GCE

Chemistry

Advanced GCE **A2 7882**

Advanced Subsidiary GCE **AS 3882**

Combined Mark Schemes And Report on the Units

June 2005

3882/7882/MS/R/05

Oxford Cambridge and RSA Examinations

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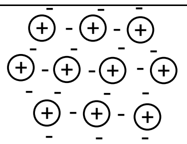
Advanced Subsidiary GCE Chemistry (3882)

MARK SCHEME ON THE UNITS

REPORT ON THE UNITS

Mark Scheme 2811
June 2005

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….. with different numbers of neutrons/different masses ✓	**[1]**
(ii)	isotope protons neutrons electrons ^{46}Ti 22 24 22 ✓ ^{47}Ti 22 25 22 ✓	**[2]**
(b)	$A_r = \frac{(46 \times 8.9) + (47 \times 9.8) + (48 \times 81.3)}{100}$ / 47.724 ✓ = 47.7 ✓	**[2]**
(c)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^2 4s^2$ ✓	**[1]**
(d) (i)	 positive ions ✓ electrons ✓ (must be labelled)	**[2]**
(ii)	electrons move ✓	**[1]**
(e) (i)	moles Ti = 1.44/47.9 = 0.0301 mol/0.03 mol (accept use of answer from (b))	**[1]**
(ii)	mass of Cl = 5.70-1.44 = 4.26 g ✓ moles Cl = 4.26/35.5 = 0.120 mol ✓ 5.70/35.5 = 0.161 mol gets 1 mark	**[2]**
(iii)	Ti:Cl = 0.0301 : 0.12 = 1:4. Empirical formula = $TiCl_4$ ✓ 0.0301 : 0.161 mol gives $TiCl_5$ for 1 mark	**[1]**
(iv)	$Ti + 2Cl_2 \longrightarrow TiCl_4$ ✓ (ecf possible from (iii)	**[1]**
(v)	covalent ✓ simple molecular ✓	**[2]**
		Total: 16

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Question			**Expected Answers**	**Marks**
2	**(a)**		$RaCl_2$ ✓	**[1]**
	(b)		Reduction is gain of electrons/decrease in oxidation number ✓ Ra^{2+} gains 2 electrons $\longrightarrow$ Ra/ Oxidation state goes from +2 in $RaCl_2 \longrightarrow$ 0 in Ra ✓	**[2]**
	(c)	**(i)**	effervescence/bubbles ✓ Ra disappears/dissolves ✓	**[2]**
		(ii)	8-14 ✓	**[1]**
	(d)	**(i)**	First ✓ ionisation (energy) ✓	**[2]**
			$Ra(g) \longrightarrow Ra^{+}(g) + e^{-}$ ✓✓ 1 mark for equation 1 mark for state symbols '–' not required on 'e'	**[2]**
		(ii)	atomic radii of Ra > atomic radii of Ca/ Ra has electrons in shell further from nucleus than Ca/ Ra has more shells ✓ Ra has **more** shielding than Ca ✓ :*'**more**' is essential* Ra electron held less tightly/less attraction on electron✓	**[3]**
				Total: 13

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Question	**Expected Answers**	**Marks**
3 (a)	$\ldots Mg(OH)_2(s) + \mathbf{2}\ldots HCl(aq) \rightarrow \ldots MgCl_2(aq) + \mathbf{2}\ldots H_2O(l)$ ✓	**[1]**
(b) (i)	moles HCl = 0.108 x 500/1000 = 0.054 ✓	**[1]**
(ii)	moles $Mg(OH)_2$ = ½ x moles HCl = 0.027 ✓ molar mass of $Mg(OH)_2$ = 24.3 + 17x2 = 58.3 ✓ (do not penalise 24) mass $Mg(OH)_2$ = 58.3 x 0.027 = 1.57 g / 1.5741 g ✓ (accept ans from (ii) x 0.027 = 1.566 g) (mass $Mg(OH)_2$ of 3.15 g would score 2 marks as 'ecf' as molar ratio has not been identified)	**[3]**
(iii)	Too much **if** 2.42 g (dose) > ans to (ii) ✓ (If answer to (ii) > 2.42 g then 'correct' response here would be 'Not enough'	**[1]**
(c)	$CaCO_3$ reacts with (or neutralises) HCl ✓ (or $CaCO_3$ + HCl in an equation) $CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$ ✓ (correct equation would score both marks)	**[2]**
		Total: 8

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 (a)	$Cl_2(g) \longrightarrow NaOCl(aq)$: Cl(0) ⟶ Cl(+1) ✓ $Cl_2(g) \longrightarrow NaCl(aq)$: Cl(0) ⟶ Cl(–1) ✓ Cl is both oxidised (in forming NaOCl) and reduced (in forming NaCl)/disproportionation Cl reduces Cl to form NaCl AND Cl oxidises Cl in forming NaOCl ✓	**[3]**
(b) (i) **(ii)**	$Cl_2 + 2I^- \rightarrow I_2 + 2Cl^-$ ✓✓ 1 mark for species. 1 mark for balancing Cl atom is smaller/has less shells ✓ electron to be captured will be attracted more ✓	**[2]** **[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**
5 (a) (i)	H bonding from O of 1 H_2O molecule to H of another ✓ dipoles shown ✓ with lone pair involved in bond ✓	**[3]**
(ii)	Two properties from: Ice is lighter than water/ max density at 4°C ✓ *explanation:* H bonds hold H_2O molecules apart / open lattice in ice / H-bonds are longer ✓ Higher melting/boiling point than expected ✓ *explanation*: strength of H bonds that need to be broken ✓ *must imply that intermolecular bonds are broken* High surface tension/viscosity ✓ *explanation* strength of H bonds across surface ✓	**[4]**
(b)	NH_3: 107° ✓ (range 106 – 108°) electron pairs repel other electron pairs ✓ lone pair has more repulsion ✓ electron pairs get as far apart as possible ✓	**[4]**
(c)	N has less protons than O (ora) ✓ electrons are in same shell /have same or similar shielding ✓ weaker nuclear attraction in N (ora) ✓ shell drawn in less by nuclear charge in N (ora) ✓ watch for distinction between nuclear **attraction** and nuclear **charge** in candidates' scripts.	**[4]**
	QoWC: links together two statements in at least two of the sections (a)(ii), (b) and (c) ✓	**[1]**
		Total: 16

Mark Scheme 2812
June 2005

1.

(a) C_6H_{14} ✓

(b) (i) boiling point increases with increase in M_R/molecular formula/N° of carbon atoms/chain length ✓

(ii) more intermolecular forces/electrons/surface area/

surface interactions/van der Waal forces ✓

(iii) 120 –130 °C ✓

(c)(i) $C_9H_{20} \longrightarrow C_7H_{16} + C_2H_4$ ✓

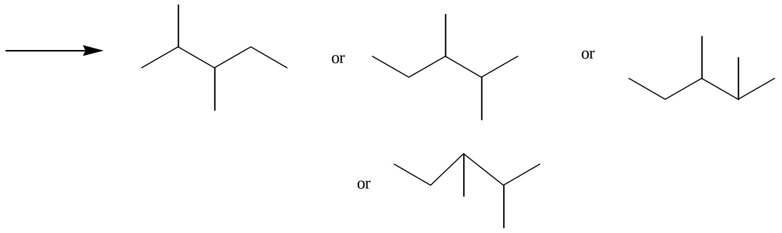
(ii) $C_2H_4 + H_2O \longrightarrow C_2H_5OH$ ✓

temperature > 100 °C/ steam

✓

phosphoric acid (catalyst) ✓

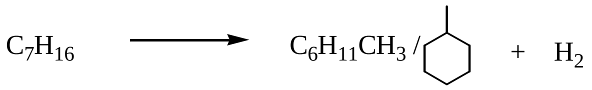
(d) (i)



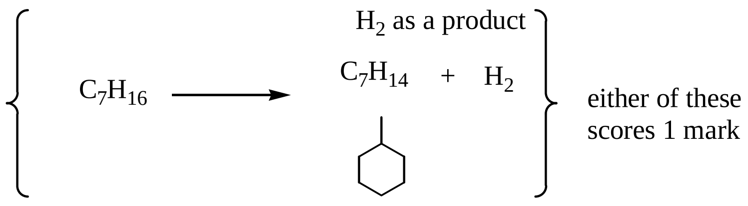
✓

(ii) 85 –98 °C ✓

(e)



$C_7H_{16} \longrightarrow C_6H_{11}CH_3$ / + H_2 ✓✓



H_2 as a product

$C_7H_{16} \longrightarrow C_7H_{14} + H_2$

either of these scores 1 mark

(f) more efficient fuel/better fuel/ higher octane number/reduces knocking/more volatile/lower boiling points/burn better/burn more easily/quicker

✓

[Total: 13]

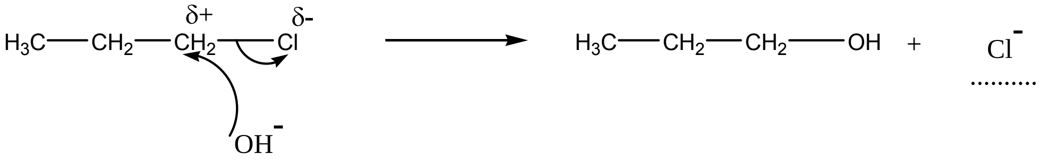
2.

(a) (i) reaction 1 ✓

(ii) reaction 4 ✓

(iii) reaction 3 ✓

(b) (i) lone pair/electron pair donor ✓



Correct dipole ✓

Curly arrow from the O in the OH^- to C in the CH_2 ✓

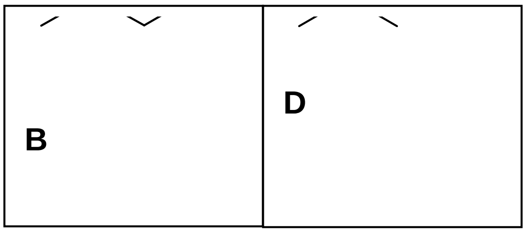
Curly arrow to show movement of bonded pair in the C-Cl bond ✓

Cl^- as a product ✓

(c) (i) same molecular formula , different structure/arrangement of atoms. ✓✓

(same formula , different structure.✓)

(ii)

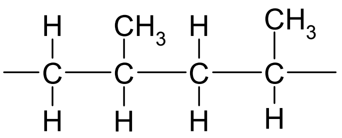


✓✓

(d) (i) addition, (not additional) ✓

(ii) poly(propene)/ polypropene/ polypro-1-ene, polypropylene ✓

(iii)



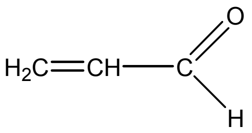
$—CH_2—CH(CH_3)—CH_2—CH(CH_3)—$ ✓

[Total: 15]

3.

(a) (i) prop-2-en-1-ol $CH_2{=}CHCH_2OH$ must show the C=C double bond ✓

acrolein



must clearly show the aldehyde group and the C=C ✓

(ii) alkene/C=C double bond ✓

(b) (i) acidified /H^+ ✓

dichromate/$Cr_2O_7^{2-}$ ✓

(ii) CH_2CHCH_2OH/ C_3H_6O/ C_3H_5OH + [O] $\longrightarrow$ CH_2CHCHO/ C_3H_4O/ C_2H_3CHO + H_2O ✓
not CH_2CHCOH

(c) acrylic acid ✓

approx 1700 cm^{-1} (range 1650 – 1750) indicates C=O ✓

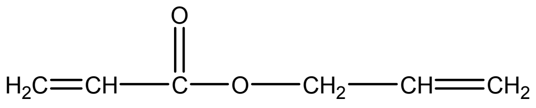
approx 3000 cm^{-1} (range 2500- 3300) indicates O-H ✓

not 3230 – 3550 cm^{-1}

(d) (i) $CH_2CHCH_2OOCCHCH_2$ /($C_6H_8O_2$) ✓

H_2O ✓

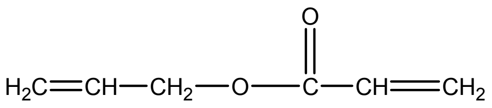
(ii)



$$H_2C{=}CH{-}\overset{\displaystyle O}{\overset{\|}{C}}{-}O{-}CH_2{-}CH{=}CH_2$$

✓✓

or



$$H_2C{=}CH{-}CH_2{-}O{-}\overset{\displaystyle O}{\overset{\|}{C}}{-}CH{=}CH_2$$

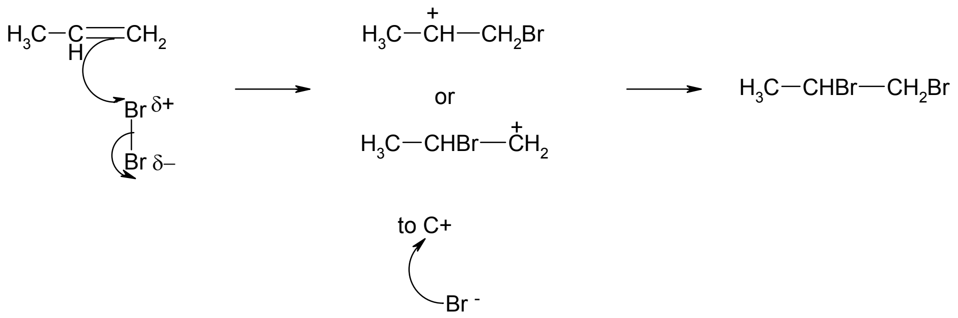
1 mark if the ester group, 1 mark for the rest of the molecule.
COO/CO_2 without displaying the ester, they can still get 1 mark.

[Total: 13]

4.

(a) (i) decolourises/not clear/not discolours ✓

(ii)



curly arrow from C=C to $Br^{\delta+}$ ✓

dipole on Br-Br **and** curly arrow showing movement of bonded pair of electrons✓

correct intermediate/carbonium ion/carbocation **and** curly arrow from Br^- to C+✓

1,2-dibromopropane as product ✓

(b) $CH_3CBr_2CH_3$ ✓

$CH_3CHBrCH_2Br$ ✓

$CH_3CH_2CHBr_2$ ✓

($CH_3CHBrCH_2Br$ has a chiral centre, hence optical isomers of 1,2-dibromopropane are acceptable but must be drawn with ‘wedge-shape’ bonds and be non-superimposable mirror images)

[Total: 8]

5

(a) Essential marks:

Order	RI>RBr>RCl /owtte	✓
reason for the order	C-I bond weakest/length/C-Cl bond strongest and mention/intermolc forces loses the mark	✓
an equation	$Ag^+ + X^- \longrightarrow AgX$ (solid or ppt) or an equation for hydrolysis/using OH^- or H_2O	✓

max = 3

Two possible methods of monitoring the reaction

Method 1	**Method 2**	
$AgNO_3$	$AgNO_3$	✓
Ethanol & Waterbath/ /hydroxide temp 40 – 80 °C not heat/not bunsen	$NaOH/OH^-$ & neutralise with HNO_3	✓
relative <u>rate</u> of precipitation	relative <u>amount</u> of precipitation	✓

(b) Properties:

Non-toxic/harmless ✓

non-flammable ✓

any two from: ✓✓

(propellant in) aerosols	because it is volatile/ unreactive/ non-toxic/easily compressed
blowing polystyrene	because it is unreactive
dry cleaning	because it is a good solvent for organic material
degreasing agent	because it is a good solvent for organic material
fire extinguishers	because it is non-flammable

QWC

- reasonable spelling, punctuation and grammar throughout ✓

[Total: 11]

Mark Scheme 2813/01
June 2005

1(a)(i) bonds broken

$(N-N) + (O=O) + 4(N-H) = 163 + 497 + 4(390) = 2220$ (kJ mol^{-1}) (1)

bonds made

$(N\equiv N) + 4(O-H) = 945 + 4(463) = 2797$ (kJ mol^{-1}) (1)

broken ΔH is +ve and made ΔH is –ve (1)

enthalpy of reaction = –577 (kJ mol^{-1}) (1) [4]

(ii) $\frac{577}{32} = 18.0$ (kJ) (1) [1]

(b) N-N bond is weak/ higher Ea for ammonia/ rate too slow for ammonia/ too much energy to break bonds in ammonia / hydrazine is liquid/ do not need pressurised containers/ more moles/ lots of gas produced by hydrazine/ more energy per mole produced by hydrazine (1) [1]

(c)(i) as a base (1) ………. accepts a proton/H^+/ **neutralises** an acid/ reacts with acid to form salt/ has a **lone** pair of electrons (1) [2]

(ii) fertiliser (1) [1]

(iii) manufacture of explosives/ dyes/ nitric acid/ fibres/ ammonium nitrate/ urea/ refrigeration/ cleaning agents/ fertiliser (if not allowed in (ii) (1) [1]

[Total: 10]

2(a) when the conditions on a system in equilibrium are changed (1)

the equilibrium moves to minimise the effects of the change/

counteract/ resist/ oppose the change(1) [2]

(b)(i) becomes brown/ darker/ colour more intense (1)

moves towards LHS/ towards NO_2 (1)

forward reaction is exothermic/ **reverse** reaction is endothermic (1)[3]

(ii) becomes less brown/ pale/ colourless (1)

moves towards RHS/ towards N_2O_4 (1)

fewer moles on RHS (1) [3]

(c)(i) because nitrogen starts as NO_2 in oxidation number +4 (1)

and forms (HNO_3) oxidation state +5 and (HNO_2) oxidation state +3 (1) [2]

(ii) internal combustion engine/ vehicular transport/ lightning (1) [1]

(d)(i) H^+/ hydrogen (1) [1]

(ii) $2H^+ + CaCO_3 \rightarrow Ca^{2+} + CO_2 + H_2O$

$CO_3^{\square} + 2H^+ \rightarrow H_2O + CO_2$

formation of CO_2 (1)

rest of equation (1) [2]

(iii) stone crumbles/ decays/ corrode/ dissolve after reaction/
chemically eroded (1) [1]

[Total: 15]

3(a) (enthalpy change) when 1 mole of substance/ element/ compound (1)
NOT energy needed

is completely burnt (1) [2]

(b) $C_3H_7OH(l) + 4\frac{1}{2} O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$

correctly balanced equation (1)

state symbols (species must be correct) (1) [2]

(c)(i) $\Delta H = mc\Delta T$ (1)

$\Delta H = 50 \times 4.18 \times 12.8 = 2675$ (J) = 2.68 (kJ) (1) [2]
ignore sign

(ii) Mr propan-1-ol = 60 (1) (1)

number moles = 0.00167 (1) [2]

(iii) $\Delta H = -1608$ (kJ mol^{-1}) (1) [1]

(ii) heat losses (1)

thermal capacity of beaker ignored (1)

conditions were non-standard (1)

combustion could be incomplete (1)

propan-1-ol evaporates (1)

water evaporates (1) [2max]

[Total: 11]

4(a) catalyst alters rate of reaction/ lowers Ea (1)

remains unchanged **after** the reaction/ is not changed at the **end** of the reaction BUT negated by does not take part in reaction (1) [2]

(b) homogeneous catalyst and reagents are in the same state (1)

heterogeneous catalyst and reagents in different states (1)

example of homogeneous eg H^+ in esterification/ $\mathrm{C\tilde{l}}$ with ozone/ named enzyme (1)

example of heterogeneous eg iron in Haber process/ rhodium, platinum, palladium in catalytic converters/ pumice/ conc. sulphuric acid in dehydration of ethanol, zeolite/ aluminium oxide/ silicon dioxide in cracking (1)

equation for heterogeneous/ homogeneous catalysed reaction (1)

mode of action of heterogeneous catalyst **-** gases a**d**sorbed/ bonds forming between reactants and catalyst (1)

bonds weakened allowing reaction to take place (1)

product gases desorbed/ description of desorption (1)

[7 max]

[Total: 9]

Mark Scheme 2813/03
June 2005

AS Practical Test 2813/03
Mark Scheme - May 2005

Plan: Skill P - 16 marks (max)

Indigestion tablets that contain $MgCO_3$ usually contain either $CaCO_3$ or $NaHCO_3$ as well.

- *If the candidate refers to $NaHCO_3$ as being present, separation is necessary prior to both procedures, since $NaHCO_3$ would interfere with both reactions. He/she would score T2 (below) for outlining what to do.*
- *If $CaCO_3$ is stated to be present, separation prior to the procedures is not necessary.*
  Medium heating will decompose $MgCO_3$ but not [much] $CaCO_3$.
  Use of sulphuric acid will dissolve $MgCO_3$ but not [much] $CaCO_3$.

