	**[1]**
(iii)	$k = \frac{\text{rate}}{[O_2]\,[NO]^2} = \frac{7.10}{0.0010 \times 0.0010^2} = 7.10 \times 10^9$ ✓ units: $dm^6\ mol^{-2}\ s^{-1}$ ✓	**[2]**
(c) (i)	The slowest step ✓	**[1]**
(ii)	$2NO_2 \rightarrow NO + NO_3$ ✓ $NO_3 + CO \rightarrow NO_2 + CO_2$ ✓ (or similar stage involving intermediates)	**[2]**
(d)	$4NO_2 + O_2 + 2H_2O \rightarrow 4HNO_3$ ✓ N from +4 to +5 O from 0 to –2 ✓ Could be below equation	**[2]**
		Total: 13

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument			
Question	**Expected Answers**			**Marks**
3 (a)	strength of acid/extent of dissociation/ionisation ✓			**[1]**
(b) (i)	$H_2SO_3(aq) + CH_3COOH(aq) \rightleftharpoons HSO_3^-(aq) + CH_3COOH_2^+(aq)$ acid 1 base 2 ✓ base 1 acid 2 ✓ *1 mark for labels on each side of equation*			**[2]**
(ii)	CH_3COOH is the stronger acid/ K_a CH_3COOH is greater/ CH_3COOH is more acidic ORA ✓			**[2]**
	$C_6H_5OH(aq) + CH_3COOH(aq) \rightleftharpoons C_6H_5OH_2^+(aq) + CH_3COO^-(aq)$ ✓			
(c)	For HCl, $pH = -\log[H^+]$ ✓ (or with values). Could be awarded below $= -\log 0.045 = 1.35$ ✓ (accept 1.3) For CH_3COOH, $[H^+] = \sqrt{(K_a \times [CH_3COOH])}$ / $\sqrt{(1.70 \times 10^{-5} \times 0.045)}$ ✓ $[H^+] = 8.75 \times 10^{-4}$ mol dm^{-3} ✓ $pH = -\log 8.75 \times 10^{-4} = 3.058/3.06$ ✓ (accept 3.1)			**[5]**
(d)	HCl and CH_3COOH have same number of moles/ release same number of moles H^+ / 1 mole of each acid produce ½ mol of H_2 ✓ $[H^+]$ in CH_3COOH < $[H^+]$ in HCl/ CH_3COOH is a weaker acid than HCl (ora) ✓ $Mg + 2HCl \rightarrow MgCl_2 + H_2$ ✓ $Mg + 2CH_3COOH \rightarrow (CH_3COO)_2Mg + H_2$ ✓ or $Mg + 2H^+ \rightarrow Mg^{2+} + H_2$ ✓✓			**[4]**
				Total: 14

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument			
Question	**Expected Answers**			**Marks**

4	Buffer
	A buffer minimises changes in pH ✓
	
	Role of NH_4Cl
	NH_4Cl provides NH_4^+ /
	$NH_4Cl \rightarrow NH_4^+ + Cl^-$ ✓
	
	equilibrium:
	1 $NH_4^+ \rightleftharpoons NH_3 + H^+$ /
	2 $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$ ✓
	
	How alkali is removed: ✓
	NH_4^+ removes added alkali / OH^-
	OR
	if equilibrium 1 has been used:
	H^+ removes added alkali / OH^- ✓
	Could be from an equation
	
	How acid is removed: ✓
	NH_3 removes added acid or H^+ /
	OR
	if equilibrium 2 has been used:
	OH^- removes added acid / H^+ ✓
	Could be from an equation
	
	A correct equilibrium statement:
	Any of the following ✓
	on addition of alkali,
	$NH_4^+ \rightleftharpoons NH_3 + H^+$ moves to right
	$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$ moves to left
	on addition of acid,
	$NH_4^+ \rightleftharpoons NH_3 + H^+$ moves to left
	$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$ moves to right
	
	QWC A correct equation **and** a correct chemistry sentence related to buffers ✓
				[6]
				
				[1]