T Thermal decomposition – 8 marks

If candidate heats and attempts to ***measure the volume*** *of CO_2, T3 is not awarded*

T1 Research: $CaCO_3$ ***or*** $NaHCO_3$ are also present [in many types of tablet] [1]

T2 Suitable [separation] method to obtain/analyse $MgCO_3$ outlined [1]

- *In the case of $NaHCO_3$, add water and filter off insoluble $MgCO_3$*
- *In the case of $CaCO_3$, "moderate" heating will decompose $MgCO_3$ but not $CaCO_3$* ***and*** *candidate must use sulphuric acid in second part of Plan to score T2*

T3 Three "basic" weighings are listed/described: [1]
Crucible ***or*** container [+ lid] (i) empty (ii) + tablet before heat (iii) + residue after heat

T4 Heating to constant mass procedure described ***or*** heat until volume stops increasing (if gas volume collected) [1]

T5 Gives a list of necessary equipment for doing the experiment safely [1]
6 out of the following 7 items on the line below must be included (somewhere)

- *Crucible, lid, Bunsen, mat, tripod, pipe-clay triangle* ***or*** *gauze, tongs*

Items can be credited from a diagram, if there is one
or (if gas collected) cool to room temperature before measuring volume of gas

T6 Equation for reaction: $MgCO_3 \rightarrow MgO + CO_2$ [1]
An equation with ICT errors (e.g MGO or MgCO3) is penalised ***once*** *in Plan*

T7 Specimen calculation to show % of $MgCO_3$ from mass loss [1]
Calculation cannot be based on mass of MgO residue
Mark is for the correct ***method*** *of calculation shown by the candidate*

T8 Candidate states/notes **two** of the following precautions/problems [1]

- crushes/powders the tablet before heating
- heats then cools crucible before weighing
- repeats whole experiment
- assumption made that no other ingredient of tablet decomposes
- $MgCO_3$ is "basic", so hydroxide component also decomposes

G Acid: Gas measurement procedure – 7 marks

There are alternative methods of executing for ***(b)*** *of the Plan.*
The main two are ***G*** *(gas measurement) and,* ***B*** *(back titration)*
Other options may also be credited.
A method that involves no acid at all scores no marks.

If the candidate attempts to measure the ***mass loss of gas****, mark as per bullet points below*

G1 Use **excess** specified/named acid with known mass of tablet [1]

- *Mass loss: mark as above*

G2 Neat labelled diagram showing suitable gas collection method [1]

Must be drawn with ruler: no mark awarded for a freehand diagram.

- *Diagram must show a porous plug at mouth of reaction flask*

G3 Ignition tube (or alternative) used to keep reagents apart/prevent loss of gas [1]

- *Mass loss: this marking point is* ***not*** *available*

G4 Measure volume of gas when reaction/fizzing stops/syringe stops moving [1]

- *Candidate must state/explain precisely all weighings that are needed*

G5 Equation (or ionic equation) for reaction of $MgCO_3$ with the acid [1]

- *As above*

G6 Specimen calculation shown to justify mass of $MgCO_3$ (***or*** tablet) used [1]

Mass of solid must be deduced from capacity of gas collecting vessel

- *G6 awarded for knowing that CO_2 takes a long time to diffuse out of flask* ***or*** *for "weighing to constant mass"*

G7 Calculation shown to deduce a suitable volume/concentration of acid [1]

Amount of acid should be deduced from mass of solid ***or*** *volume of gas*

- *Mass loss – as above*

B Acid: Back titration (or titration) method – 7 marks

If a candidate weighs $MgCO_3$ for each individual titration and titrates it as a ***suspension,*** *the answer is marked as shown in the bullet points below.* ***Six*** *marks can be awarded, all except B2*

*A candidate who titrates a "****solution****" of $MgCO_3$ can be awarded* ***only*** *4 marks (see below).*

B1 Use known/stated mass of tablet ***and*** add known amount of specified acid [1]

- *Suspension: known mass of tablet* ***and*** *add to water*

B2 Wait until fizzing stops (***or*** reaction ceases)
and make solution obtained up in a volumetric flask using pure water [1]

- *Suspension: mark B2 is not available*

B3 Titrate acid left over with named/specified alkali of known concentration [1]

B3 can only be awarded if the acid was originally used in excess

- *Suspension: titrate with a known concentration of specified acid from a burette*

B4 Use of pipette and burette to measure solutions outlined
and two consistent titres (***or*** within 0.1 cm^3) obtained [1]

- *Suspension: repeat entire process (inc weighing)* ***and*** *titrate very slowly*

B5 Suitable indicator chosen ***and*** correct end-point/final colour stated [1]

Litmus and universal indicators are not acceptable.

- *Mark B5 is available for suspension method (allow any of these indicators)*

B6 Equations for **both** reactions involved given (eg) [1]

$MgCO_3 + H_2SO_4 \rightarrow MgSO_4 + CO_2 + H_2O$

$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

- *Suspension or solution: only the first equation is needed for B6*

B7 **Calculation** to deduce a minimum volume/concentration of acid for excess [1]

Amount of acid used must be deduced from mass of solid

- *Suspension: calculates a suitable concentration of HCl for titration*

*A candidate who titrates a "**solution**" of* $MgCO_3$ *can be awarded **only** the following 4 marks.*

- *B1 (for weighing and make up to 250* cm^3 *in volumetric flask with distilled water)*
- *B3 (for titrating with "known" acid from the burette)*
- *B6 (for the equation)*
- *B7 (for linking a suitable concentration of the acid to the mass of carbonate used*
  eg 1.1 g of $MgCO_3 \rightarrow 250\ cm^3$*, titrate with 0.1M HCl for a titre of about 25* cm^3*)*

S Safety, Sources and QWC – 4 marks

S1 Hazard of hot crucible ***or*** of acid/alkali stated ***plus*** a sensible safety measure [1]

Note: HCl is corrosive > 6M, so S1 not awarded for over-stating its hazard

S2 References to **two** secondary sources quoted as footnotes ***or*** at end of Plan. [1]

- *Book references must have page numbers*
- *Internet references must go beyond the first slash of web address*
- *Accept one specific reference to "Hazcards" (only one ref counted)*

S3 **QWC**: text is legible and spelling, punctuation and grammar are accurate [1]

*Accept not more than **five** different errors in legibility, spelling, punctuation or grammar.*

- *Treat one type of ICT slip in text (eg "cm3") as one error.*
- *Don't penalise an error that has already been penalised in an equation.*
- *Do not award mark S3 if there are more than five words you can't read*
- *Bullet pointed methods/ note form accounts are acceptable*

S4 **QWC**: information is organised clearly and accurately [1]

- *Is a word count given and within the limits 400 – 1000 words?*
  Photocopied/downloaded material counts within the total.
  Apparatus list, calculation and sources need not count in the total
- *Is scientific language used correctly? (Allow **one** error without penalty.)*
  [Is there any error of terminology - eg "strong" for "concentrated"?]
  [Is there an incorrect chemical formula in the text?]
  [If units are quoted in the text, are they correct?]
- *Are the descriptions logical and without lots of irrelevant/repeated material?*

Practical Examination (Part B)

Note: *The marks shown on the question paper for Parts 1 – 4 were redistributed slightly when the paper was being marked. This was done to make the award of marks for accuracy in the gravimetric experiment more convenient for Examiners. In addition one mark was transferred from Part 3 to Part 4 to assist with differentiation of candidates' responses.*

Parts 1- 4: Skills I and A - 30 marks

1 **Readings**: Four mass readings clearly labelled [1]

All mass readings to 2 d.p. (*at least*) ***and*** unit (g) given somewhere [1]
This mark can be awarded if only a minimum of three masses are recorded

The fourth mass reading is within 0.02 g of the candidate's third one [1]
However, if candidate uses a 3 d.p. balance, then allow only 0.01 g

1 **Safety**: turn to yellow/orange flame ***or*** close the air-hole [1]

Yellow flame is more visible ***or*** is [less dangerous] because it isn't as hot [1]
*Visibility **or** reference to temperature needed.*

2(a) Correct subtraction for mass of anhydrous $MgSO_4$ = (reading 4) – (reading 1) [1]

2(b) M_r of anhydrous $MgSO_4$ = 120 ***or*** 120.4 [1]

n($MgSO_4$) = $^{a}/_{120\ \text{(or 120.4)}}$ [1]
Answer should be expressed to 2 or *3 s.f.*

2(c) Mass of water correctly calculated = (reading 2) – (reading 4) [1]

2(d) n(water) = $^{\text{“c”}}/_{18}$ [1]
Answer should be to expressed to 2 or 3 s.f. and is awarded for correct working

2(e) Answer correct for mole ratio = $^{d}/_{b}$ = 7 [1]
Mark is for the correct calculation from candidate's answers to (d) and (b)

Accuracy marks [3]

These marks are based on the data supplied by the supervisor.
Calculate the supervisor's mean % mass loss (= $^{\text{mass of water}}/_{\text{mass of hydrated salt}}$ *x 100)*
Calculate candidate's % mass, using correct masses from his/her data.

If candidate's % mass loss is within 1.0 % (inclusive) of supervisor's % loss → 3 marks
if % mass loss is within 2.0 % (incl) of supervisor → 2 marks
if % mass loss is within 3.0 % (incl) of supervisor → 1 mark

Accuracy marks are shown as "+1, +2 or +3" in the right hand margin

3(a) Table <u>drawn</u> with some lines ***and*** shows rows/columns labelling all three acids [1]
If candidate uses formulae of acids as labels, they must all be correct

HNO_3: Fizzing/bubbles/effervescence reported [1]
This mark is not awarded for "gas produced".

HCl: Reaction also fizzes ***and*** rate of both reactions commented upon [1]

In the experiment with sulphuric acid the reaction/fizzing starts but soon stops [1]
Do not allow "no reaction" / "slow reaction" unless initial "faster" rate was noted.

The reactions with the HCl/HNO_3 are still going after two minutes (*owtte*)
or the marble chips haven't dissolved by the end of reaction period [1]
Award the mark either of the above observations at the end of two minutes

3(b) Equation balanced: $2HCl + CaCO_3 \rightarrow CaCl_2 + CO_2 + H_2O$ [1]

3(c) Sulphuric acid ***and*** the reaction slowed down/stopped/prevented [1]

3(d) Surface layer reduces/prevents ions/"molecules" of acid <u>colliding</u> with the marble [1]
Specific reference to collisions of reagents is needed

3(e) Calcium sulphate [1]

4(a) Red litmus goes/turns blue ***or*** universal indicator/"pH paper" goes blue/purple [1]

Z is an alkali ***or*** is a base ***or*** it has pH greater than 7 [1]

4(b) **Z** gives a white precipitate/solid/suspension [1]
"Goes milky/cloudy" is not acceptable

4(c) **Z** is lime water/calcium hydroxide/slaked lime [1]
Allow a correct formula instead.

Carbon dioxide gas was produced [1]

Calcium carbonate is **formed** [1]

Alkalinity is caused by [aqueous] hydroxide ions [1]

Part 5: Evaluation - 14 marks max

(a)(i) **2 marks**

When heating, lid stops solid spitting out/frothing over/escaping [1]

When cooling, lid helps to prevent absorption/condensing of water [vapour] [1]

(ii) **1 mark**

Hot crucible causes convection/air currents affecting weighing
or hot crucible might damage the balance
or a reference to danger of moving hot equipment around the lab [1]

(iii) **2 marks**

To ensure that all the water [of crystallisation] was driven off *(aw)* [1]

Idea of "heating to constant mass" [1]

(b)(i) **3 marks**

Advantage: less time/heat needed [to drive out the water] [1]

Disadvantage: greater [%] inaccuracy in weighing [1]

Student's inaccuracy in weighing is $^{0.02}/_{0.24}$ x 100 = 8.3% ***or*** *$^{0.01}/_{0.24}$ x 100 = 4.2%* [1]

(b)(ii) **1 mark**

Disadvantage [is more significant] [1]

(c)(i) **3 marks**

To make the test fair ***or*** valid *(aw)* [1]

Both acids are strong ***or*** both solutions have equal concentrations of H^+ ions [1]

A more concentrated acid would react faster [than a dilute one] *(ora)* [1]
This mark is not credited if the terms "weak/"dilute" or "strong/conc" are confused

(ii) **2 marks**

Sulphuric acid is dibasic ***or*** diprotic ***or*** it contains two H^+ ions [per formula] [1]

H_2SO_4 concentration should be lower than 1.0 mol dm^{-3} *(accept 0.5 mol dm^{-3})*
or both other acids should be more concentrated than 1.0 mol dm^{-3} [1]

(d) **3 marks (maximum)**

*Credit **three** ideas given from the six below, giving **one mark** for each*
No mark awarded for repeats or for accurate measurement of acid **[3]**

- Ensure that the mass of chips used is the same
- Use marble chips all having the same surface area
- Wash/clean the chips to remove any powdered calcium carbonate
- Check [with a thermometer] that the acids are at the same temperature
- Measure/compare the volumes of gas produced in a given time
  or time the reaction until it stops

Measure the volume of gas with a gas syringe/burette/measuring cylinder

Mark Scheme 2814
June 2005

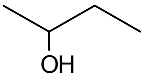
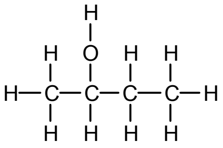
Abbreviations, annotations and conventions used in the mark scheme

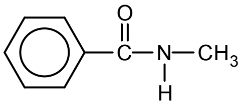
/ = alternative and acceptable answers for the same marking point
; = separates marking points
NOT = answers not worthy of credit
( ) = words which are not essential to gain credit
___ (underlining) = key words which must be used
ecf = allow error carried forward in consequential marking
AW = alternative wording
ora = or reverse argument

Marking structures in organic chemistry

When a structure is asked for, there must be sufficient detail using conventional carbon skeleton and functional group formulae (e.g. CH_3, C_2H_5, OH, COOH, $COOCH_3$) to unambiguously define the arrangement of the atoms. (E.g. C_3H_7 would not be sufficient).

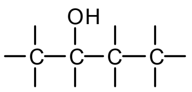
If not specified by the question, this may be given as either:

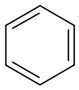
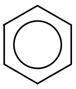
- a **structural formula** – e.g. $CH_3CH(OH)C_2H_5$,
- a **skeletal formula** – e.g.  ,
- a **displayed formula** – e.g. 

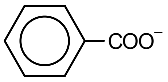
or as a hybrid of these – e.g. 

The following errors should be penalised – although each one only loses a maximum of one mark on the paper:

- clearly connecting a functional group by the wrong atom
- showing only ‘sticks’ instead of hydrogen atoms –

  e.g. 

Benzene rings may be represented as  as well as  in any of the types of formula above.

1 (a)(i) *balanced equation to give* 

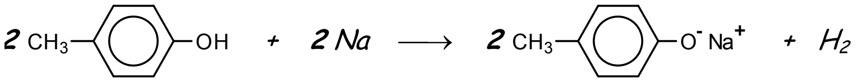
✓ + H_2O ✓

allow $C_7H_5O_2^-$ **[2]**

(ii) *4-methylphenol reacts (phenylmethanol does not)* ✓

… because phenols are (more) acidic / donate H^+ *more easily* ***AW*** ✓ **[2]**

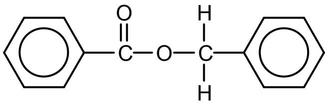
(b)(i) H_2 */ hydrogen* **[1]**

(ii) 

phenoxide/sodium phenoxide structure / formula ✓
rest the equation also correct and balanced ✓

allow C_7H_7ONa
but ***NOT*** *–NaO*
or O-Na **[2]**

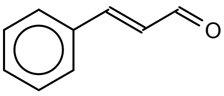
(c) (i) H^+ */acid / named strong acid eg* H_2SO_4 */ HCl* **[1]**

(ii) 

displayed ester group ✓
rest of the ester ✓ **[2]**

[Total: 10]

2 (a) (i)



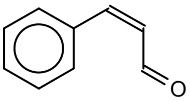
✓ **[1]**

(b) *C=C double bond does not rotate* ✓

two different groups on each carbon (of the C=C) ***AW*** ✓ — ***NOT*** *on "each side" of the C=C* **[2]**

i. *trans because H / groups are on opposite sides* ***AW*** ✓ **[1]**

ii. *any formula that shows the H on the same side – eg*



✓ **[1]**

(c) (i) *aldehyde / C=O / carbonyl* ✓ **[1]**

(ii) $C_6H_5CHCHCHO + \mathbf{2}\,[H] \longrightarrow C_6H_5CHCHCH_2OH$ ✓ — *allow* $C_9H_{10}O$ **[1**

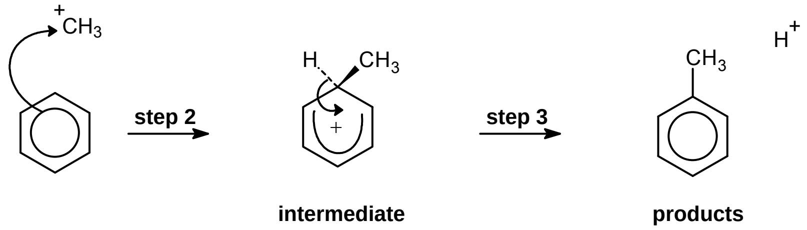
(d) ***method***
silver nitrate ✓
ammonia / ammoniacal ✓
warm / heat ✓
silver (mirror) / brown ppt forms ✓

explanation
silver ions reduced / $Ag^+ + e^- \rightarrow Ag$ ✓
aldehyde oxidised to a carboxylic acid ✓
correct structure – eg $C_6H_5CHCHCOO^-/COOH$ ✓

quality of written communication
mark for correct spelling, punctuation and grammar in at least two sentences ✓ **[8]**

[Total: 15]

3 (a) (i)



curly arrow from π-bond towards the carbon of $^+CH_3$ ✓

intermediate
structure of the intermediate ✓
curly arrow from C-H bond ✓

intermediate must have the "+" within the delocalised area

products
structure of methylbenzene and H^+ shown ✓

allow HCl as product if Cl^- is shown with the intermediate **[4]**

(ii) *accepts an electron pair* ✓

***NOT** a "lone" pair* **[1]**

(iii) $H^+ + AlCl_4^- \longrightarrow AlCl_3 + HCl$ **[1]**

$C_6H_6 + CH_3Cl \longrightarrow C_6H_5CH_3 + HCl$
products ✓
rest of the equation also correct ✓ **[2]**

(b) (i) *(benzene) ring is <u>activated</u>* ✓

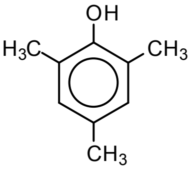
*lone <u>pair</u> from oxygen is delocalised / interacts with the π electrons around the ring / **AW** or diagram* ✓

ignore references to the inductive effect

greater electron density (around the ring) ✓

attracts $^+CH_3$ / electrophiles more easily ✓ **[4]**

(ii)



✓ **[1]**

[Total: 13]

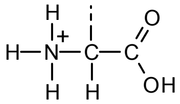
4 (a) (i) *water / evidence of a solution in water – eg (aq), 'dil' ,'6M' or ' conc' for HCl* ✓

***NOT** conc HNO_3 or conc H_2SO_4*

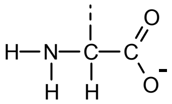
a named strong acid or alkali (heated under) reflux / a suitable enzyme at around 37°C ✓ **[2]**

(ii) *amino acids* ✓ **[1]**

(iii) *correct structure for one of the amino acids* ✓
correct ionic form for reagent used in a(i) – eg



/



✓ **[2]**

(iv) *reaction with water to split/break down the compound* ✓

*peptide bond in the compound is broken / diagram to show **AW*** ✓ **[2]**

(b) (i) *a carbon with four different <u>groups</u> attached* ✓

a chiral carbon /centre ✓

different spatial / 3-D arrangement (of the groups) ✓

(stereo)isomers / mirror images are non-superimposable / molecules are asymmetric ✓

ANY 3 out of 4 marks **[3]**

(ii) *contains 2 chiral centres* ✓

*each can have 2 (stereo)isomers/ 2x2 possibilities **AW*** ✓ **[2]**

(iii) *use naturally occurring / enantiomerically pure amino acids*
OR
use a stereospecific catalyst / enzyme / micro-organisms
OR
separate the mixture using a suitable method ✓ **[1]**

(iv) *higher doses are required* ✓

the drug /other stereoisomers may have (harmful) side-effects ✓ **[2]**

[Total: 15]

5 (a) (i) ***Diamino***

two/2 amine groups ✓

1,4

their position on the ring / numbering of carbons around ring (or shown on a diagram) ✓ **[2]**

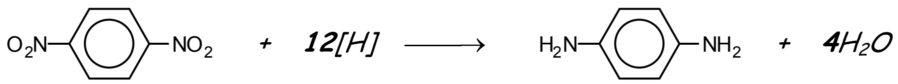
(b) (i) *reduction / redox* ✓ **[1]**

(ii) *tin and HCl* ✓

conc acid under reflux ✓

or H_2 gas + Ni/Pd catalyst **[2]**

(iii)



H_2O as product ✓

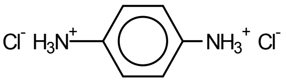
and the equation balanced ✓ **[2]**

(c) (i) *accepts H^+ using the lone pair (on N)* ✓

which is donated/forms a (dative) covalent bond ✓

either mark can be obtained with a good diagram **[2]**

(ii)



correct structure with charges shown ✓✓

one mark for either: *just one neutralised,*
both neutralised, but without Cl^-,
both neutralised, but no charges shown **[2]**

(iii) *hexane-1,6-diamine is a stronger base because:*

electrons move towards the N (due to the inductive effect) (in hexane-1,6-diamine) ✓

the lone pair from N is (partially) delocalised around the ring (in diaminobenzene) ✓

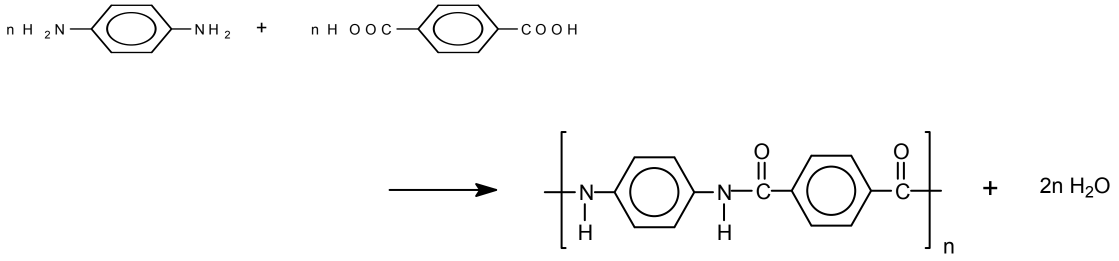
so the electron pair is more easily donated / H^+ more easily accepted (in hexane-1,6 diamine) ***ora*** ✓ **[3]**

question 5 continued overleaf

question 5 continued

(d) (i) *eg fire resistant / bullet proof clothing / cycle tyres / tennis rackets* ✓ — *allow any use where a tough flexible material is needed* **[1]**

(ii) *condensation (polymerisation)* ✓



structure of benzene-1,4-dicarboxylic acid ✓

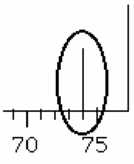
amide /peptide bond displayed ✓

repeat unit of correct polymer indicated ✓

formula of water shown as the product in an equation ✓ **[5]**

[Total: 20]

6 (a) *Molecular ion peak circled* ✓



Compound ***X*** *has* M_r *= 74* ✓

Empirical formula has M_r *= (36 + 6 + 32) = 74*
(so must be the same as the moleculor formula) ✓ **[3]**

(b) (i) *compound* ***X*** *is not an aldehyde* *<u>or</u>* *ketone / not a carbonyl compound* ✓ **[1]**

(ii) *compound* ***X*** *does not contain a C=C double bond/ is not an alkene / is not a phenol* ✓ **[1]**

(c) ***structure 1*** *ethyl methanoate* ✓
structure 3 *propanoic acid* ✓ **[2]**

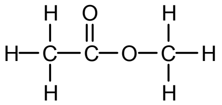
(d) ***presence or absence of relevant peaks*** *(in the context of any of the structures) …*

peak at ~1750 / 1680-1750(cm^{-1}*) for C=O* ✓
peak at ~1250 / 1000-1300(cm^{-1}*) for C-O* ✓
no *peak at 2500 – 3300(cm*$^{-1}$*)* ✓

structures possible or ruled out *…*
structures 3 is ruled out / can only be structure 1 or 2 ✓ **[4]**

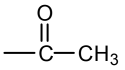
(e)

correct structure:



$$\mathrm{H{-}\overset{H}{\underset{H}{C}}{-}\overset{O}{\overset{\|}{C}}{-}O{-}\overset{H}{\underset{H}{C}}{-}H}$$ ✓

reasoning: *peak at ~2 / 2.0-2.9(ppm) is due to*



$-\overset{O}{\overset{\|}{C}}-CH_3$ ✓

peak at ~3.7 / 3.3-4.3(ppm) is due to $-O-CH_3$ ✓

allow max 1 as ecf from the wrong structure for valid reasoning from the δ *value*

relative peak area is 1:1/equal as both groups have the same number of protons ✓ ***AW***

peak(s) not split as there are no protons on the neighbouring carbons ✓

quality of written communication
for use and correct organisation of at least ***two*** *of the scientific terms: ppm, environment, methyl, proton, adjacent, singlet (doublet etc)* ✓ **[6]**

[Total: 17]

Mark Scheme 2815/01
June 2005

Mark Scheme Page 1 of 6	**Unit Code 2815/01**	**Session** June	**Year** 2005	**Version** Final Post-Standardisation
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)	Correct electronic structures magnesium either 8 electrons in outer shell or none and **both** chloride ions with 8 electrons in the outer shell (1); Correct charge on the ions, Mg^{2+} and Cl^- (1); Correct 'dot-and-cross' diagram for $SiCl_4$ with four covalent Si—Cl bonds and all lone pairs for chlorine (1)	3	
(b)	$MgCl_2$ dissolves / dissociates / ionises / forms a colourless solution / equation showing dissociation (1); With a pH of (almost) 7 (1); $SiCl_4$ is hydrolysed / reacts with water (1); to give a white precipitate / steamy fumes / white fumes / misty fumes (1); and a pH of 3 or below (1); $SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$ (1)	6	**Not** $MgCl_2$ fizzes or forms a white ppt **Allow** for $MgCl_2$ any pH between 6 and 7 **Ignore** state symbols in the equation **Allow** $Si(OH)_2Cl_2$ or $Si(OH)_4$ in the equation
(c)	$MgCl_2$ is giant ionic and $SiCl_4$ is a simple molecule (1) $MgCl_2$ – (Electrostatic) attraction between **ions** / attraction between (positive and negative) **ions** / aw (1); $SiCl_4$ - intermolecular attraction / van der Waals forces of attraction (1); Force of attraction in $MgCl_2$ is **stronger** than in $SiCl_4$ / ora (1)	3	The comparison of the strengths of forces/bonding must refer to the correct type of bonding e.g. strong ionic bonding and weak van der Waals (1) **Not** ionic bonds are stronger than covalent bonds

Mark Scheme Page 2 of 6	**Unit Code 2815/01**	**Session** June	**Year** 2005	**Version** Final Post-Standardisation
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 (d) (i)	Al_2Cl_6 (1)	1	
(ii)	$2Al + 3Cl_2 \rightarrow Al_2Cl_6$ (1)	1	**Allow** any correct multiple of equation **Allow** ecf from wrong formula in (i)
(iii)	(Solid aluminium chloride is covalent but) in solution has **ions** that can **move** / (solid aluminium chloride has no ions but) in solution **ions** can **move** (1)	1	**Not** ions cannot move in solid **Not** reference to ionic solid
(e)	PCl_6^- (1)	1	
		Total = 16	

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Question	**Expected answers**	**Marks**	**Additional guidance**
2 (a) (i)	**$CaCO_3 \rightarrow CaO + CO_2$ (1)**	1	**Ignore** state symbols
(ii)	Calcium ion has a larger charge density than barium ion / Ca^{2+} has a smaller ionic radius than Ba^{2+} / ora (1); So calcium ion polarises the carbonate (ion) **more** than the barium ion / so Ca^{2+} distorts the CO_3^{2-} **more** than Ba^{2+} / ora (1)	2	Particles referred to must be correct **Not** Ca has a higher charge density **Not** calcium has a higher charge density **Allow** calcium has a smaller ionic radius **Allow** correct description of **more** polarisation **Allow** CO_3^- **Not** Ca^{2+} polarises CO_3
(b) (i)	Oxidation state of nitrogen goes from +5 to +4 (1); Oxidation state of oxygen goes from -2 to 0 (1); Correct linking of changes of oxidation state with reduction **and** with oxidation (1)	3	If oxidation state of barium given is incorrect **max 1** for the oxidation numbers. **Allow** ecf from wrong oxidation states for the correct linking mark **Both** oxidation **and** reduction needed
(ii)	Correct use of molar ratios (1); Correct cycle (1); (+)1000 (kJ mol^{-1}) (1)	3	**Award** full marks for (+) 1000 (kJ mol^{-1}) **Only allow** ecf for final lattice energy answer from a correct cycle **Allow** -1000 (1), + 467 (2), +901 (2), +1558 (2),

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Question	**Expected answers**	**Marks**	**Additional guidance**
2 (c) (i)	Moles of Ba(NO$_3$)$_2$ = 0.005 or 0.00502 (1); Moles of gas made = 0.0125 / 0.0126 (1); Volume of gas = 300 cm^3 to 302 cm^3 (1)	3	**Allow** ecf within question **Ignore** significant figures
(ii)	Decomposition temperature may be too high / too much gas will be produced / to fill a gas syringe need a smaller amount of solid / gas syringe too small (1)	1	**Allow** NO$_2$ is toxic / barium compounds are toxic Answer is **consequential** on answer to (i)
(d) (i)	Enthalpy change when one mole of a solid / energy released when one mole of solid (1); Is made from its gaseous ions (1)	2	**Not** energy required **Allow** marks via an equation **Allow** ionic compound / crystals instead of solid
(ii)	Calcium (ion) has a higher charge density / smaller (ionic) radius / ora (1); So it is **more** strongly attracted to the oxide (ion) / ora (1)	2	**Allow** calcium oxide has stronger ionic bond / ora
		Total = 17	

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Question	Expected answers	Marks	Additional guidance
3	**Transition element** Cu^{2+} $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$ (1); Transition elements have one oxidation state that has an incomplete set of 3d electrons / have one ion with a half-filled 3d orbital (1) **Complex ion** Example of a **copper** complex ion e.g. $[Cu(H_2O)_6]^{2+}$ or $CuCl_4^{2-}$ (1); Diagram of the copper complex showing three dimensions e.g. use of wedges or dotted lines (1); Correct bond angle to match the complex / correct name of the shape of the complex (1); Ligand is an electron **pair** donor (1); Copper(II) ion is an electron **pair** acceptor (1); Dative bond exists between ligand and the copper(II) ion (1) **Properties** Several oxidation states e.g. copper has +1 and +2 or iron has +2 and +3 (1); Forms coloured compounds e.g. copper(II) chloride is green or iron(II) sulphate is pale green (1); Element or compound has catalytic properties e.g. Iron is a catalyst in the Haber process (1)	11	**Allow** has at least one half-filled d orbital / partially filled 3d sub-shell If a copper complex that does not exist is used then first three marks not available If a correct iron complex is given then example mark cannot be awarded **Allow** square planar where appropriate Electron pair donor, electron pair acceptor and dative bond marks can awarded from an appropriate diagram Ignore copper has a +3 Ignore iron has a +6 oxidation state

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Question	Expected answers	Marks	Additional guidance
3	**Quality of written communication** Use of technical terms – at least three terms from the following list are used in the correct context • ligand • dative bond • coordinate bond • tetrahedral • square planar • octahedral • oxidation (state) • catalyst • electron pair • lone pair • orbital • sub-shell (1)	1	Put a ring around the technical terms
		Total = 12	

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Question	**Expected Answers**	**Marks**
(1) (a)	Any two from Specific ✓ More reactive/effective/faster✓ More sensitive to changes of pH/temperature✓ Milder conditions✓ Cleaner product✓ But not active site. AW in each case.	**2**
(b)	Allow uncharged structure/zwitterion ✓ for CONH and ✓ for the rest(correct). Must be a genuine attempt to link them. $HOC_6H_4CH_2CH(NH_2)CONHCH(COOH)CH_2C_6H_4OH$ Or displayed in part or full.	**2**
(c)	Phenylalanine – van der Waals ✓ using benzene/phenyl/arene ring.✓AW Tyrosine – hydrogen bonding✓ using the OH/phenol.✓ AW Accept van der Waals again here for 1 mark. The structural feature mark only follows from a correct attraction. Ignore any reference to ionic attraction using the terminal COO^- and NH_3^+.	**4**
(d)	Any 6 marks. AW throughout. • Correct use of term transcription/translation.✓ • A different t-RNA,(with a different amino acid), will be brought up to altered m-RNA triplet.✓ • Example of one transcription eg ATA (in DNA) → UAU (in m-RNA) Or AAA(in DNA) → UUU (in m-RNA) ✓ • Translation of normal RNA eg UAU → Tyr✓ • Translation of changed RNA UUU → Phe✓ Do not give the second translation if same acid. • New amino acid has a different sidechain ✓ • then an important part of the tertiary structure/active site/shape may be changed.✓ For one of these two marks accept reference to degeneracy of the triplet code. Accept also a base change which results in a new stop code rather than new amino acid.	**6**
	Question total	**14**

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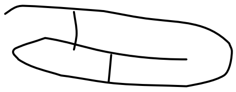
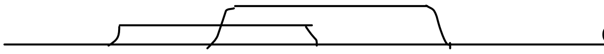
(2) (a)(i)	Their diagram should show two bridges, either as –S-S- or as lines. Give ✓ for one bridge; ✓ for other bridge which will require a loop/spiral/crossover. Eg  or  etc Accept any one bridge (even if wrong structure) eg –SH---HS-	**2**
(ii)	In primary structure it is a peptide/amide link ✓ In bridges it is a disulphide link (bond between S atoms) ✓ Either -CONH- or –S-S- for third mark✓ (But if both given and one incorrectly then CON) If only structures without names give 2 marks. Fish back to part (i) for correct –S-S- if no structure.	**3**
(b)	Link between S and Zn ✓; dative/covalent✓ or Link between Zinc ion (Zn^{2+}) and COO$^-$/COOH; ionic/covalent .✓ AW In either case must have first mark to score the second	**2**
	Question total	**7**

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Question	**Expected Answers**	**Marks**
(3) (a)(i)	$\longrightarrow$ $2C_6H_{12}O_6$ ✓ Accept version with structures or with separate molecules of $C_6H_{12}O_6$	**1**
(ii)	Similarities: any two points from • made from glucose only • glycosidic link • 1,4 link But not other alternatives. Difference: α in maltose, β in cellobiose.	**3**
(b)	Cellobiose is wrong shape for active site ✓ AW. Accept maltase specific for 1α4 links/not 1β4 links. Do not accept maltase specific for maltose.	**1**
(c)	At low maltose concentrations: • the rate is lowered by glucose✓ • because it is similar in structure/shape to maltose✓ • and competes for the binding/active site✓ • reversibly✓ • leaving fewer sites available to the maltose substrate✓ • mention of end product inhibition✓ At high maltose concentrations: • greater probability that maltose will bind✓ • rate increases, possibly almost back to uninhibited rate✓. A graph can earn the 2 rate marks. AW throughout. Find any 5 marks, at least 1 must be at high concentration.	**5**
	QWC mark is for SPG, which can be awarded for a well organised answer with fewer than 3 mistakes in two complete sentences.	**1**
	Question total	**11**

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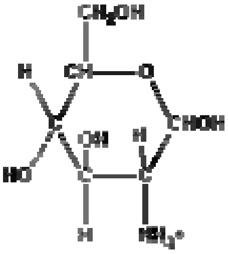
Question	**Expected Answers**	**Marks**
(4) (a)	1.00 g of the acid produces 11360/284 kJ✓ = 40 kJ 2800 kJ of heat is produced by 180 g of glucose 40 kJ is produced by 180 x 40/2800 ✓ = 2.57 g ✓ (accept 2.6 g) Find 3 marks for any correct answer with working. A correct method with too early trimming of sig figs can earn 2. In an incorrect answer find 1 mark for moles of acid = 1/284 = 3.52 x 10^{-3}.	**3**
(b)	The energy is produced by the formation of bonds✓ in carbon dioxide and water✓. In carbohydrates some of these bonds have already been formed/carbohydrates are partially oxidised.✓ Any reference to exothermic bond breaking is wrong.	**3**
(c)	Any three points ✓✓✓ from • insoluble (therefore cannot move out of cells) • minimise OP for many glucose molecules • compact/occupy little space • not involved in immediate reactions in cells • easily hydrolysed to glucose when required Mark first three points if more are given.	**3**
(d)(i)	✓ for amino glucose (accept $-NH_2$ version)  Must all be there. Ignore stereochemistry at C1 – others must be correct.	**1**
(ii)	Hydrolysis ✓ with hydrochloric acid ✓ Accept other acids, eg aqueous sulphuric (but not conc). Allow 1 mark for hot instead of the hydrolysis mark.	**2**
(iii)	1β- glycoside also/ monomer like β-glucose. ✓	**1**
	Question total	**13**
	PAPER TOTAL	**45**

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1.(a)(i)	Any two points from • Production of (photochemical) smog ✓ • Eg aldehyde(s)/PAN/organic peroxides/ leads to production of ozone✓ • causing breathing difficulty/other specific problem✓	**2**
(ii)	$2C_8H_{18} + 17O_2 \rightarrow 16CO + 18H_2O$ or halved ✓	**1**
(b)(i)	open to allow easy access for gas stream AW ✓ honeycombed to provide large surface area for catalyst✓	**2**
(ii)	$NO + CO \longrightarrow 0.5N_2 + CO_2$ or doubled ✓	**1**
(iii)	preheat catalyst/move catalyst nearer engine AW ✓ Allow specific mention of rhodium.	**1**
	Question total	**7**

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Question	**Expected Answers**	**Marks**
2.(a)(i)	Photosynthesis ✓	**1**
(ii)	Aqueous carbon dioxide dissolves/reacts with calcium carbonate/limestone ✓ to form calcium hydrogen carbonate solution/ aqueous calcium ions ✓.AW A correct equation ✓ $CaCO_3(s) + H_2O(l) + CO_2(g)$ $Ca(HCO_3)_2(aq)$ Correct state symbols can earn one of the description marks. $\longrightarrow$	**3**
(iii)	The calcium hydrogen carbonate is decomposed /breaks down on heating ✓ to form insoluble calcium carbonate✓.AW A correct equation can earn one of these marks.	**2**
(b)(i)	Transfer of hydrogen ions/protons from H_2CO_3 and HCO_3^- to water ✓ $CO_2 + H_2O \rightleftharpoons H_2CO_3$ ✓ $H_2CO_3 + H_2O \rightleftharpoons HCO_3^- + H_3O^+$ ✓ $HCO_3^- + H_2O \rightleftharpoons CO_3^{2-} + H_3O^+$ ✓ Accept H^+ versions. Any three marks from the above.	**3**
(ii)	Any two marks from : • Higher pH means lower hydrogen ion concentration ✓ • Moving both equilibria to right and increasing carbonate ion concentration ✓, with increasing probability of precipitating insoluble metal carbonates. AW • Ionic equation for precipitation A discussion based on Ks is not expected.	**2**
(c)(i)	Residence time✓ Ability to absorb infrared radiation ✓. AW in both.	**2**
(ii)	The gas will be less soluble in warm water✓.	**1**
	Question total	**14**