				Total: 7

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
5 (a) (i)	mass sucrose = 0.47 x 43 g or 20.21 g ✓ M_r of sucrose = 342 ✓ moles sucrose = 0.47 x 43/342 or 0.059 mol ✓ (calc: 0.0590935672) no of sucrose molecules = .059 x 6.02 x 10^{23} = 3.6 x 10^{22} ✓	**[4]**
(ii)	$C_{12}H_{22}O_{11}(s) + 12\ O_2(g) \rightarrow 12\ CO_2(g) + 11\ H_2O(l)$ ✓ Ignore state symbols Energy = .059 x 5640 = 332.76 kJ ✓ = 332.76/4.18 = 79.6 Calories ✓ (i.e. mol sucrose from (a) x 5640/4.18) If 0.059 is missed, 5640/4.18 = 1349 Calories would score 1 mark	**[3]**
(b)	Empirical formula N : O = 63.64/14 : 36.36/16 ✓ = 4.56 : 2.27 = 2 : 1. Empirical formula = N_2O ✓ Molecular formula M_r of gas = 1.833 x 24 = 44 ✓ (calc 43.992) With these two pieces of evidence, assume that molecular formula = N_2O	**[3]**
(c)	amount of NaOH in titration = 0.175 x 22.05/1000 or 3.86 x 10^{-3} ✓ (calc: 3.85875 x 10^{-3}) amount of **A** in 25.0 cm^3 = 0.5 x mol NaOH or 1.93 x 10^{-3} ✓ (calc: 1.929375 x 10^{-3}) amount of **A** in 250 cm^3 = 10 x 1.93 x 10^{-3} or 1.93 x 10^{-2} ✓ 1.93 x 10^{-2} mol **A** has a mass of 2.82 g molar mass of **A** = 2.82/1.93 x 10^{-2} = 146 g mol^{-1} ✓ (or M_r of **A** is 146) Therefore **A** is adipic acid / $HOOC(CH_2)_4COOH$ ✓	**[5]**
		Total: 15

Mark Scheme 2816/03
June 2006

A2 Practical 2816/03

PLAN Skill P 16 marks (out of 19 available)

P 8 marks for Preparation for the Titration

P1 Add sulphuric acid to a known/weighed mass of [cast] iron **[1]**
Use of HCl forfeits mark P1 only

P2 Use excess acid to ensure all of the iron reacts/dissolves **[1]**

P3 Conditions desirable for the reaction – any **two** points from the seven listed below

- iron should be powdered/filed/ground down [*if possible*!]
- heat the mixture
- stir the mixture
- *reason for the above*: to increase rate of reaction ***or*** reference to low reactivity of Fe
- wait until reaction/fizzing stops before proceeding ***or*** wait until iron has dissolved
- reaction with acid should be done in the absence of air/oxygen
- iron(II) ions could be oxidised [by oxygen] to iron(III)
  or use a Bunsen valve [to ensure an atmosphere of hydrogen] **[1]**

P4 Equation for reaction: $Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$ **[1]**
Correct ionic equation is acceptable. Ignore attempt at state symbols

P5 Calculation of minimum volume ***or*** concentration of acid needed to react with iron **[1]**

P6 Cast iron contains about 5% of carbon as the main impurity.
Or three correct impurities named from carbon, silicon, sulphur and phosphorus **[1]**

P7 Impurities do not react/dissolve in acid ***and*** filter to remove impurities **[1]**

P8 Make [filtrate] up to (*e.g.*) 250 cm^3 with distilled water, using a volumetric flask **[1]**

T The titration

T1 Use $KMnO_4$ of known/specified concentration in the burette **[1]**
Concentration of $KMnO_4$ used must be between 0.01 and 0.2 mol dm^{-3}

T2 Pipette a known volume of iron(II) sulphate solution into a [conical] flask
and acidify with [plenty of dilute] sulphuric acid. **[1]**

T3 No indicator required (implied) ***and*** statement of end point colour **[1]**

T4 Titrate until two consistent/concordant/equal accurate titres are obtained **[1]**
Accept 'titres within 0.1 cm^3' (unit needed).

T5 Equation for redox reaction involved **[1]**
$MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$

T6 Calculates concentration of solution of iron(II) sulphate from specimen titration data.
or calculates no of moles of iron(II) ions in pipetted volume **[1]**
*Mark T6 is **not** available if 25.0 cm^3 chosen as specimen titre*

T7 Calculation to show how % purity is iron is determined from conc^{n} of Fe^{2+} salt **[1]**
Calculations must be clearly explained, intelligible and accurate

S 4 marks for safety, sources and qwc

S1 One significant hazard **and** safety measure stated for sulphuric acid **[1]**
The safety measure must the linked to the hazard of the acid
Note – H_2SO_4 is irritant > 0.5 M and corrosive > 1.5 M
Accept 'standard' safety measures such as safety specs., gloves or lab coat

S2 **Two sources** quoted in the text ***or*** at end of plan. **[1]**
*Book references **must** have chapter or page numbers*
Internet reference must go beyond the first slash of web address
The same book or internet reference cannot be quoted twice.
*Accept **one** specific reference to 'Hazcards', by name or number*
*Accept **one** specific reference to past papers (of any board)*

S3 **QWC**: text is legible ***and*** spelling, punctuation and grammar are accurate **[1]**
*Award S3 if there are fewer than **six** errors in legibility, spelling, punctuation or grammar.*
Treat each type of ICT mistake in the Plan (e.g. 'cm3') as one error.
A repeated error (e.g. no capitals at start of sentences) is penalised once only.