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Question	**Expected Answers**	**Marks**
3.	Look for 10 of the following marks . • 2:1 clays have layers consisting of two tetrahedral/silicate sheets ✓ and one octahedral/aluminate sheet.✓ Diagram eg silicate / aluminate / silicate or description of layers ✓. • There are only weak attractions/is no hydrogen bonding between layers ✓ allowing easy access to water ✓ and cations. • On the inner surfaces of the layers some Si^{4+} can be replaced by Al^{3+}✓ giving the clay a large negative charge ✓, which attracts cations such as K^+✓ retaining them. • There is a large surface area between layers for Ion exchange ✓ eg $Clay^-K^+(s) + H_2O(l) = ClayH(s) + K^+(aq) + OH^-(aq)$ ✓ • When the concentration of the nutrient cation in the soil solution drops , it is replaced ✓ by the clay to maintain equilibrium/by le Chatelier.✓	**10**
	The QWC mark is for a well organised answer with fewer than three spg errors in two complete sentences.	**1**
	Question total	**11**

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Question	Expected Answers	Marks
4.(a)	It would be –C_5H_{10}- if saturated. AW ✓	**1**
(b)	Rubber would burn if oxygen were present/ no oxygen in equation/ no carbon dioxide or water formed. AW.✓	**1**
(c)	• Reduces bulk of waste • Recycling of hydrocarbons • Provides fuel • Reduces emission of greenhouse gas CO_2 • Avoids long time for tyres to decompose Any two points. AW ✓✓	**2**
(d)	Bond making releases more ✓ heat energy than bond breaking requires✓. AW (or diagram)	**2**
(e)	Fractional distillation	**1**
	Question total	**7**

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Question	**Expected Answers**	**Marks**
5.(a)(i)	Hydrochloric acid ✓ and chloric(I)/hypochlorous acid ✓. Accept formulae or equation. Do accept hydrogen chloride or HC*l* .	**2**
(ii)	To kill bacteria ✓ AW.	**1**
(b)	(Sunlight/UV light) releases chlorine free radicals/Cl ✓ from CFCs. The chlorine radicals react with ozone to give ClO and oxygen ✓ or an equation Eg $Cl + O_3 \rightarrow ClO + O_2$ This is a chain reaction/one C*l* destroy many O_3 molecules.	**3**
	Question total	**6**
	Paper Total	**45**

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Question	Expected Answers	Marks
1 (a) (i)	Separation of compounds depends on partition/different solubilities (1) between the stationary phase / water (1) and the mobile phase / solvent (1)	3
	Distance travelled by sample divided by the distance travelled by the solvent	1
(b)(i)	Ninhydrin / iodine	1
(ii)	6	1
(iii)	4 spots(1) at the same height as x with 1 at x (1)	2
(c)(i)	Charged compounds/ions applied to paper / gel (1) Move towards electrodes under applied voltage(1) Distance/speed of travel depends on the mass/charge of the compounds (1) Further two marks can be gained by candidate giving specific examples of ions formed from the $–NH_2$ and –COOH groups Or link to change in pH)	5
	QWC mark if no more that 3 spg mistakes in first two complete sentences.	1
(ii)	By using buffer solutions	1
		Total : 15

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Question	**Expected Answers**	**Marks**
2 (a)	The hydrogen atom has different energy levels (1) The electron may be promoted to any level and drop back to any lower level, each producing a line (1) The energy levels are quantised / there are discrete energy levels (1)	**3**
(b)(i)	f = c/λ so $\frac{3.00 \times 10^8}{568 \times 10^{-9}} = 5.28 \times 10^{14}$ Hz (1)	
(ii)	E =hf so $6.63 \times 10^{-34} \times 5.28 \times 10^{14} = 3.50 \times 10^{-19}$ J (1) ecf	**2**
(c)	Helium	**1**
(d)	Measure intensity at a particular wavelength / frequency (1) Compare this with the intensity of a sample of known concentration / use a calibration graph (1)	**2**
		Total : 8

Mark Scheme	**Unit Code** **2815/04**	**Session** **June**	**Year** **2005**	**Version** **1.03**
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Question	**Expected Answers**	**Marks**
3 (a)	Benzene rings (1), double bond (1) and lone-pair / non-bonded electrons/SO_3^{2-}/$N(CH_3)_3$ (1)	**3**
(b)(i)	A system of bonds in which π and/or lone-pair/non-bonded electrons are delocalised between more than two atoms	**1**
(ii)	A decrease in conjugation increases the energy gap between (electronic) energy levels in the molecule (1) Larger energy gap means that higher frequency / shorter wavelength blue light is absorbed (1) This means that lower frequency / longer wavelength red light is observed. (1)	**3**
		Total : 7
4 (a)(i)	**A** C_3H_6 (1) **B** C_4H_8 (1)	**1**
(ii)	**A** $CH_3CH=CH_2$ (or displayed) ('sticks' penalised once)	**2**
(iii)	$C_3H_5^+$ (1) for formula and (1) for charge	**2**
(b)	3 : 1	**1**
		Total : 6

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	2815/04	June	2005	1.03

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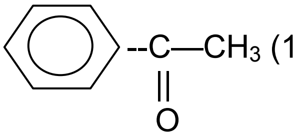
Question	Expected Answers	Marks
5 (a)	N = 100(M+1) / 1.1M (1) gives x = 8 (1) No of hydrogens(y) = 120 – (8 x 12 + 16) = 8 (1) A correct answer for x which does **not** use ratio of M+1 / M only scores (1).	**3 x 1**
(b)	From ir spectrum peak at 1690-1700 cm^{-1} suggests C=O (Data booklet range accepted)(1) No –OH absorption (1) Nmr spectrum shows 2 proton environments (1) Singlet at 2.6δ suggests $–CH_n$ next to carbonyl (1) with no C neighbour bonded to H (1) Multiplet at 7.7-7.9δ suggests C_6H_5- / benzene ring (1) Structural formula of **G** is  (1) Allow any logical and unambiguous route which arrives at the correct answer and uses data from each spectrum	**max 6** **Total : 9**

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Question	Expected Answers	Marks
1 a)	Similar distances between particles / similar density (1) Particles in liquids flow past each other / in solids particles held in a lattice/regular arrangement (1) At low temp. particles move more slowly, intermolecular forces significant. (1) At high press. The volume of the particles becomes significant. (1)	4
b)(i)	$n = \frac{m}{M}$ $M = \frac{mRT}{PV}$	1
(ii)	$M = \frac{0.275 \times 8.31 \times 373}{1.01 \times 10^{5} \times 9.6 \times 10^{-5}}$ (1) =87.9 (88) (1) eval.	2
(iii)	Intermolecular forces / hydrogen bonds are significant in alcohols (1) (reverse argument accepted) This causes ‘association’ of molecules effectively reducing the number of particles or hydrocarbons vaporise more easily(1)	2 Total: 9

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Question	Expected Answers	Marks
2. a)(i)	**A** liquid **B** liquid + solid lead **C** liquid + solid tin **D** solid Four areas correct scores 2, two or three areas correct scores 1	**2**
(ii)	Eutectic is the mixture which has a single sharp melting point	**1**
b)(i)	Liquid cooling (1) Eutectic solidifying / solid or crystals forming (1) Solid cooling (1)	**3 x 1**
(ii)	**Any 5 points:** On cooling the temperature drops steadily until the temp reaches 240-260 °C (1) crystals of lead start to form (1). The temperature drops more slowly (1) as more lead crystallises until the temperature reaches 183 °C (1). At this point the whole mixture begins to solidify (1) with no change in temperature (1). Finally the solid begins to cool (1) QoWC mark for logical sequence	**5 max** **1**
c)	Small amounts of ‘foreign’ metal changes the metal lattice (1). The different sized atoms prevent ‘slip’ in the lattice(1)	**2**
		Total : 14

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Question	**Expected Answers**	**Marks**
3. a)	Concn of gas dissolved in a liquid at constant temp.(1) is proportional to the partial pressure of the gas (1)	**2**
b)(i)	$p_{Ox} + p_N = 100$kPa, and 20% of air is O_2, 80% is N_2 $p_{Ox} = 20$ kPa, $p_N = 80$kPa (1) $\frac{[O_2]}{p_{Ox}} = 1.3 \times 10^{-5}$, $[O_2] = 1.3 \times 10^{-5} \times 20 = 2.6 \times 10^{-4}$(1) $\frac{[N_2]}{p_N} = 6.5 \times 10^{-6}$, $[N_2] = 6.5 \times 10^{-6} \times 80 = 5.2 \times 10^{-4}$ (1)	**3**
(ii)	Gases are less soluble at higher temps / K_H decreases with increasing temp.(1) Aeration ensures that the dissolved oxygen is kept at a maximum concentration (1)	**2**
c)	The equilibrium constant for an equilibrium that exists for a substance dissolved in two liquids in contact with each other	**1**
d)(i)	$\frac{x/100}{(5-x)/100} = 20$ (1) hence x = 20(5-x) or x =100-20x Thus 21x=100 and x = 4.76 g (1)	**2**
(ii)	$\frac{y/50}{(5-y)/100} = 20$ hence 2y = 20(5-y) or 2y = 100-20y Thus 22y =100 and y = 4.55 g (1) $\frac{z/50}{(0.46-z)100} = 20$ hence 2z = 20(0.46-z) or 2z = 9.2 –20z Thus 22z = 9.2 and z = 0.41 Total extracted = 4.96 g(1)	**2** **Total : 12**

Mark Scheme	Unit Code 2815/05	Session June	Year 2005	Version 1.02
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. a)	Vapour pressure of a solvent in a solution is equal to the mole fraction of the pure solvent in the solution multiplied by its vapour pressure	**1**
b) (i)	Vapour pressure of the mixture is greater than that which would be expected.	**1**
(ii)	Forces between the particles in the mixture are weaker than those between particles of either component.	**1**
c) (i)	An azeotropic mixture is one which has a constant b.p.(and which still contains two or more substances) / mixture whose vapour has an identical composition to the liquid.	**1**
(ii)	It is not possible to obtain 100% pure ethanol by distillation (1), since the azeotrope distils over (1)	**2**
d)	Efficient fractionation relies on good exchange between the liquid and vapour phases in the column. (1) This relies on a large area of contact between the two phases (1). The beads provide a very large surface area for this (1). Establishes a temperature gradient (1)	**2 max**
e)	The boiling point of the mixture is when the sum of the vapour pressures reaches atmospheric pressure. (1) Since water boils at 100 °C in steam distillation the boiling point of any mixture has to be below 100 °C (1). The product and water are immiscible (1)	**2 max** **Total : 10**

Mark Scheme 2815/06
June 2005

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Question	**Expected Answers**	**Marks**
1 (a)	Emf of a cell / voltage / potential difference / cell potential	**1**
	Comprising half cell combined with standard hydrogen electrode	**1**
	Conc = 1 mol.dm^{-3}; Pressure (of H_2) = 1 atm; Temp = 298K (all of above=1mark)	**1**
(b)	+0.16 V (unit required)	**1**
(c) (i)	$2MnO_4^- + 10Cl^- + 16H^+ \rightarrow 2Mn^{2+} + 5Cl_2 + 8H_2O$	
	correct species on both sides of equation	**1**
	equation balanced (ignore electrons for first mark, penalise for balance)	**1**
(ii)	Chlorine -1 → 0	**1**
	Manganese +7 → +2 Link to c(i) and allow ecf	**1**
(iii)	Chloride ion oxidised (not chlorine)	**1**
	Manganate(VII) ion reduced (not manganese)	**1**
(d)	0.16 V too small/rate too slow/insufficient activation energy/not standard conditions	**1**
(e)	Peak between 500-550 nm	**1**
		Total: 12

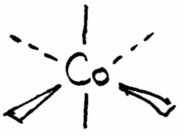
Question	Expected Answers	Marks
2 (a) (i)	Zinc	**1**
(ii)	Coins + resist corrosion (not rusting) / hard wearing Or statues + resist corrosion/ attractive patina Or electrical connections + good conductor Or musical instruments + attractive / sonorous Or plumbing fixtures + hard / corrosion resistant	**1**
(b) (i)	Sodium carbonate/sodium hydroxide/other suitable named alkali (accept correct formulae) Do not accept 'alkali' on its own	**1**
(ii)	Starch	**1**
(iii)	<u>Just</u> before the end point/when solution turns pale straw	**1**
(c) (i)	0.002 mol	**1**
(ii)	One (1)	**1**
(iii)	0.002 mol	**1**
(iv)	0.002 mols Cu^{2+} contains 0.002 x 63.5 g of Cu =0.127 g 250 cm^3 of solution contains10 x 0.127 g = 1.27 g % Cu = 1.27/1.65 x 100 = 77.0% (Allow 76.9-77.0; allow ecf)	**1** **1** **1** **Total: 11**

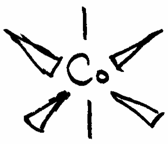
Question	**Expected Answers**	**Marks**
3 (a)	Number of coordinate / dative covalent bonds attached to metal ion / number of lone pairs accepted (not number of ligands)	**1**
(b) (i)	$[Co(H_2O)_6]^{2+}$ is octahedral; $[CoCl_4]^{2-}$ is tetrahedral Drawings must be 3 dimensional (See additional sheet for acceptable 3-d diagrams)	**2**
(ii)	Pink → blue	**2**
(iii)	Add water. (Allow other suitable suggestions, e.g. add lead nitrate to precipitate Cl^- as $PbCl_2$)	**1**
(c)	$[Co(NH_3)_6]^{2+}$ $E^\ominus$ for forward reaction is least positive Reverse reaction (oxidation) more likely to occur	**1** **1** **1**
(d)	Ammonia is a stronger ligand than water / ammonia forms stronger bonds / ammonia is a stronger base / ammonia can donate its lone pair more easily	**1**
		Total: 10

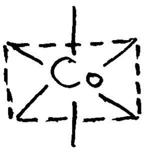
2815/06 Transition Elements June 2005 - Additional Sheet.

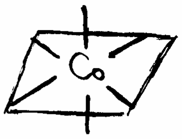
Question 3

(b) (i) Acceptable shapes for $[Co(H_2O)_6]^{2+}$ include:

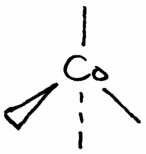


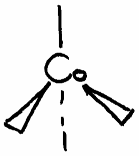






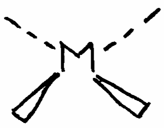
Acceptable shapes for $[CoCl_4]^{2-}$ include:

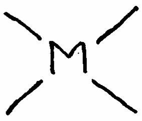


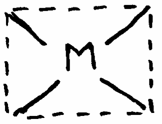


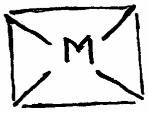
Question 4

(b) Any examples which show the principle of cis/trans isomerism and optical isomerism are fine but, all diagrams must be 3-d. The shapes, shown in Q3 are allowed for octahedral or tetrahedral. For square planar complexes used to illustrate cis/trans isomerism the following illustrations are fine. For optical isomerism, there must be a mirror line and the isomers must be non-superimposable object/mirror images.









Question	**Expected Answers**	**Marks**
4 (a) (i)	Cis platin	**1**
(ii)	Binds to DNA Prevents cell from replicating / cells die	**1** **1**
(b)	(Cis/trans) + Examples (must be 3-d drawings) Correctly labelled as cis and trans (allow this mark if diagrams are planar) Cis has same atoms at 90^0 + Trans has same atoms at 180^0 (need reference to bond angles for mark) (Optical) + examples (must be 3-d drawings) Rotate plane polarised light (by same number of degrees) in opposite directions Non-superimposable mirror images NB If use $H_3N\ CH_2\ CH_2\ NH_3$ penalise only once (see additional sheet for acceptable 3-d diagrams)	**2** **1** **1** **2** **1** **1**
	QWC – to be awarded for the correct use of scientific terms, to include at least 3 of the following: Cis & trans, optical, plane, polarised, non-superimposable, mirror images, geometric, bidentate, ligand, octahedral, square planar, tetrahedral	**1**
		Total: 12

Mark Scheme 2816/01
June 2005

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)	constant half-life ✓	[1]
(ii)	rate = k [N_2O_5] ✓ Common error will be to use '2' from equation.	[1]
(iii)	curve downwards getting less steep ✓ curve goes through 1200,0.30; 2400,0.15; 3600,0.075 ✓	[2]
(iv)	tangent shown on graph at t = 1200 s ✓	[1]
(v)	3.7(2) x 10^{-4} ✓ mol dm^{-3} s^{-1} ✓ ecf possible from (ii) using $[N_2O_5]^x$ (2nd order answer: 2.2(3) x 10^{-4})	[2]
(b) (i)	slow step ✓	[1]
(ii)	$(CH_3)_2C{=}CH_2 + H_2O \longrightarrow (CH_3)_3COH$ ✓	[1]
(iii)	H^+ is a catalyst ✓ H^+ used in first step **and** formed in second step/ regenerated/ not used up ✓	[2]
(iv)	rate = k [$(CH_3)_2C{=}CH_2$] [H^+] ✓ common error will be use of H_2O instead of H^+	[1]
		Total: 12

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Question	Expected Answers	Marks
2 (a)	**High Pressure** Equilibrium ⟶ right as fewer moles on right hand side and the shift reduces number of molecules/compensates for increasing pressure ✓ Rate increases/ more collisions ✓	[2]
	High temperature Equilibrium ⟶ left as equilibrium goes to the left to compensate for increased temperature/absorbs the energy/in endothermic direction (ora) ✓ Rate increases/ more successful collisions ✓	[2]
	Other effect High pressures expensive/ high temperatures expensive /high pressures cause safety problems ✓	[1]
QoWC:	One correct statement followed by correct explanation ✓	[1]
(b) (i)	CO H_2 CH_3OH 1.0 2.0 0.0 0.9 1.8 ✓ 0.1 ✓ 0.9/2.8 or 0.321 or 0.32/0.3 1.8/2.8 or 0.643 or 0.64/0.6 0.1/2.8 or 0.036 or 0.04 ✓ 3.21 (MPa) 6.43 (MPa) 0.36 (MPa) ✓ In 3rd and 4th rows, ecf from previous row	[4]
(ii)	$K_p = \frac{p\,(CH_3OH)}{p\,(CO) \times p\,(H_2)^2}$ ✓✓ 1 mark for K_c / use of any [ ] /inverted/power missing.	[2]
(iii)	K_p stays the same ✓ Equilibrium position moves to the right/yield increases ✓ in response to increase in reactants ✓	[3]
(iv)	$K_p = \frac{0.261}{3.70 \times 5.10^2} = 2.71 \times 10^{-3}$ ✓ MPa^{-2} ✓ calc value 2.7120546×10^{-3}; answer and/or units ecf from (ii)	[2]
(c)	$CH_3OH + 1.5O_2 \longrightarrow CO_2 + 2H_2O$ ✓	[1]
		Total: 18

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) (i)	completely dissociates/ionised ✓ proton donor ✓	**[2]**
(ii)	NO_3^- ✓	**[1]**
(b) (i)	pH = $-\log[H^+]$ / $-\log(0.015)$ ✓ = 1.82 / 1.8 ✓ (Not 2)	**[2]**
(ii)	$[H^+] = 0.0075$ mol dm^{-3} pH = $-\log(0.0075)$ = 2.12 / 2.1 ✓	**[1]**
(c) (i)	$K_w = [H^+(aq)]\,[OH^-(aq)]$ ✓ *state symbols not needed*	**[1]**
(ii)	$[H^+(aq)] = 10^{-pH} = 10^{-13.54} = 2.88/2.9 \times 10^{-14}$ mol dm^{-3} ✓ $[NaOH]$ / $[OH^-(aq)] = \dfrac{K_w}{[H^+(aq)]} = \dfrac{1.0 \times 10^{-14}}{2.88 \times 10^{-14}}$ = 0.347 / 0.35 mol dm^{-3} ✓	**[2]**
(d) (i)	a solution that minimises/resists/opposes pH changes ✓	**[1]**
(ii)	The buffer must contain both CH_3COOH and CH_3COONa / CH_3COO^- /weak acid and conjugate base ✓ Solution **A** is a mixture of CH_3COOH and CH_3COONa / / has an excess of acid /is acidic ✓ Solution **B**, contains only CH_3COONa/ only CH_3COO^- /only the salt/ is neutral ✓ $CH_3COOH(aq) + NaOH(aq) \longrightarrow CH_3COONa(aq) + H_2O(l)$ / acid/alkali has been neutralised/ $CH_3COOH(aq)$ and NaOH react together ✓	**[4]**
(e)	$[H^+]$ increases ✓ H_2O ionises more / for $H_2O \rightleftharpoons H^+ + OH^-$, equilibrium moves to the right ✓ exo/endo is 'noise'	**[2]**
		Total: 15

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Question	**Expected Answers**	**Marks**
4 (a)	moles of Cu = 0.68 x 5/1000 = 0.0034 ✓ mass of Cu = 0.0034 x 63.5 = 0.216 g ✓ % Cu = 0.216/0.28 = 77% ✓	**[3]**
	ratios: Cu = 26.29/63.5 = 0.41 1 N= 11.6/14 = 0.83 OR 2 O = 59.63/16 = 3.73 9 H= 2.48/1 = 2.48 6 ✓ empirical formula = $CuN_2O_9H_6$ ✓	**[2]**
	Formula with $3H_2O$ shown separately scores 1: i.e. $CuN_2O_6.3H_2O$ ✓ Correct formula shown with $(NO_3)_2$ scores 2nd mark: $Cu(NO_3)_2.3H_2O$ ✓ (Correct answer automatically scores both marks)	**[2]**
(b)	$Cu \longrightarrow Cu^{2+}$: Cu from 0 to +2 ✓ $NO_3^- \longrightarrow NO$: N from +5 to +2 ✓ $3Cu + 8H^+ + 2NO_3^- \longrightarrow 3Cu^{2+} + 2NO + 4H_2O$ ✓ 'simple balance' as the only creditworthy response scores 1 mark: i.e. $Cu + 4H^+ + NO_3^- \longrightarrow Cu^{2+} + NO + 2H_2O$	**[3]**
(c)	moles of A = 90/24000 = 3.75×10^{-3} ✓ M_r of A = 0.24/ 3.75×10^{-3} = 64 ✓ Gas is SO_2 ✓ $Cu + 2H_2SO_4 \longrightarrow CuSO_4 + SO_2 + 2H_2O$ / $Cu + 4H^+ + SO_4^{2-} \longrightarrow Cu^{2+} + SO_2 + 2H_2O$ / $Cu + 3H^+ + HSO_4^- \longrightarrow Cu^{2+} + SO_2 + 2H_2O$ ✓	**[4]**
		Total: 14

Mark Scheme 2816/3
June 2005

A2 Practical 2816/03
May 2005: Mark Scheme

Planning [16 marks, max]

- *19 marking points are available*

R First stage reaction (8 marks)

R1 Adds <u>excess</u> of a specified iron(II)compound to a <u>pipetted</u> volume of aqueous Cl_2 [1]
The iron(II) compound must be soluble: oxide, carbonate and hydroxide are not suitable

R2 Equation ***or*** ionic equation for the reaction [1]
$Cl_2 + 2Fe^{2+} \rightarrow 2Cl^- + 2Fe^{3+}$

R3 Two correct redox statement(s) made about the role of chlorine in the reaction [1]
Example: "chlorine is reduced because it gains electrons"

R4/R5 **Two** ideas from those listed below, **with** the relevant comment [2]

- stir/ swirl/ heat - to speed up the reaction [of chlorine with iron(II) ions]
- leave for a while – to ensure that reaction has finished
- use a reaction vessel with a stopper - to prevent loss of chorine gas
- avoid [excessive] contact with air - to prevent any oxidation of iron(II) ions
- use fresh source of iron(II) compound - to avoid contamination with iron(III) ions
- use ammonium iron(II) sulphate – more resistant to oxidation by air
- allow for the w.o.c. in $FeSO_4.7H_2O$ in any calculation – so Mr = 278
- use freshly made up/recently standardised aq $KMnO_4$ – solution decomposes slowly

R6 Make mixture obtained up to (say) 250 cm^3 using a <u>volumetric flask</u> with <u>pure</u> water [1]
The mark is for outlining the procedure to make up any relevant standard solution

R7 Correct calculation of [approximate] molar concentration of saturated aqueous chlorine [1]
Approximate concentration = $^{7}/_{71}$ = 0.1 mol dm^{-3}

R8 Calculation of quantity of iron(II) compound needed to ensure that it is in excess [1]
*Example: 25 cm^3 of chlorine needs a **minimum** of 50 cm^3 of 0.1 mol dm^{-3} aq $FeSO_4$*

T Titration procedure (7 marks)

T1 Use known/standard solution of <u>$KMnO_4$</u> for titration in the <u>burette</u> [1]

T2 <u>Pipette</u> aqueous iron(II) ions into conical flask ***and*** add [excess] <u>sulphuric acid</u> [1]

T3 No indicator needed for $KMnO_4$: the end point colour change is to pale purple/pink [1]

T4 First/trial titration outlined ***and*** [at least] two <u>consistent</u> titres obtained [1]
Within 0.05/0.1 cm^3 (unit required) is equivalent to "concordant"

T5 Equation for the titration reaction [1]
The full ionic equation is: $8H^+ + 5Fe^{2+} + MnO_4^- \rightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O$

T6 Calculates concentration of left over Fe^{2+} ions left over in the solution being titrated
or calculates number of moles of iron(II) ions left over in the solution being titrated. [1]

T7 Justifies a suitable concentration of $KMnO_4$ for use in the titration [1]

The concentration needed is about one-fifth of [Fe^{2+}] in the solution titrated

The explanation/calculation given must use the mole ratio from the equation

S Safety, sources and QWC (4 marks)

S1 **Chlorine** is toxic/choking/causes breathing problems ***and*** first stage done in fume cupboard ***or*** wear gas mask ***or*** ensure that lab is well ventilated

Hazard ***and*** *safety measure for chlorine are both required for S1* [1]

S2 References to **two** secondary sources quoted as footnotes ***or*** at end. [1]

Book references must have page numbers

Internet references must go beyond the first slash of web address

Accept one specific reference to "Hazcards" as an alternative to either of the above

S3 **QWC**: text is legible ***and*** spelling, punctuation and grammar are accurate [1]

Allow not more than ***five*** *different errors in legibility, spelling, punctuation or grammar.*

S4 **QWC**: information is organised clearly and coherently [1]

Is a word count given and within the limits 400 – 1000 words?

Is scientific language used correctly? (Allow ***one*** *error without penalty).*

Is the Plan presented in a logical easy-to-follow order?

NB: A student who used an I_2-thiosulphate titration *to analyse chlorine has not answered the question set because this is not a back titration. The student could be awarded a maximum of 12 marks.*

A2 Practical Test (Part B)

Pages 2 + 3: Part 1 [8 marks]

(a) 3 marks

[Solution] loses yellow/orange/light brown colour [1]

[Pale] yellow/cream/cloudy/misty precipitate/suspension forms [1]

Colour and state word are both required

Iodide ions react *(name required)* [1]

(b) 1 mark

Iodine [molecules] [1]

(c) 1 mark

Species from both sides [of the equation] are present in the solution

or silver ions react with iodide ions, thereby moving the equilibrium to the right [1]

(d) **3 marks**

Yellow colour removed ***or*** [solution] goes colourless [1]

NaOH (***or*** hydroxide ion) neutralizes/removes/reacts with H^+ ions ***or*** $H^+ + OH^- \rightarrow H_2O$ [1]

Equilibrium position moves to <u>right</u> [in eq^n 1:1], thereby removing colour/ I_2 [1]
Reference to position of equilibrium <u>and</u> implication are both required

Page 4: Part 2 **[5 marks]**

(a) **1 mark**

Brown/red solution/suspension formed [1]

(b) **3 marks**

The [red] colour is caused by iodine [1]

$2I^- - 2e^- \rightarrow I_2$ ***or*** $2I^- \rightarrow I_2 + 2e^-$ [1]

Iodide ions are oxidized because they lose electrons [1]
*Simple justification is required in terms of electrons (**or** oxidation state increase)*

(c) **Safety: 1 mark**

Peroxide is irritant/causes itching/damages skin so wash with running water [1]
Hazard <u>and</u> remedial action are both required

Page 7: Part 3 - Titration **[10 marks]**

Mass readings [1]

- Both mass readings must be listed with <u>units</u> shown (somewhere)
- All masses should be recorded to two (or three) decimal places
- Subtraction to give mass of **H** must be correct.
- Labelling of the masses must have minimum of the words “bottle”/”container” (*aw*)

Presentation of titration data **[2]**

- Labelled table drawn *and* used to record burette data
- Trial titre is shown *and* is labelled as such
- All “accurate” burette data are quoted to 0.05 cm^3 (i.e. 2 decimal places)
- All subtractions are correct

A table giving only the titration differences forfeits both marks.

Self-consistency of titres [1]

Candidate’s two accurate titres should agree within 0.10 cm^3.
Units, cm^3 or ml, are given somewhere (once in or alongside the table is sufficient)

Mean titre correctly calculated, with “cm^3 or ml” unit given [1]

Candidate must not include the trial when calculating the mean.
Mean should be correctly calculated and quoted to ***two*** *d.p.*

<u>Accuracy</u> – 5 marks are available

Write the supervisor's data (mass and mean titre) in a ring next to the candidate's table.

Work out *what the candidate's adjusted titre* ***(T)*** *would have been if the candidate had used the same mass of* ***H*** *as the supervisor did. Then award marks as shown in the table.*

$$T = \text{candidate's mean titre} \times {}^{\text{candidate's mass}}/_{\text{supervisor's mass}}$$

T is within 0.20 cm^3 of mean supervisor's value → [5 marks]
T is within 0.30 cm^3 of mean supervisor's value → [4]
T is within 0.50 cm^3 of mean supervisor's value → [3]
T is within 0.70 cm^3 of mean supervisor's value → [2]
T is within 1.00 cm^3 of mean supervisor's value → [1 mark]

Spread penalty: *If the accurate readings differ by more than 0.30 cm^3, subtract 1 mark*
Penalties for greater spreads are cumulative

Pages 8 + 9: Part 4 **[7 marks]**

- *Each answer is marked error carried forward to the previous one*
- *All answers should be given to* ***three*** *significant figures*

(a) *n*(thiosulphate) in 250 cm^3 correctly calculated = ${}^{\text{mass used}}/_{248}$ [1]

(b) *n*(thiosulphate) in mean titre, correctly calculated = ${}^{\text{“a” x mean titre}}/_{250}$ [1]
This mark is for the correct answer from candidate' mean titre.

(c) $I_2 + \mathbf{2}Na_2S_2O_3 \rightarrow Na_2S_4O_6 + \mathbf{2}NaI$ [1]

(d) *n*[I_2] in titre = “b” x 0.5 [1]

[I_2] correctly calculated = “b” x 0.5 x 40 [1]
Answer should be about 0.050 mol dm^{-3}

(e) M_r of iodine = 254 [1]

Mass of Iodine = “d” x 254 (correctly calculated) [1]

Pages 10 + 11: Part 5 (Evaluation) **[14 marks, max]**

- *17 marking points are available*

(a) **3 marks**

Inversion mixes the solution ***or*** ensures same concentration [1]

If the concentration in the flask is not uniform, the titres will vary/not be consistent [1]

Titres would be greater [to start with] since the solution at top of the flask is more dilute [1]

(b) **2 marks**

Error/tolerance on pipette is 0.06 cm^3 [1]

% error = $^{0.06}/_{25}$ x 100 = 0.24% [1]

Accept the answer 99.76/99.8 %

(c) **3 marks**

Balance tolerance is 0.01 g (or 0.001 g or 0.005g) [1]

Possible error is doubled because two weighings are needed for **H** [1]

Balance % error = $^{0.02}/_{mass}$ x 100 = 0.33% ***and*** pipette is more accurate
or balance % error = $^{0.01}/_{mass}$ x 100 = 0.17% ***and*** pipette is less accurate [1]

(d) **2 marks**

End point/colour change is sharper/ easier to see when starch is used [1]

The change from blue → colourless is clearer than yellow → colourless [1]

(e) **2 marks**

It **is** reliable because the titration was repeated [1]

Titration differences were consistent/condordant ***or*** were within 0.1 cm^3
or there were no anomalous results [1]

Accept a negative statement if candidate's own readings justify it

(f) **3 marks max** *– award marks for the **best** three ideas from the list below*

Back titration is more complicated/ has more stages/ uses more chemicals *(aw)*
or iodine procedure was simpler /involved fewer measurements [1]

Errors [in measurement] are **cumulative**
or just one extra reading doesn't make much difference [1]

Chlorine gas is more likely to escape from its solution than iodine [1]

Sodium thiosulphate is more stable than potassium manganate(VII) [1]

Burette/meniscus is difficult to read/see when using aq $KMnO_4$ [1]

(g) **2 marks**

No effect on the titre because iodide ions [in KI] don't react [1]

Only iodine reacts with thiosulphate in the titration [1]

These marks are not awarded if there is any confusion between iodine/iodide

Report on the Units

Chief Examiner's Report

General Comments

The Summer 2005 session saw a continued increase in entries.
For AS level aggregation, numbers increased from 11,228 in Summer 2004 to 12,719 in Summer 2005.
For A level aggregation, there was an increase from 8,619 in Summer 2004 to 9,277 in Summer 2005.
Unfortunately, there continues to be a sizable minority of candidates who achieve little in the examinations, particularly at AS level. It is evident that many centres use the AS year to filter out students for the A2 year. The aggregation figures above indicate that about 25% of students do not progress from AS Chemistry.
The most popular A2 options continue to be Biochemistry (3874 entries) and Transition Elements (3128 entries).
Overall, the examiners continue to be extremely impressed with the high standard of work seen in the examination papers and this is a clear reflection of the work put in by teaching staff and their students.
From candidates' responses, it is clear that many centres are using mark schemes extensively. Some candidates seem to be learning mark schemes by rote, but possibly at the expense of understanding. Examiners are now seeing on candidates' scripts some of the abbreviations, annotations and conventions used in mark schemes as examiner guidance. Examples seen by examiners this session included 'aw' (alternative wording), 'ora' (or reverse argument) and 'owtthe' (or words to that effect). This presumably is a consequence of increased transparency in the examination process and also pressure to produce better examination results. It would indeed be a pity if chemistry courses became over-dominated by the need to memorise examination mark schemes.
Across the whole suite of AS and A2 units, structure and bonding continues to create considerable problems for many candidates, particularly a confusion between the type of particle and the related type of bonding.

Revision of coursework exemplars

Teachers in Centres are again reminded of a major revision of the Coursework guidance that took place in 2003. Details of the experiments may be found on the OCR website or as a printed Teacher's version from OCR. It is essential, to maintain consistent standards nationally, that the revised exemplar experiments are used in place of the 'old' exemplars. There are still some centres using the old exemplars and this has been penalised during moderation this year.

Entry to modules

Centres are again reminded of the codes that are to be used for entry in those units of assessment with more than one component.

AS

2813	A	How far, how fast? + Coursework
2813	B	How far, how fast? + Carry forward coursework mark
2813	C	How far, how fast? + Practical exam

A2

2816	A	How far, how fast? + Coursework
2816	B	How far, how fast? + Carry forward coursework mark
2816	C	How far, how fast? + Practical exam

Options

2815	A	Trends and patterns + Biochemistry
2815	B	Trends and patterns + Environmental chemistry
2815	C	Trends and patterns + Methods of analysis and detection
2815	D	Trends and patterns + Gases, liquids and solids
2815	E	Trends and patterns + Transition elements

2811: Foundation Chemistry (Written Examination)

General Comments

Overall the standard of performance by the candidates in this paper was slightly better than that of previous years. There is no doubt that the changes to the format of the final question gave candidates a structure within which they could display better their knowledge and so gain more marks. This said, however, there is no doubt that the general performance was higher and it appeared that candidates made fewer serious errors than in previous years. In addition, the standard of answers appeared more uniform across the different questions. Of the different concepts that are examined it is still the case that redox chemistry presents candidates with the greatest difficulty

Comments on Individual Questions

1) (a) Both parts of this question were well answered and provided an excellent start for most candidates.

(b) Again most candidates were able to handle this calculation with ease and few failed to give the answer to the required number of decimal places.

(c) Mostly this was well answered. Apart from the handful of answers that were very wide of the mark, some responses featured $3d^4$ in their electronic configuration.

(d) (i) Once again most candidates answered this part well by annotating a suitable diagram. Nearly all candidates involved delocalised electrons in their description but some candidates did fail to identify the metal ions, describing either protons or metal atoms in their place.
(ii) The answers of a significant number of candidates fell short of this mark by stating that conduction relied on the presence of delocalised electrons and so failing to show that it is the ability of such electrons to move that confers conductivity.

(e) (i) This was well answered.
(ii) Although nearly all candidates used the relative atomic mass of chlorine correctly, many failed to subtract the mass of titanium from the mass of titanium tetrachloride and so performed the calculation using 5.70 g of chlorine. A number of candidates simply assumed a 1:2 stoichiometric ratio of reactants to products and thus assumed the product would be $TiCl_2$.
(iii) Some candidates found this surprisingly difficult even where their answers to the two earlier parts had been correct. In some cases they divide the answers to (i) and (ii) by the atomic mass a second time, in other cases they performed the entire calculation again.
(iv) Most candidates were able to give a balanced equation describing the formation of the chloride they had proposed in part (iii). There were a number of careless errors, most noticeably the use of Cl in place of Cl_2.
(v) In terms of the bonding, many candidates were able to identify this as covalent. Many candidates felt it necessary to convey all their thoughts here and to describe why neither metallic nor ionic bonding occurs in $TiCl_4$. Far fewer candidates went on to describe the structure of **X** as being simple molecular.

2) (a) Most candidates gave a correct answer to this initial part.

(b) Although many candidates correctly stated that reduction involves the gain of electrons, very few went on to illustrate this using the extraction of radium. Of the few that did try, the answers they produced were extremely confused and often described the transfer of electrons from radium to chlorine in the bonding or formation of $RaCl_2$. Presumably, the absence of an equation for the process made it difficult for most candidates to identify the reduction process. This is supported by the fact that many of these candidates were able to identify oxidation states correctly in question 4(a).

(c) (i) Most candidates foresaw the bubbling of hydrogen gas although some lost the mark by failing to note the 'see' in the question and so referred to the evolution of gas. Fewer candidates, although still a reasonable proportion, noted that the radium would disappear or dissolve.
(ii) This was very well answered, nearly all candidates gave a pH in the basic range.

(d) (i) A large majority of the candidates identified that the process involved ionisation but fewer gained the additional mark for noting that it is the first ionisation. Many candidates gave a correct equation but very few added state symbols. A significant number of candidates were confused by the presence of Ra(II) in the earlier part of the question and so gave equations involving Ra^{2+}.
(ii) Of the responses required for this answer, most identified the greater radius of the radium atom, fewer referred to the increase in shielding of the nuclear charge or to the decrease in attraction of the electron. A few candidates did discuss the competing factors of higher nuclear charge and greater distance. Although this gained no marks it was, nevertheless, pleasing to see that some candidates at least appeared to have a good grasp of the factors that dictate the trend in ionisation energies.

3) (a) This was extremely well answered with almost all candidates gaining this first mark.

(b) (i) This was generally well answered.
(ii) Most candidates appeared to have a reasonable idea about how to tackle this part of the question. Where errors did occur, they were the result of failing to note the 1:2 stoichiometry of the reaction or miscalculating the molar mass of $Mg(OH)_2$ (often omitting one of the oxygens). A number of candidates tried to involve the mass of 2.42 g in their calculation and a few even went on to compare the required amount with that taken in terms of the quantities expressed in the number of moles.
(iii) The majority of the candidates picked up the mark for this relatively straightforward part of the question.

(c) This was well answered. Almost all the candidates identified the reaction of $CaCO_3$ with acid and a very pleasing number were able to give a balanced equation. The most common error involved CaCl as one of the products. In some cases this error was perpetrated by candidates whose performance elsewhere on the paper was of a good standard. It is depressing to see these candidates commit such a fundamental error of this sort.

4) (a) Nearly all candidates were able to assign the oxidation state of Cl in NaCl but fewer were able to give the correct oxidation state for Cl in Cl_2 or NaOCl. Frustratingly, some candidates correctly identified the processes of oxidation and reduction but failed to state at any point in their answer that the oxidation state of Cl in Cl_2 is zero. The term disproportionation was relatively rarely used

but credit was given for any explanation that chlorine had been both oxidised and reduced.