S4 **QWC**: information is organised clearly and coherently **[1]**
- *Is a word count given and within the limits 450–850 words?*
  Photocopied/downloaded material counts within the total
- *Is scientific language used correctly? (**One** error is allowed without penalty).*
  Is there a serious terminology error – e.g. 'strong' for 'concentrated'?
  Is there an incorrect chemical formula in the text?
  Are units used correctly in text and specimen calculations?
- *Is the description in a reasonably logical order?*

Practical Test (B): Mark Scheme

Page 3 **[12 marks]**

Mass readings **[1]**

- Both weighings must be listed
- All masses should be recorded consistently to two (or three) decimal places
- Units, g, must be shown (somewhere)
- Subtraction to give mass of F must be correct.
- Labelling of masses must have minimum of the words 'bottle'/'container' (*aw*)

Presentation of titration data **[2]**

All bullet points below correct = 2 marks.
Three bullets correct = 1 mark.
Two bullets correct = 0 marks

A table giving **only** the volume differences loses **both** marks.

- Correctly drawn and labelled table (initial, final and difference) used to record data
- All 'accurate' burette data (including 0.00) are quoted to 0.05 cm^3
- The trial titre is shown and clearly labelled
- All subtractions are correct

Self-consistency of titres **[1]**

- Both of the candidate's accurate titres should agree within **0.10 cm^3**.
- **Units,** cm^3 or ml, must given at least **once** – in or alongside the table is sufficient.

Mean titre correctly calculated [1]

- The mean should normally be calculated using the two [closest] accurate titres.
- The mean must be quoted to 2 d.p (but **not** to 3 d.p.).
- Unit must be shown (but absence of cm^3 not penalised twice on page 3)

Accuracy and Safety – *6 + 1 marks are available*

The conversion chart below is used to award the mark out of 6 for accuracy.

T (Candidate's adjusted titre) **= candidate's mean titre x** $\frac{\text{supervisor's mass}}{\text{candidate's mass}}$

T **i**s within 1.20 cm^3 of mean supervisor's value	[1 mark]
T is within 0.90 cm^3 of mean supervisor's value	[2]
T is within 0.70 cm^3 of mean supervisor's value	[3]
T is within 0.50 cm^3 of mean supervisor's value	[4]
T is within 0.30 cm^3 of mean supervisor's value	[5]
T is within 0.20 cm^3 of mean supervisor's value	[6 marks]

Safety

Requires reference to hazard (corrosive/causes burns) ***and*** wash with plenty of water **[1]**

Page 4 [5 marks]

(a) M_r of $K_2Cr_2O_7$ = 294 or 294.2 **[1]**

$[K_2Cr_2O_7] = {}^{5}/_{294} = 0.0170$ mol dm^{-3} **[1]**

(b) $n(K_2Cr_2O_7) = {}^{\text{titre x } 0.0170}/_{1000}$ **[1]**

(c) $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$ **[1]**

(d) $Fe^{2+} - e^- \rightarrow Fe^{3+}$ *or* $Fe^{2+} \rightarrow Fe^{3+} + e^-$ **[1]**

Page 5 [4 marks]

(e) Award mark for the full ionic equation (if completely correct)
$Cr_2O_7^{2-} + 14H^+ + 6Fe^{2+} \rightarrow 6Fe^{3+} + 2Cr^{3+} + 7\ H_2O$
or a clear explanation of the mole ratio using the numbers of moles of electrons **[1]**

(f) $n(Fe^{2+})$ = 6 x "b" **[1]**

(g) This method mark is for realising the need to scale up from 25 cm^3 to 250 cm^3
and for dividing mass of F used by number of moles of Fe^{2+} **[1]**

$M_r = {}^{\text{mass of F used}}/_{\text{titre x } 0.00102}$ [= *approx. 392*] **[1]**
Mark is for a correct calculation from candidate's mass and mean titre

Page 6 [2 marks]

(h) M_r of "anhydrous" $FeSO_4.(NH_4)_2SO_4$ = 284 *and* subtract this from 'hydrated' M_r **[1]**

x = 6 (*or correctly calculated answer from candidate's data*) **[1]**

Page 7 [7 marks]

(a) **3 marks**

Green, blue or turquoise [solution formed] **[1]**

R is an aldehyde **[1]**

[Only] aldehydes can be oxidised [by dichromate(VI) ions]
or aldehydes can behave as reducing agents
or ketones cannot be oxidised **[1]**