(b) (i) This was moderately well answered. Although a significant number of candidates failed to balance the equation properly, others made more serious errors. It is clear, given that iodide ions, iodine and chlorine are all referred to in the question, that for some candidates the difference between a halogen and a halide is still a cause of confusion.
(ii) This was the most poorly answered question on the paper. Although many candidates gained the first mark by identifying the smaller radius of a chlorine atom few went on to discuss how this leads to a greater attraction for electrons. Of those that did, only a handful made clear that the electron in question is an additional one that is gained. In many answers there was a great deal of confusion often involving discussion of electronegativities.

5) There is no doubt that presenting this final question as a series of parts greatly alleviated the problems that candidates experienced in the past with structuring their answers. As a consequence the candidates were given an easier opportunity to show what they knew and overall this resulted in a better quality of answer.

(a) (i) Most candidates scored well here. A failure to involve the lone pair in the bonding was a common error.
(ii) Many candidates discussed the lower density of ice compared to water and were able to explain this in terms of an open structure in the solid phase. Of the other anomalous properties of water that relating to its boiling point was clearly in the mind of nearly all the candidates. Many, however, did not pick up these two marks, firstly by failing to identify the unusual nature of the higher boiling point than expected and secondly by omitting to discuss how intermolecular bonds must be broken upon boiling.

(b) Most candidates gave a correct angle of 107° and many identified the importance of the lone pair in determining this value. Although nearly all candidates knew that repulsion was involved many did not gain credit as they failed to discuss the repulsion between electron pairs. It is clear that a confusion arises between the repulsion of single electrons, for example when they occupy the same orbital, and the mutual repulsion of pairs of electrons that is central to VSEPR theory. Of the candidates who scored three of the possible four marks in this part of the question, the most common omission was to fail to discuss the idea of minimising the repulsion by placing the pairs of electrons as far apart as possible.

(c) Generally this was well answered. Nearly all candidates focussed on the increase in nuclear charge and its resultant increased attraction for the valence electrons but many also noted that the electrons were in the same shell. A number of candidates became confused with the trend in ionisation energies and so discussed the repulsion of two electrons in the same orbital of the oxygen atom. In some cases this led to answers in conflict with the given data.

2812: Chains and Rings (Written Examination)

General Comments

The paper produced a spread of marks with the marks ranging from 1 to 60. Very few scored below 10 marks but equally the top 8 or 9 marks were elusive. Weak candidates found the paper challenging and a substantial number scored between 20 and 30, whilst able candidates coped well and many scored between 40 and 50.

The majority of candidates seem to have been well prepared. Candidates displayed good examination technique in questions 1 to 4 but most struggled with the final question. There was no evidence to suggest that some candidates ran out of time.

The extended writing question, Q5, proved to be very challenging and even the most able struggled to structure their response. Q5b involved using data, which was unfamiliar to the students, and most found it difficult to respond. Even the most able students often scored below half marks.

The majority scored the marks allocated for "quality of written communication".

Comments on Individual Questions

1) (a) This was an easy start with most scoring the mark. Most candidates are now aware of the need to write molecular formulae in the C_xH_y format.

(b) Part (i) was well answered with most scoring the mark.
In (ii), the majority correctly related the variation in boiling points to the amount of intermolecular forces but a substantial minority incorrectly related boiling point to the number of C–C and C–H bonds.

(c) In (i), most scored the mark.
In (ii), most showed a correct equation but many did not know the essential conditions which are clearly stated in the specification.

(d) Candidates found (i) straightforward and drawing skeletal formulae of branched alkanes was well done
Part (ii) was poorly answered, with few using the information given in the question. Anything within the range 85 ^{o}C to 98 ^{o}C was accepted.

(e) Many struggled with this part. Many forgot to include H_2 and others wrote cyclohexane as C_7H_{14} which was not accepted as it is ambiguous. Many drew the cyclic structure of cyclohexane but couldn't resist putting a ring within the hexagon.

(f) This easy mark was scored by almost all.

2) (a) Most candidates coped well with this and scored all three marks.

(b) Part (i) was generally well answered. However, a substantial number of candidates still explain what is meant by a nucleophile as its "love of protons". Nucleophiles and electrophiles should be defined in terms of movement of electron pairs.
In (ii), the understanding of mechanisms is improving and many successfully tracked the movement of electrons through the reaction. However, the response was often centre-specific such that all candidates from a particular centre either answered this very well or very badly. In order to score full marks the curly arrow had to start and finish at the correct points.

(c) Part (i) provided easy marks for most.
In (ii), many struggled with the skeletal formulae of propan-1-ol and propan-2-ol. This was in contrast to the ease with which candidates answered Q1(d). Propan-1-ol was particularly challenging with many drawing the skeletal formula of ethanol instead of the correct structure.

(d) Part (i) was straightforward for most.
In (ii), the naming of polymers still proves to be difficult.
Part (iii) was much better answered with a substantial number drawing the correct repeat units.

3) (a) In (i), the structure of prop-2-en-1-ol was well answered but many drew the aldehyde group in acrolein with C–O rather than C=O.

(b) Part (i) proved to be surprisingly difficult with very few scoring both marks.
In (ii), many struggled despite the formula of both reagent and product being given at the start of the question.

(c) This was generally well answered with most candidates finding infra-red spectroscopy straightforward
Part (i) was a difficult question but it was very pleasing to see the number of correct responses.
In (ii), there were some really pleasing answers and it is pleasing to see so many candidates able to apply their knowledge to unfamiliar situations.

4) (a) Part (i) was generally well answered with most scoring the mark.
In (ii), as with Q2(b), the understanding of mechanisms is much improved with responses very centre-specific.

(b) Many simply drew any isomers of $C_3H_6Br_2$ and often repeated 1,3-dibromopropane. Two marks out of three were very common.

5) (a) Although taken directly from the specification (Assessment Outcome 5.2.6 (d)), this part was very poorly answered and it appeared to be unfamiliar to very many students. A substantial number identified silver nitrate as the reagent but failed to clearly mention the differential rates of appearance of the precipitate. Many students recognised that the rate of hydrolysis for the halogenoalkanes varied from chloro- to iodo-, but it was uncommon to see responses that considered how the rates differed and which was faster. Many candidates did not write any equations and many tried to incorporate the nitrate ion and/or the Ag^+ ion into the organic product. Few, if any, managed to correctly state the correct conditions and procedure.

(b) Many failed to comprehend the first part of this section and did not use the evidence from Midgley's demonstration to predict appropriate properties. The understanding of why a gas put out a flame was very poor.
In the second part many did not read the question correctly and mentioned CCl_2F_2 as a refrigerant or coolant. Candidates often suggested a use of CFCs but then failed to justify this with a reason. Others simply could not identify the uses of CFCs. Many candidates mentioned that CFCs, such as CCl_2F_2, destroy the ozone layer, which was not relevant to the question. Better examination technique could have resulted in an extra 3 or 4 marks for many candidates.

2813/01: How Far, How Fast? (Written Examination)

General Comments

It was evident that most candidates were well prepared for the unit test and in very few cases were a significant proportion of a Centre's candidates apparently not ready to at least attempt the questions in a meaningful way.

It was pleasing to note that the majority of candidates were familiar with the concepts underpinning the calculations on the paper but slightly disappointing to note how many answers lacked real structure and explanation of the steps involved. Where a standard formula such as $Q = mc\Delta T$ is to be used, candidates would be advised to quote the formula and hence potentially gain credit for that. If they then substitute incorrect numbers, they will then score at least some of the potential marks.

As noted in previous years, there were examples where marks were not gained through candidates not reading/ignoring the instructions given in the question. A particular example in this case is Q2(b) where the question specifically asks candidates to describe what they would **see** when particular changes in condition are applied. A significant number clearly understood the use of le Chatelier's principle but never actually stated what would be seen.

In spite of numerous attempts to highlight the problem, it would appear that candidates find ionic equations challenging.

Comments on Individual Questions

1) (a) In (i), most candidates clearly knew how to solve this type of problem, and many gained full marks. Common mistakes included incorrect multipliers for numbers of bonds (eg. 2 x O–H) and also reversing the signs for the bonds broken and bonds made. Answer: –577 kJ mol^{-1}.

In (ii), a significant number of candidates did not attempt this part. Of those who gave an answer, common incorrect responses included dividing (i) by 1000 or simply repeated their answer to (i). If the candidate realised the basis of the question, the answer was generally correct. Answer: –18 kJ.

(b) Since the question required candidates to **suggest** why hydrazine is preferable to ammonia for use as a rocket fuel, this gave an opportunity to apply chemical principles, so that a variety of answers were acceptable. Some logical answers were seen but others confused the signs of the enthalpy changes or ignored the information given in the question that the products of the reaction and the energy released per gramme on combustion were the same.

(c) In (i), apart from a few candidates who stated that ammonia was behaving as an acid or a catalyst, most recognised its function in the equation given.

In (ii), most candidates gave an acceptable use, generally as a fertiliser.

In (iii), most recognised a use for ammonia and the examiners were very tolerant in accepting a variety of ways of describing the use. It is clearly preferable, for example, to write 'used in the manufacture of explosives', rather than 'as explosives'. It was perhaps surprising how often the answer 'in the Haber process' was given.

2) (a) Most candidates knew the basic idea of le Chatelier's principle and, although some suggested that the change in condition made could be completely 'cancelled out', this was less common than has been seen in previous years. Candidates are clearly learning to use the words that are considered acceptable to express this idea.

(b) As already discussed, a significant number of candidates did not actually describe what would be **seen**. This was a pity since often explanations showed good understanding of what was happening to the equilibrium position. It should be noted that it is not acceptable for candidates to state 'it is an exothermic reaction' without saying that this is in the forward direction since clearly the reverse direction is endothermic. A small but significant number lost marks by stating or implying that, once shifted to the left, the equilibrium would then move to the right again to 'restore itself' or 'oppose the change'. A small number of candidates misinterpreted the question completely and discussed rates of reaction.

(c) In (i), consideration of changes in oxidation numbers was slightly disappointing. Although some candidates calculated the relevant oxidation states, others tried to discuss oxidation numbers of hydrogen and/or oxygen. A few identified oxidation numbers correctly but then claimed that +4 to +5 was reduction and +4 to +3 was oxidation.
The mark in (ii) was scored by the vast majority of candidates although some simply put "power stations" or, even more vaguely, "factories". Neither of these responses was considered sufficiently specific.

(d) In (i), whilst most candidates scored this mark, N^{3-}, H^- or H were occasionally seen.
In (ii), candidates appear to find writing ionic equations difficult and only the most able scored both marks. Many gained 1 mark as credit for recognising carbon dioxide as one of the products but few recognised that spectator ions or whole formulae should not be included.
In (iii), although a variety of terms were allowed, it was intended that candidates should recognise the role of a chemical reaction in the potential downfall of the cathedral.

3) (a) Most candidates knew and correctly defined the enthalpy change of combustion, although a few defined it in terms of energy 'required'. A significant number made reference to standard conditions. This was ignored as it was clearly unnecessary in the definition as requested.

(b) While the majority of candidates knew how to write the equation and scored one mark, a large number failed to balance it properly with $5O_2$ being common. Very few, however, scored the second mark for correct state symbols. Most omitted them completely and, of those who did write them, many gave propan-1-ol as (aq) and/or water as (g).

(c) In (i), most candidates clearly appreciated the need to use the formula: $Q = mc\Delta T$ and many scored both marks. However, a large number incorrectly used the mass as 0.100 g. A few candidates did not recognise that the calculated value was in J and therefore did not change this to kJ in quoting the final answer. Answer: 2.68 kJ
In (ii), explanations were often totally absent but credit could be given to correct answers. Reasonable approximations of significant figures were allowed but candidates should recognise that 1.67 could not reasonably be approximated to 1 or 2 in this context. Answer: 0.00167
In (iii), candidates were given credit for dividing (i) by (ii), even if one or both of these were incorrect numerically. A significant number of candidates however failed to attempt this part of the question. Answer: 1608 kJ mol^{-1}

(d) Many acceptable reasons were seen and credited, the most common being heat loss, heat going into equipment rather than the water, incomplete combustion and the lack of standard conditions. However a very large number of candidates suggested errors that amounted to experimental incompetence, such as incorrect readings or impurities in materials. These were not accepted.

4) (a) Most candidates knew that a catalyst speeds up a reaction but a significant number stated or implied that it did not take part in the reaction. This meant that they were given one mark.

(b) The mode of action of heterogeneous catalysts was well known by many candidates but a significant number suggested the reactants were a**b**sorbed by the catalyst.

The majority of candidates clearly knew what homogeneous and heterogeneous catalysts were and defined the terms in an acceptable way. A number of suitable heterogeneous examples were credited, the most common being iron in the Haber process and platinum, etc., in a catalytic converter. The most common homogeneous examples were Cl in ozone depletion or acid in esterification.

Very many candidates gave more than one equation, despite the instructions in the question. If both were correct this had no effect but, if one was incorrect, the mark available for the equation could not be awarded.

2813/2: Coursework I (Coursework)

General Comments

An increasing number of Centres used the coursework option to assess their candidates' practical skills. The majority applied the published criteria reliably and within the tolerance allowed for the assessment. The Moderators were grateful for the generally high standard of presentation of the work and for the careful annotations that had been included on the scripts. There is however still a significant number of teachers who appear to be uncertain of the standards expected. Mostly this is apparent for the awarding of marks in which a candidate has made a point to insufficient depth to be acceptable. For example, skill E (Evaluation) should extend beyond stating that a burette would be read more carefully or that a solid would not be spilled and so on. These are normal laboratory precautions and not improvements. It should also be appreciated that repeating an experiment many times does not necessarily produce a better result if the failing is procedural.

Although no penalty was applied this year, references, which are a requirement of skill P7a, should be precise and refer to the particular page in a book or give a detailed web reference. P7a must not be awarded if candidates 'spelling, punctuation and grammar' are not of sufficient standard. This should be taken to include the correct use of sub- and super- scripts – a frequent error in work that has been word-processed. Candidates should be advised to be careful how numerical data are rounded during the course of a calculation. There were a large number of instances in which the answer quoted was substantially inaccurate as a result and, in these cases, A7b could not be justified.

The listing of hazards likely to be encountered in performing an experiment is still an area of misunderstanding. It is not intended that the full contents of a hazcard should be copied but rather a clear assessment should be made in the context of the experiment being performed. So dilute hydrochloric acid may well be an irritant but it does not fume nor is it best described as corrosive. Diluting it from 2 mol dm^{-3} to a less concentrated solution does require care but it is not a hugely dangerous procedure. Likewise listing the problems of handling a solid is irrelevant when the experiment involves a solution which is provided. The Moderators rarely penalised these statements but it was felt that Centres might advise candidates more carefully.

Some packages of work received included the form CEF 2813/6 which is used to answer a coursework enquiry but should not be included at the examination stage. The necessary paperwork is a copy of the MS1 form, the Coursework Summary Form (CSF 2813/6) and the Centre Authentication Form. Individual Candidate Authentication Forms should **not** be included but held instead at the Centre.

Comments on Individual Skills

It is emphasised that candidates are expected to use the proformas provided to help them structure their responses for skills A and E. Some Centres seem to expect candidates to make a free response for these skills but the evidence suggests that this makes it noticeably harder and can lead to essential points being missed.

Skill E continues to present the greatest challenge and many scripts failed to address the issue of the main sources of error (required for E5b) satisfactorily. It is clear that practice is necessary within the teaching schedule to explain to candidates what is expected. The published marking scheme implies that this error should apply to measurements but, since this is not made explicit, the Moderators also accepted significant procedural errors where this was appropriate. However, where candidates do identify relevant errors they should be careful to provide a correct reason. For example, in the determination of the relative atomic mass of lithium, a two decimal place balance creates a significant potential error in the small mass of lithium which is quite independent of whether the lithium was impure, oxidised or coated with oil. It is intended, incidentally, that Centres should not use a more accurate balance for this experiment as it makes the evaluation harder for candidates.

Centres were generally more consistent in their application of the criteria for skill A but candidates were often vague in their approach to significant figures. The same was true for skill I where the accuracy appropriate to a piece of apparatus was not always appreciated. Centres are reminded that experimental observations should be made during the preparation of ethanal and that the initial reading must be present when using a burette.

The calculations required for the exemplar experiments for skill P were not always well done and it was felt that Centres were sometimes too generous in their award of level P5a. For example, in the limewater experiment it is insufficient to just state a random dilution for the hydrochloric acid; it should be calculated from the information given for the limewater.

2813/03: Practical Examination II (Practical Examination)

General Comments

Many candidates found the paper very accessible and there were a number of high raw marks. The Plans were generally well written, although there were not quite as many scoring top marks as usual. Many of the word-processed answers were a delight to mark, but a small number of hand-written submissions were almost illegible. The practical section in Parts 1 – 4 was well answered by the majority of candidates. However, as usual, it was the Evaluation section that caused most difficulties. Candidates often penalised themselves by giving answers that were not expressed in clear, unambiguous English or that were not sufficiently precise.

Teachers and lecturers are asked to remind their candidates to write/type on only one side of the paper when writing the Plan. In addition, it is **very** helpful if Plans and Tests are attached with treasury tags (not with pieces of string) and with the Practical Test on top.

Comments on Individual Questions

Plan The general standard of Plans was high, and the tasks set gave scope for a variety of strategies to be employed. Relatively few candidates reported having done research on what other ingredients might be present in the indigestion tablets apart from magnesium carbonate. Many candidates did not state precise details of the sources they used (page numbers referred to in titled books are required); very few used footnotes at the point of use. Other candidates over-stated the safety problems of HCl (which is not corrosive unless used at a concentration above 6.5 mol dm^{-3})

Most students employed a gravimetric experiment involving a crucible for section (a). Many very thorough and concise responses were read. Other candidates attempted to collect and measure the gas produced from heating the magnesium carbonate in the tablet. Few seemed aware of the practical difficulties of measuring the volume of gas accurately and so this alternative proved less productive in terms in the number of marks gained.

A number of different procedures were described for the reaction with acid. Collecting and measuring the gas volume proved to be the most popular and the most high-scoring method. It was encouraging to see that many candidates presented clear calculations to justify the quantities of reagents used. However, some wasted time by showing how the % purity would be calculated from their results, despite the fact that this calculation was not required by the task set.

Other students approached the problem by measuring mass loss when acid is added to tablets. This approach scored fewer marks, partly because candidates were generally not aware that the carbon dioxide takes a considerable time to diffuse out the flask, so a comment such as "measure the mass when fizzing stops" is not accurate. A few candidates opted for a back-titration and there were some well-crafted descriptions of this technique. A common error was to make up a "solution" (sic) of the magnesium carbonate in the tablet and then attempt to carry out a simple titration with acid. Candidates who chose this method were awarded some marks, but their score was "capped".

Test **Part 1** This section was well answered. Most candidates stated the need for constant mass during heating. For convenience of marking, Examiners awarded three accuracy marks in Part 2 rather than in Part 1. The distribution of marks on candidates' scripts was therefore slightly different to the number of marks indicated on the question paper and candidates were not adversely affected by this change.

Part 2 The standard of accuracy, marked relative to the supervisor's results, was very high indeed. However, a few supervisors reported results that seemed highly dubious: this is almost certain to count against their candidates. Many weaker candidates did not calculate the masses correctly in questions (a) and (c): these were sometimes quoted the wrong way round. Some candidates are confused between 3 decimal places and 3 significant figures: inappropriate use of significant figures is always penalised, but only once. In the final step of the calculation, the majority of candidates managed to arrive at the correct answer, **x** = 7.

Part 3 Even some of the better students did not act on the instruction to draw a table of observations, nor did they observe (and report on) what was happening after two minutes. Some did not notice the initial reaction of the sulphuric acid before the surface layer was formed. Although (d) was generally well answered, some candidates were not careful enough to specify what collisions were being prevented.

Part 4 This was well answered by most candidates. Inevitably, though, many students were content to record "milky", rather than the more precise "white precipitate" for the observation in (b). Relatively few were aware that hydroxide ions cause alkalinity.

Part 5 This proved to be the lowest scoring section but, encouragingly, some weaker students performed relatively well. The ability to communicate their ideas clearly let down a number of candidates in this part of the paper. For example, in **(a)** the lid is kept on at the start to prevent escape of solid. In **(b)(i)** the disadvantage is a high % error in the weighings when a low mass is used. In both of these cases, many answers lacked the precision being sought.

Relatively few candidates in **(c)** were able to focus their answers on the numbers/concentrations of hydrogen ions present. Many wrongly suggested that sulphuric acid is a weak acid, whereas it is strong in its first ionisation. Confusion between the terms "strong" and "concentrated" was common. In **(d)**, far too many candidates gave irrelevant suggestions, such as accurate measurement of the volumes of acid. This was not credited because the volume of acid does not affect the initial rate of reaction. Better answers compared the volumes of gas produced with time and addressed the need to weigh the marble chips and to use constant surface areas in each case.

2814: Chains, Rings and Spectroscopy (Written Examination)

General Comments

The paper produced a wide range of marks with a good number of centres preparing their candidates very well. There were relatively few very poor scripts, which is to be expected as candidates finding the subject very challenging will often have decided not to continue to A2 level. However, this does mean that all candidates must have a precise knowledge of the specification content to be sure of scoring well at this level. Candidates clearly benefit from using past papers to practice answering the questions. A greater number this time had a good knowledge of some of the key areas of the specification, such as explanations for activation of the benzene ring and the basicity of amines. Candidates are also becoming more confident at answering questions set in novel contexts, and it is hoped that teachers will continue to be encouraged to present the subject content in interesting and different ways as they prepare their candidates. There was no evidence that candidates ran short of time on this paper.

Comments on Individual Questions

1) (a) Most candidates identified the benzoate ion and water as the products of neutralising benzoic acid with sodium hydroxide, but a significant number did not gain the second mark for balancing the ionic equation. Ionic equations are introduced at AS level and candidates should expect to meet them in a variety of contexts by this stage.
A surprising number thought that phenylmethanol, rather than just the 4-methylphenol, would be neutralised by sodium hydroxide.

(b) Most candidates identified the products of the reaction with sodium metal, although a few did not balance the equation correctly.

(c) Most candidates answered this well. Any strong acid was accepted here for the catalyst, as the question was not requiring the conditions to make a good yield of the ester.

2 (a) Candidates are becoming much more confident at drawing skeletal formulae and few had problems with this example.

(b) Relatively few however could explain that *cis-trans* isomerism arises due to non-rotation of the C=C bond **and** the requirement for different groups on each double bond carbon. Many simply described the difference between the *cis* and *trans* isomers. Teachers should note that this type of stereoisomerism is on the A2 as well as the AS specification, and it is well worth reviewing the topic again before the exam. Candidates however had fewer problems distinguishing between *cis* and *trans* isomers of cinnamaldehyde.

(c) Most knew that the aldehyde group is reduced by sodium borohydride, although again a few struggled with the balanced equation.

(d) This part produced a wide range of responses, with some candidates writing excellent answers, while others had simply learnt that the result is a silver mirror without understanding how or why. Full credit was given to those who identified the ammonia and silver nitrate as the essential ingredients of Tollens' Reagent, although some forgot to mention that the mixture must be warmed to get a result. An equation involving the complex ion was not required as it is beyond the scope of this specification, but candidates did need to be clear that it was the silver ions that were being reduced to form the silver mirror.

3) (a) The electrophilic substitution mechanism was well known and few candidates seemed to be put off by the less familiar context. However some were still not gaining all the marks when curly arrows or the structure of the intermediate were not precisely enough drawn. Also teachers should reinforce the idea introduced at AS that an electrophile always accepts an electron pair (but not a lone pair, as the electron pair comes from a π bond in this type of mechanism).

(b) The equation for the Friedel-Crafts reaction was well known.

(c) The activation of the benzene ring by an OH group was well explained by many of the more able candidates. It is important that they are clear that this is due to delocalisation of a lone pair of electrons. A few candidates also confused this effect with an explanation for the increased acidity of phenols. A good number adapted their knowledge of the reaction with bromine and phenol and correctly predicted the 2,4,6 substitution by the methyl groups, although 2,4,6-trichlorophenol was a common incorrect answer.

4) (a) A suitable aqueous acid or alkali had to be identified for the hydrolysis of a peptide, but it is also necessary to heat this mixture under reflux, as the peptide bond is relatively hard to break. Most candidates knew that amino acids are formed and could draw the structure of one of them. However very few picked up the cue to give the correct ionic form for the reagent that they had used. Hydrolysis as the reaction with water to split the compound, in this case by splitting the peptide bond, was only well described by the better candidates.

(b) Optical isomerism and its implications for drug synthesis were well described overall. There is a range of possible ways to synthesise only the correct isomer, including starting with chiral compounds using a stereospecific catalyst (such as an enzyme) or separating the mixture by a suitable method such as chromatography. Some candidates thought that production of a mixture might be disadvantageous because it would be expensive to separate. However this is still sometimes the cheapest approach if a suitable catalyst is not available.

5) (a) Most candidates could explain the origin of name of the 1,4-diaminobenzene and are clearly confident with the use of systematic IUPAC names for organic compounds.

(b) Many correctly identified the conversion of the 1,4-dinitrobenzene to the 1,4-diaminobenzene as reduction. However, the reaction does require concentrated hydrochloric acid with the tin and the mixture must be kept under reflux to prevent the heat generated by the reaction evaporating the reactants. The equation was harder than some to balance, but a pleasing number of candidates deduced the correct number of [H] to form four water molecules.

(c) The explanation for the basicity of primary amines was better known than in previous sessions. It was important that candidates identified the role of the lone pair of electrons on the nitrogen. In the comparison between hexane-1,6-diamine and 1,4-diaminobenzene, for full credit it was necessary to refer to both the positive inductive effect of the alkyl groups in the alkylamine as well as the opposite effect of the delocalisation of the nitrogen's lone pair for the aromatic amine. When describing the inductive effect, it is important that candidates are clear about the direction of electron flow. Vague answers such as "increased basicity is due to the inductive effect" were not credited.

(d) Most candidates had a good understanding of condensation polymerisation and knew the formation of Kevlar from its monomers. Uses of Kevlar were accepted as long as they required a particularly strong fibre.

6) (a) Most candidates correctly identified the peak at m/e=74 to deduce that the M_r of the compound was 74. As long as candidates also stated that the atoms in the empirical formula would add up to 74, then they could justify that the empirical formula was also the molecular formula. Credit was given for those who provided clear reasoning. Some candidates would benefit from a little more practice at this type of question, so that they feel more comfortable with the type of explanation needed.

(b) This was very well known, although a few candidates forgot to state that 2,4-dinitrophenylhydrazine reacts with both aldehydes and ketones.

(c) A pleasing number of candidates gave the correct names as ethyl methanoate and propanoic acid.

(d) Candidates generally find infrared spectroscopy easy at this level, although some did not give both the bond responsible and the wavenumber of the peak in their reasoning. In identifying the absence of a peak, the correct range as given in the *Data Booklet for Chemistry* should be quoted; in this case the range between 2500 cm^{-1} and 3300 cm^{-1} for the O–H in the carboxylic acid. A few candidates appeared to think that the small peak at around 3000 cm^{-1} was due to the O–H. It would be worth pointing out to candidates that a C–H peak always occurs in this region.

(e) The majority of candidates identified the correct structure from the n.m.r. spectrum. However only a minority scored full marks for explaining their reasoning by referring to all the aspects mentioned in the question. For the □ value, it was important to identify which group in the particular molecule was responsible for the peak, and not to just list all the possibilities in the *Data Booklet* for that range. Many identified that there were two chemical environments, but didn't go on to explain that the 1:1 ratio of peak areas resulted from an equal number of protons in each. In describing the peak splitting, it is important that candidates demonstrate that they know that protons on adjacent carbons are responsible, rather than just give vague terms such as "has no neighbours". In this question, the quality of written communication was a little more demanding than usual so that credit was given to those using technical terms such as 'protons', 'environment', 'adjacent' or the units of δ as ppm.

2815/1: Trends and Patterns (Written Examination)

General Comments

This examination paper allowed candidates of all ability levels to show positive achievement. The paper had a mean mark of 26 and candidate scores covered almost all of the mark range. There was little evidence, in terms of incomplete answers to question 3, that candidates did not have sufficient time to finish.

Candidates found question 3 that focussed on the chemistry of transition elements, the most accessible. The examination paper contained a large proportion of marks that were synoptic in nature and relied on knowledge and understanding of theories, ideas and concepts from other modules within the AS and A2 specification. As in previous examination sessions there was evidence that a significant proportion of the candidates had not fully prepared themselves for the synoptic element of the examination paper.

Many candidates failed to use chemical terminology correctly such as ionic bonding, covalent bonding, intermolecular forces, ion, atom and molecule. Many Assistant Examiners commented that candidates' answers to calculations were often poorly presented with little evidence of a logical argument.

Comments on Individual Questions

1) This question focussed on the chlorides of some of the elements in Period 3.

(a) Although many candidates could draw '*dot-and-cross*' diagrams for magnesium chloride and silicon(IV) chloride, there was a significant number who made mistakes. The most frequent misconception with magnesium chloride was to draw a '*dot-and-cross*' diagram for a covalent molecule. Other candidates did not clearly show the transferred electrons even though they did give the correct charge on the ions. Candidates found the '*dot-and-cross*' diagram for silicon(IV) chloride much easier than that for magnesium chloride. A frequent error for silicon(IV) chloride was not to include all the outer electrons on the chlorine atoms.

(b) Despite the bullet points in this question some candidates did not describe the experimental observations or state the pH value after addition.

The majority of candidates stated that silicon(IV) chloride reacted with cold water; most referred to a hydrolysis reaction and gave a chemical equation. A small proportion of candidates referred to a substitution reaction. Both SiO_2 and $Si(OH)_4$ were accepted in the chemical equation. The majority of candidates gave a correct description of hydrogen chloride but few described the white precipitate of silicon(IV) oxide formed. The majority of candidates gave a correct pH value.

A significant proportion of candidates gave a pH of 7 when magnesium chloride was added to cold water, although values between 6 and 7 were also accepted in the mark scheme. A common misconception was to refer to a reaction between magnesium chloride and water with the formation of magnesium oxide or magnesium hydroxide and hydrochloric acid.

(c) As with similar questions in previous examination sessions, many candidates still thought that ionic bonds are stronger than covalent bonds. A significant proportion of the candidates referred to strong intermolecular forces in ionic magnesium chloride. The best answers compared the strong electrostatic attraction between ions in magnesium chloride with weak intermolecular forces in silicon(IV) chloride.

(d) The majority of candidates deduced that the formula for aluminium chloride was Al_2Cl_6. A small number of candidates gave the formula as $2AlCl_3$. Only a very small proportion of candidates could not write an equation in (ii). An error carried forward was allowed using the formula from part (i).
In part (iii) the majority of candidates were unable to explain why solid aluminium chloride does not conduct electricity, whereas its aqueous solution does conduct. The most common misconception was to state that electrons were not free to move in the solid but could move in the solution. Only a very small proportion of candidates realised that solid aluminium chloride was covalent.

(e) Although the majority of candidates gave the correct answer, PCl_6^-, others gave Cl^-.

2) This question focussed on the thermal decomposition of carbonates and nitrates of Group 2 elements.

(a) In part (i) most candidates could write the balanced equation for the decomposition of calcium carbonate. The most common misconception was to include oxygen as a reactant.
Although the majority of candidates could relate the decomposition temperature with the polarisation of the carbonate ion, many candidates gave imprecise answers which did not specify the particles concerned. To get full marks a correct comparison of the ionic radii or the charge density and the polarising ability of the two cations had to be made.

(b) In part (i) many candidates were unable to deduce the oxidation numbers of barium, nitrogen and oxygen in the substances given in the equation. In particular a 'combined' oxidation number, e.g. –12 for oxygen in $Ba(NO_3)_2$, was given. A common misconception was to give barium different oxidation numbers in $Ba(NO_3)_2$ and BaO. The majority of candidates could interpret oxidation and reduction in terms of changes in oxidation numbers and so obtained an error carried forward mark.
Many candidates correctly calculated the enthalpy change of reaction in part (ii) as +1000 kJ; however a significant proportion gave the answer –1000 kJ, while others did not use the correct number of moles as shown in the equation. Many candidates did not show sufficient working out. A small proportion of the candidates just added the numbers up as shown in the table.

(c) A large proportion of candidates obtained the correct answer of 300 cm^3 in part (i). Other candidates did not appreciate that they had to calculate the volume of both oxygen and of nitrogen dioxide and gave an answer of 60 cm^3 or 240 cm^3. A common misconception was to use the M_r of $Ba(NO_3)_2$ as 522.
In part (ii) the majority of candidates realised that the syringe was too small.

(d) The majority of candidates gave a correct definition for lattice enthalpy in part (i). Common misconceptions included that it was the energy required rather than the energy released and that it involved one mole of constituent ions rather than one mole of ionic solid. A small proportion of the candidates gave the definition for the enthalpy change of formation.
In part (ii) candidates needed to compare the ionic radii of the two cations involved. Credit was not given for comparing atomic radii. A common misconception was to refer to polarisation of the oxide ions rather than to compare the strength of attraction between the two cations and the oxide ion.

3) Many candidates answered this question about copper complexes and the properties of transition elements very well. A significant proportion of the candidates obtained full or nearly full marks for this question.
A small proportion of the candidates did not score the mark available for the quality of

written communication in this question. Candidates needed to use at least three of the technical terms listed in the mark scheme in the correct context.

The mark scheme had two marks allocated to why copper is a transition element, six marks for the copper complex and three marks to the properties of the transition elements.

Most candidates were able to explain why copper is a transition element but a significant proportion of candidates did not write or could not write the electronic configuration of the copper(II) ion. Many candidates that did write the electronic configuration included 4s electrons.

Most candidates gave either $[Cu(H_2O)_6]^{2+}$ or $[CuCl_4]^{2-}$ as examples of complex ions. The most popular complex ion given was $[Cu(H_2O)_6]^{2+}$. Some candidates forgot to include the charge on the complex ions. The bonding within this complex ion was well known, with many candidates giving both a written explanation and a diagram. The most likely omission was not to state that the central metal ion is an electron pair acceptor. Although most candidates could give the correct name for the shape of the complex ion they often gave the wrong bond angle. Diagrams of the octahedral complex should indicate the three-dimensional shape with the use of wedges, and candidates that did not were not credited.

Only catalytic properties, coloured compounds or ions and several oxidation states were given credit for typical properties of transition elements or their compounds. To be awarded a mark each property had to have an associated example. The most popular example for a catalyst was iron in the Haber process. Often incorrect oxidation numbers for copper were included and so the mark was not awarded. A small proportion of the candidates gave physical properties typical of all metals and these were not given credit.

2815/02: Biochemistry (Written Examination)

General Comments

The full range of marks was achieved by the increased entry, with a slightly higher proportion achieving E or better than in previous years. The best candidates showed extensive knowledge of the subject across the specification, sometimes to a depth greater than that required by the specification. The majority of candidates scored well on three of the four questions, with their poorer fourth coming anywhere in the paper. Too many marks are still being lost because of a lack of care in reading the question or poor expression in answers, particularly in the two places where extended writing was required. Weak candidates often gave vague generalised responses. Solutions to the numerical problem were often difficult to follow.
A minority of candidates appear to know little biochemistry beyond that encountered in an A level biology course.

Comments on Individual Questions

1) (a) Most scored the first mark for the specificity of enzymes, but few mentioned their high activity.

(b) The dipeptide structure was well done, although a few marks were lost by carelessly using phenylamine instead of a second tyrosine molecule as asked. A few did not know the structure of the peptide link.

(c) Good candidates homed in on the appropriate attractions and found part of each side chain involved. Benzene was not recognised as being suitable for van der Waals attraction in many cases. Weaker candidates often wrote about ionic attractions using terminal COO^- and NH_3^+ groups, which are not part of the side chains of these amino acids. The weakest candidates wrote down all they knew about the forces holding a tertiary structure together.

(d) This part discriminated well, the best answers showing clearly the links between DNA, m-RNA, t-RNA and the primary structure of proteins. Most candidates could use the triplet code provided, but some were not sure whether they should be providing RNA or DNA sequences in their response. A few did not use the table at all. In spite of base substitution being specified in the question, many chose to write additionally about deletion.

2) (a) In (i), nearly all achieved 1 mark for showing a bridge of some kind. The second bridge proved more elusive, the peptide chain needing a spiral or S bend, but many candidates achieved this. Part (ii) was well done with all but the weakest listing peptide and disulphide bonds.

(b) There are several ways in which cysteine and zinc could interact: by covalent bonding between Zn^{2+} and S or by ionic attraction between Zn^{2+} and COO^-. Credit was also given for the use of cysteine as a bidentate ligand. The NH_3^+ group would not act as a ligand at physiological pH.

3) (a) Part (i) was correctly answered by most. A few simply added to arrive at $C_{12}H_{24}O_{12}$ for the product or wrote an incorrect formula for their monosaccharide. In part (ii), candidates who concentrated on the 1□-4 and 1□□glycosidic links scored, whereas vague answers such as those relating to molecular formulae did not.

(b) Some reference to the shape or fit of the active site was required. Stating that maltase was specific for maltase was already implied in the stem.

(c) This part allowed candidates to display their knowledge of competitive inhibition, which half did competently often with the appropriate graphs of reaction rate against substrate concentration; full marks were common. However, too many other candidates got themselves in a muddle by labelling a correctly drawn graph with axes of reaction rate against time. In doing so they found themselves forced to suggest that the rate increased with time until it reached V_{max}, from which it later died away. End product inhibition by glucose would also come into play if anything but initial rate were considered, and a few candidates were able to gain some compensation by spotting this.

4) (a) A minority succeeded in arriving at the correct answer for the calculation (2.57 g), but most scored at least 1 mark for making a start. The usual route was to work out the enthalpy change per gram of each and then to take the ratio, with an approach via moles being seen frequently. Overall, the calculations were set out poorly, with very few linking words of explanation. Significant figures were often dropped too early, and mathematically incorrect moves were frequent, for example: 1/284 = 0.00352 x 11360 = 40 kJ.

(b) Nearly all candidates recognised that carbohydrates are partially oxidised, but few could explain what this meant for the exothermic formation of C=O and O–H bonds.

(c) The relevant properties of polysaccharides were well known. The commonest source of error, which only appeared in a few scripts, was to regard these compounds as being important in a structural sense.
In (i), most candidates showed correct structures, except for the few who omitted a hydrogen atom carelessly – usually from C5.
Hydrolysis was familiar in (ii), but many candidates did not mention a specific acid or that aqueous conditions were required. About half the candidates wrote an unambiguous structural similarity between the polymers in (ii), the best noting the 1β-4 glycosidic link. Poor use of English led to ‘like β-glucose’ and this was not rewarded.

2815/03: Environmental Chemistry (Written Examination)

General Comments

The general standard of work seen has improved, but this may have been partly from a decrease in entry with more weak candidates lost than strong. The best candidates showed a thorough knowledge and understanding of the specification, coupled with an ability to communicate clearly on paper. The work of the less successful was often characterised by patchy knowledge, an inability to answer the question set and poorly expressed answers.

Comments on Individual Questions

1) (a) Most candidates knew about photochemical smog, but only a minority mentioned ozone formation, PAN etc.. A specific health problem was required, not just 'toxic'.
Most were successful with the equation in part (ii), for which the balancing numbers were 2-17-16-18 (or half of these). The usual mistake was to show carbon dioxide as a product.

(b) In (i), nearly all candidates mentioned increased surface area, but the significance of 'open' in providing access for the gas stream to the catalyst proved more elusive.
The equation in part (ii) proved difficult for a majority of candidates, with the given reactants and the word 'reduced' being ignored.
$2NO + 2CO \rightarrow N_2 + 2CO_2$ was expected.
Part (iii) asked for a sensible suggestion, such as preheating the catalyst, but few scored this mark.

2) Overall, only a minority of candidates was successful with this question, especially the parts on hard water and acid/base equilibria of dissolved CO_2,

(a) In (i), most remembered photosynthesis.
However, recall of the formation of hard water in part (ii), and its removal by boiling in part (iii), had been forgotten by most candidates. There were many strange equations, some including oxygen or hydrogen gas. Hard water was thought by several to be formed from either dissolved calcium carbonate or carbonic acid without a reaction between the two.