(b) **4 marks**

S gives no colour change/ stays orange/ has no reaction / no observation **[1]**

S is a <u>tertiary</u> alcohol **[1]**

Tertiary alcohols cannot be oxidised *or* primary <u>and</u> secondary types can **[1]**

S could be $(C_2H_5)_2C(OH)CH_3$ ***or*** formula of any tertiary alcohol with **6** carbons **[1]**
Any unambiguous representation of the formula (structural or displayed)
All H atoms must be shown in the formula

Pages 9 + 10 [14 marks]

(a) 3 marks

Volume of ammonia = 0.0060 x 24000 cm^3 ***or*** 0.0060 x 24 dm^3 **[1]**
Award this mark for 0.0040 x 24000 or 0.0080 x 24000

Volume = 144 cm^3 **[1]**
Mark 96 cm^3 or 192 cm^3 correct, by ecf

No. of moles of NH_4^+ = 0.0080 so amount of NaOH (0.0060 mol) is limiting **[1]**

(b) 6 marks maximum

- Insufficient NaOH was used/ more NaOH should be used **[1]**

NaOH should be in excess to ensure that all NH_4^+ ions react **[1]**

[Minimum of] 0.0080 moles of NaOH must be used [to react with all NH_4^+] **[1]**

- Iron(II) hydroxide is [the green precipitate] produced **[1]**

NaOH reacts with iron(II) ions [as well as with ammonium ions] **[1]**

At least 0.016 mol of NaOH should be used [to ensure complete reaction]
or 0.0080 mol NaOH extra is needed to react with iron(II) ions **[1]**

- Ammonia is soluble in water *or* dissolves in [the water present in] aq NaOH **[1]**

Water evaporates/steam produced while heating the mixture **[1]**

Use a solid alkali ***or*** use a more concentrated solution of alkali **[1]**

- Use an ignition tube containing one of the reagents [inside the boiling tube]
or some other specified method of keeping reagents apart at the start **[1]**

This error is small because reaction won't start if cold/reaction requires heating **[1]**

(c) 2 marks

In the titration, the titres were consistent/within 0.1 cm^3 **[1]**

Student's results, spread by 7cm^3, were not consistent and therefore not reliable **[1]**

(d) 3 marks

Volumetric flask: $^{100 \times 0.3}/_{250}$ = 0.12% **[1]**

Pipette: $^{100 \times 0.06}/_{25}$ = 0.24% **[1]**

Volumetric flask has lower % error/ is more accurate **[1]**

Advanced GCE Chemistry 3882/7882
June 2006 Assessment Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2811	Raw	60	46	40	34	28	22	0
	UMS	90	72	63	54	45	36	0
2812	Raw	60	48	42	36	30	24	0
	UMS	90	72	63	54	45	36	0
2813A	Raw	120	93	83	73	64	55	0
	UMS	120	96	84	72	60	48	0
2813B	Raw	120	93	83	73	64	55	0
	UMS	120	96	84	72	60	48	0
2813C	Raw	120	86	76	66	56	47	0
	UMS	120	96	84	72	60	48	0
2814	Raw	90	68	59	50	41	33	0
	UMS	90	72	63	54	45	36	0
2815A	Raw	90	67	59	51	44	37	0
	UMS	90	72	63	54	45	36	0
2815B	Raw	90	66	59	52	45	38	0
	UMS	90	72	63	54	45	36	0
2815C	Raw	90	70	63	56	49	43	0
	UMS	90	72	63	54	45	36	0
2815D	Raw	90	68	61	54	47	40	0
	UMS	90	72	63	54	45	36	0
2815E	Raw	90	67	59	51	44	37	0
	UMS	90	72	63	54	45	36	0
2816A	Raw	120	94	84	74	65	56	0
	UMS	120	96	84	72	60	48	0
2816B	Raw	120	94	84	74	65	56	0
	UMS	120	96	84	72	60	48	0
2816C	Raw	120	88	77	67	57	47	0
	UMS	120	96	84	72	60	48	0

Specification Aggregation Results

Overall threshold marks in UMS (*i.e*. after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
3882	300	240	210	180	150	120	0
7882	600	480	420	360	300	240	0

The cumulative percentage of candidates awarded each grade was as follows:

	A	B	C	D	E	U	Total Number of Candidates
3882	20.3	40.1	58.1	73.9	86.4	100.0	14192
7882	28.6	54.3	73.6	87.3	96.2	100.0	10291

For a description of how UMS marks are calculated see:
www.ocr.org.uk/OCR/WebSite/docroot/understand/ums.jsp

Statistics are correct at the time of publication.

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