(b) In (i), the question asked about the equilibria involved in the formation of carbonic acid, and its dissociation in two stages. Few candidates managed to score three marks, the commonest mistake being to combine the two dissociations into one equation: $H_2CO_3 \rightleftharpoons 2H^+ + CO_3^{2-}$. State symbols were not required. Achieving both marks in (ii) required candidates to make the connections between high hydroxide concentration, high carbonate concentration and the precipitation of $CaCO_3$. K_s was not needed

(c) Part (i) asked for recall of the characteristic of gases that contribute to global warming. Most scored at least one of the marks, but poor expression let down a minority of candidates.
Part (ii) was about the solubility of gases at different temperatures, but some candidates complicated matters by using the exothermic nature of gas dissolution as their starting point.

3) A large majority of candidates had learnt the clay chemistry required and were able to write detailed and relevant accounts of the structure and ion exchange properties of 2:1 clays. The most difficult part proved to be the equilibria involved in the release of potassium ions to the soil solution – 'when plants need them' did not quite do it. The poor responses of weaker candidates were often caused by a combination of patchy knowledge and an inability to express their ideas in clear English with appropriate use of technical vocabulary.

4) (a) Some candidates tried to explain why the monomer had to be unsaturated, whilst others tried unsuccessfully to use C_nH_{2n+2} rather than C_5H_{10} as the key.

(b) Most candidates wrote something sensible, usually in terms of absence of oxygen from the products or the need to avoid combustion.

(c) This part was straightforward for those who avoided vague references to pollution.

(d) Only a minority remembered that bond breaking is endothermic and too many still think the reverse.

(e) The great majority recognised distillation, with the commonest unacceptable response being cracking.

2815/04: Methods of Analysis and Detection (Written Examination)

General Comments

This paper was generally similar in performance to those of previous June sessions, with pleasingly no ‘dead’ marks. Inevitably candidates found some marks more difficult to score than others but on the whole candidates seemed to have been well prepared for this paper.

Comments on Individual Questions

1) This question tested the principles of paper chromatography and electrophoresis. Good candidates scored at least 12 marks, but some candidates confused electrophoresis with DNA fingerprinting.

(a) In (i), most candidates knew that this was a partition process between the water held on the paper and the solvent acting as the mobile phase.
In (ii), a few candidates inverted the expression for R_f.

(b) In (i), most candidates could name suitable developing agents, although some quoted ^{32}P, confusing this with DNA fingerprinting.
In (ii), most candidates correctly identified 6 amino acids.
Part (iii) was less well answered the correct pattern requiring 4 spots.

(c) Part (i) proved to be the most taxing part of the question with a number of candidates losing marks because of imprecision in their answers.
In (ii), just about everyone knew that a buffered solution was needed.

2) Questions on this area of the specification have been poorly answered in the past, so it was pleasing to see so many candidates scoring well. The only part which appeared to cause difficulty was part (c), where answers lacked detail.

(a) This was generally answered well with few candidates confusing absorption and emission.

(b) In (i), most candidates knew how to calculate the frequency, although inevitably some inverted the expression.
In (ii), having calculated the frequency in the previous part, a high proportion of candidates were then able to go on to calculate the energy.

(c) This caused more problems than expected with a significant number of candidates choosing hydrogen rather than helium. There were also answers suggesting a wide range of other elements from sodium to uranium!

(d) Although many candidates knew that a calibration graph could be used, few knew much more than that. The examiners were looking for a measurement of the intensity of a line or frequency characteristic of sodium and comparing this to a sample of known concentration or a calibration graph.

3) Candidates coped well with parts (a) and (b)(i), but the logic used in part (b)(ii) was often muddled.

(a) Almost all candidates were able to identify at least two structural features that would bring about absorption in the uv/visible region of the spectrum.

(b) In (i), most candidates correctly explained what conjugation meant in this context, although a number of candidates described conjugate acids and bases.
In (ii), this part caused the most problems with a significant number of candidates either not understanding the principle, or confusing the logic. The examiners were looking for answers that stated that a decrease in conjugation increased the gap between energy levels. This in turn would bring about the absorption of shorter wavelength or higher frequency light, leaving longer wavelength (red) transmitted.

4) This question was the most straightforward and highest scoring question on the paper, with marks below 4 relatively rare.

(a) In (i), almost all candidates were able to deduce the molecular formulae of **A** and **B**.
In (ii), with few exceptions candidates were able to draw the structural formula of **A**.
In (iii), most candidates knew the formula of the species responsible for the peak at m/e 41, but a significant number forgot that it carried a positive charge.

(b) Although almost all candidates knew that the M+2 peak was caused by the chlorine atom, a significant number gave incorrect ratios for the heights of the M and M+2 peaks.

5) This type of question presents a challenge to candidates in interpreting spectra. It appears that teachers are giving their candidates plenty of practice as there were many very good answers to this question.

(a) This was generally well answered, with most candidates correctly using the M+1 peak to calculate the number of carbon atoms and then using the single oxygen atom to deduce the number of hydrogen atoms present.

(b) There were a number of ways of tackling the structure. The i.r. spectrum shows a clear C=O peak at around 1690 cm^{-1} and no large –OH absorption. Since there is only one oxygen atom, this means there has to be a carbonyl group present. The n.m.r. spectrum shows a large singlet at around 2.6 δ characteristic of $RCOCH_3$. The other absorption is characteristic of a benzene ring and candidates should have deduced that the compound was phenylethanone.

2815/05: Gases, Liquids and Solids (Written Examination)

General Comments

This remains a relatively unpopular option, but this session's candidates seemed better prepared than in recent examinations with some good marks being scored.

Comments on Individual Questions

1) This question was reasonably well answered, although the descriptions related to the interactions between particles were often rather weak and imprecise.

   (a) Many candidates scored at least 2 of the 4 marks here, the most common reason for dropping marks being vague descriptions of the similarities and differences between solids and liquids.

   (b) In (i), despite being a very familiar type of calculation, some candidates could not write an expression to give M_r. Those that could often went on to score full marks in part (ii). Consequential marking was used here for sensible calculations.
   In (iii), whilst a pleasing number of candidates discussed the hydrogen bonding in alcohols, a large number felt that alcohols would be more volatile. Few discussed why hydrogen bonding would lead to errors in determining M_r by this method.

2) This question should have been familiar territory for candidates, being based around metal mixtures that form a eutectic. Although there were some good answers, once again a lack of precision or detail caused marks to be lost.

   (a) In (i), candidates needed to identify what was present in each of the four areas and, whilst many candidates had little difficulty, a significant number failed to read the composition axis correctly.
   In (ii), Most candidates gave an adequate definition of a eutectic.

   (b) In (i), few candidates had any difficulty labelling the three parts of the cooling curve.
   In (ii), marks were lost largely because candidates failed to give sufficient detail about what would happen, omitting temperatures and observations. There were 7 marking points, but candidates scoring the maximum 5 were rare.

   (c) This part was generally well answered, with few failing to score.

3) Marks on this question seemed harder to score for many candidates, perhaps due to the calculations involved.

   (a) Most could state Henry's law, although it was common to omit the need for a fixed temperature.

   (b) In (i), good candidates had little difficulty, whilst weak candidates forgot to base their calculation on the proportions of the gases in air.
   In (ii), most candidates knew that gases were less soluble at higher temperatures and therefore that aeration was needed to maintain the maximum amount of dissolved oxygen.

   (c) Most candidates could explain what is meant by 'partition coefficient'.

(d) Candidates who had seen this type of calculation had little difficulty, whilst those who were less familiar struggled to score a mark.

4) (a) Most candidates could state Raoult's law.

(b) In (i), most candidates knew that the vapour pressure would be greater than expected.
In (ii), as a result of their answers to (i), most candidates deduced that forces between particles in the mixture were weaker than between those in either component.

(c) In (i), definitions of an azeotrope were sometimes insufficiently precise to score the mark.
In (ii), it was clear that some candidates were unaware that an ethanol-water mixture forms an azeotrope.

(d) Answers to this part were often vague and poorly expressed. Some candidates seemed to understand very little about how fractionation occurred and the function of the glass beads, particularly in providing a large surface area to assist exchange between the two phases present in the column, and to establish a temperature gradient.

(e) Those candidates who knew that boiling occurs when the vapour pressure above a liquid reaches atmospheric pressure had little difficulty with this part. It was clear, however, that some candidates had little idea of how steam distillation works.

2815/06: Transition Elements (Written Examination)

General Comments

A complete range of marks was seen on this paper. Many candidates were well prepared and scored high marks. There were some very impressive performances but also candidates who knew very little chemistry at all with responses such as ‘excess nitric acid may be neutralised by sulphuric acid’. The organisation of longer answers was a problem in some cases and a number of scripts were very difficult to read.

There were no ‘dead marks’ as such although generally candidates did not score well on questions relating to colour (such as the visible spectrum) and on questions requiring knowledge of standard electrode potentials.

Too many candidates continue to draw shapes of complexes which are two dimensional and the formulae of ligands, particularly bidentate ligands, is a concern particularly when answering questions on optically active complex ions.

Comments on Individual Questions

1) (a) This was generally well answered, but many candidates failed to state that the standard conditions are 1 atmosphere pressure, 298 K and 1 mol dm^{-3}.

(b) A majority of candidates scored this mark. A few omitted the unit and a few gave the obvious wrong answer of +2.88 V. There were also a few responses of –0.16 V.

(c) (i) More able candidates scored well here. Many weaker candidates showed chlorine on the left hand side and chloride on the right hand side. A few candidates left electrons in the final equation and were unable to correctly balance the equation.
(ii) This was generally well done. Candidates who placed chlorine on the left-hand side were awarded a mark here, carrying forward their error from part (i).
(iii) Many candidates failed to score here because they did not specify the actual species that was oxidised or reduced, often merely stating ‘chlorine is oxidised’ and ‘manganese is reduced’

(d) Many candidates commented that the concentration was too low without linking this to a slow reaction. A few suggested that the reaction would be slow owing to a small cell potential. Very few suggested that the reaction was no longer possible because conditions were not standard.

(e) Very few candidates scored this mark. Many knew the correct shape of the graph but most placed the peak too far to the right showing maximum absorbance in the yellow, orange and red rather than the expected green at ~520 nm.

2) (a) (i) Nickel and tin were often incorrectly suggested as the second metal in brass.
(ii) Most candidates could give a use of brass but did not give the property of brass that made it useful for that purpose.

(b) (i) Many candidates could name an alkali here. The word ’alkali ‘on its own was not credited.
(ii) Surprisingly few candidates used starch as the indicator with many

suggesting methyl orange or phenolphthalein. These candidates appeared to be unfamiliar with iodine/thiosulphate titrations.
(iii) As with (b)(ii), the unfamiliarity of these titrations was obvious in many candidates.

(c) Good candidates did not have a problem with the volumetric calculations and there were many high scores for this part. One common mistake in (iii) was to use the 25 cm^3 of solution to obtain the wrong answer of 0.0025 mol. Another error was in (iv), when candidates often failed to scale up to 250 cm^3 and ending with 7.7% for the amount of copper in brass. These candidates were not awarded the final mark.

3) (a) Many candidates defined co-ordination number as the number of ligands rather than the number of co-ordinate bonds attached to the central metal ion.

(b) (i) Diagrams must show the 3-dimensional arrangement of bonds. Many candidates showed $[CoCl_4]^{2-}$ as square planar rather than tetrahedral.
(ii) Many candidates did not know this colour change. Some used the colours associated with the change from chromate(VI) to dichromate(VI), whilst others simply got the colours the wrong way round.
Most candidates were familiar with Le Chatelier but many suggested adding more $[CoCl_4]^{2-}$ to move the position of equilibrium to the left. Some candidates suggested increasing the concentration of water, which was not credited.

(c) This part of question 3 proved to be a good discriminator. Clearly the concept of standard electrode potential presents some difficulty for A level candidates. Many candidates could not identify the most powerful reducing agent and, even if they did, they tended to contradict themselves when trying to explain why it was the most powerful.

(d) Having struggled with the idea of standard electrode potential in (c), many candidates thought that they had to use the idea again in (d) when the simple required answer was ‘ammonia forms stronger co-ordinate bonds’.

4) (a) Most candidates are aware of *cis*-platin and its use in the treatment of cancer, but only stronger candidates scored all 3 marks by explaining how it bonds to DNA and prevents replication.

(b) More able candidates had an excellent opportunity to score high marks on this part and they provided well-organised answers with good examples, illustrated well with diagrams of the 3-dimensional nature of transition metal complexes. Weaker candidates scored marks for *cis-trans* isomerism but were often less confident with optical isomerism.
Many candidates showed the ethanediammine ligand as having terminal $-NH_3$ groups and this was penalised once. Weak candidates have difficulty drawing this complex in three dimensions and the second isomer is then not always a mirror image. Candidates should be advised to always draw a mirror line so that the position of the mirror image is clear.
A majority of candidates were awarded the mark for Quality of Written Communication by using at least 3 technical words in an appropriate way.

2816/1: Unifying Concepts in Chemistry (Written Examination)

General Comments

There is no doubt that this year's paper was to some degree more demanding than those of previous years. Consequently, candidates were more challenged by certain questions than before and perhaps failed to gain quite as many marks. This said, however, it was refreshing to that the more able candidates were indeed stretched and it was pleasing to observe that a reasonable number of candidates were able to rise to this challenge. One candidate achieved full raw marks on the paper. The paper also provided the less able with sufficient questions on which to show their understanding.

Candidates' ability to handle numerical data was good and many were able to write clearly using scientific language. Candidates should be encouraged to make their answers as independent of the wording of the question as they can. Here and in this year's Foundation paper there appeared to be an increase in the number of candidates whose answers relied on the wording of the question. This was noticeable in parts 2(a) and 3(e) in particular.

From the responses on scripts, some candidates appeared to have insufficient time to absorb the information in question 4 and consequently rushed through the final question.

Comments on Individual Questions

1) (a) (i) Very few candidates failed to be guided by the final statement of the question towards the correct answer.

(ii) This part was also extremely well answered but a handful of candidates suggesting that the reaction was second order, presumable by incorrectly using the stoichiometry in the balanced equation.

(iii) The graph was nearly always plotted correctly.

(iv) Nearly all candidates correctly drew a tangent to their curve at 1200 s.

(v) Again this part was well answered. It was noteworthy that of the candidates who had proposed a second order reaction in part (ii), many gave incorrect units here, presumably confusing rate with rate constant.

(b) (i) Nearly all candidates correctly described what is meant by the term rate-determining step.

(ii) This part proved a little more challenging and a number of candidates tried to involve H^+ in the overall reaction.

(iii) Nearly all candidates identified H^+ as a catalyst and the majority of these were able to explain why this was the case. For this second mark, most discussed the fact that H^+ was not used up rather than giving the better answer that H^+ was used in the first step of the reaction and regenerated in the second step.

(iv) This part proved to be more challenging. Although many did give the correct equation, a significant number involved the concentration of H_2O rather than H^+ in their proposed rate equation.

2) (a) The answers to this part were of a high standard and candidates seemed better able than in previous years to discuss the effects of temperature and pressure on such an equilibrium. Candidates should be encouraged in answering such questions to be as clear as possible. Although it did not lose candidates any marks, they should try to replace statements such as, 'because it is exothermic' with something that is less open to misinterpretation. Comparatively few candidates secured all five chemistry marks, the commonest omission being the link between increased pressure and a faster rate of reaction. The examiners were able to credit the mark for Quality of Written Communication provided that

two responses had been linked clearly together.

(b) (i) Candidates found this part more challenging. Although many worked out correctly that the equilibrium amount of H_2 would be 1.8 mol, fewer gave 0.1 mol of CH_3OH with many suggesting that the value would be 0.3. Many candidates were able to recover from these initial errors and, using their values, went on to calculate correctly the mole fractions and partial pressures of the three gases. This was credited.
(ii) Many candidates gained both marks in answer to this part of the question. The more common errors were the use of square brackets or omitting to square the H_2(g) partial pressure.
(iii) This question proved to be extremely challenging. Many candidates would have scored more marks if they had ignored the direction to consider K_p and instead had discussed the changes using Le Châtelier's principle but unfortunately few did. Some candidates did remember correctly that K_p would not be altered and some then used arguments based on the Le Châtelier's principle to gain the other two marks. Many candidates failed to gain any credit by reasoning incorrectly that an increase in the partial pressure of H_2 would lead to a decrease in K_p which would then cause a reduction in the yield of methanol. Only a handful of very able candidates discussed the change to the equilibrium yield solely in terms of the K_p expression from part (ii). Of these very few noted that the relative amount of carbon monoxide at the start of the reaction was now less than that of the previous example although a few candidates did note that changes to the H_2 concentration would have a greater effect because of the squaring of the relevant term in the K_p expression.
(iv) This was well answered, with nearly all candidates being able to take their expression for K_p, and perform the calculation with the given values. It was also very pleasing to see that the majority of candidates were also able to give the correct units.

(c) Although many candidates gave a correct equation, it was somewhat surprising how difficult many found the balancing of this equation. Given that both carbon and hydrogen occur only in one reagent and one product, it was presumably the balancing of the oxygen that gave candidates difficulty.

3) (a) (i) Most candidates obtained both marks here. A few were thrown by being asked both questions together and so only discussed strong acids and did not go on to define a Brønsted-Lowry acid.
(ii) Again, for most candidates this was an easily obtained mark.

(b) Many candidates got full marks here, although some tried to manipulate the value for pH obtained in part (i) to work out the value for part (ii).

(c) The majority of candidates were able to define K_w correctly but some then had difficulty calculating the concentration of the sodium hydroxide solution. One of the more common errors here was to omit the negative sign when working out the proton concentration.

(d) (i) Apart from a few candidates who wanted the buffer to be capable of sustaining a constant pH, most candidates were able to give a correct definition.
(ii) There is no doubt that this was an extremely challenging question, probably the hardest on the paper, but it was pleasing to see that a small group of candidates were able to give correct answers. Of the less able, many candidates fixed on the different concentrations of the solutions used to concoct **A** and **B** and reasoned that this lay behind the ability of only **A** to function as a buffer. Others incorrectly identified the components of the buffer solution as ethanoic acid (as the weak acid) and sodium hydroxide (as the conjugate base). Such

candidates then often tried to describe how *this* “buffer solution” would work in terms of the stock buffer theory. Candidates succeeded when identifying that a reaction had taken place between the ethanoic acid and sodium hydroxide to product a mixture of ethanoic acid and sodium ethanoate in **A** but only sodium ethanoate in **B**.

(e) This was generally well answered. The majority of candidates noted that the degree of ionisation would increase with rising temperature but some failed to show that this conclusion had been based on noting that the proton concentration was increasing. Many candidates went further than required in their answer and discussed the energetics of the reaction. Here again candidates should be encouraged to give answers which stand alone. Many wrote, 'it would ionise more', which gains the mark but it would be much clearer were candidates to write, 'water ionises more with increasing temperature'.

4) (a) Of the three parts to this question, the first involved calculating the percentage of copper. Candidates tended to fall into one of two groups in their response to this part, those who obtained full marks and those who clearly had no idea about how to go about such a calculation.
The second part of section (a) was much better answered and nearly all candidates were able to calculate the correct empirical formula. A few candidates who had worked out the relative ratios failed to obtain the second mark by giving an empirical formula in which they had tried to remove the water of crystallisation. The final part relating to the correct formula of **A** was very poorly answered. Only a few candidates gave formulae involving $3H_2O$ and of these even fewer recognised the presence of NO_3^-. Consequently $(NO_3)_2$ was seen only on the scripts of the most able.

(b) Although many candidates were able to correctly identify the changes in oxidation numbers that occur for Cu and N, very few indeed were able to use these to balance the overall equation.

(c) A surprising aspect of candidates' responses to this part of the question was the significant number of those who made no attempt to use the given data to evaluate the relative molecular mass of **B**. Of the candidates who correctly calculated the relative molecular mass of the gas as 64, some made some surprising suggestions for the identity of the gas with $S_2(g)$, $O_4(g)$, $2O_2(g)$ and $Cu(g)$ being seen. Some candidates correctly guessed that the gas was sulphur dioxide, presumably by studying the elements available from the reaction. A number of candidates assumed that the action of an acid on a metal would produce hydrogen. As in question 2(c), candidates again found it difficult to produce a balanced equation to show the reaction of copper with sulphuric acid. It was noticeable that many of these candidates clearly failed to check that the formal charge balanced. The very best candidates should be congratulated on producing a balanced equation for this reaction.

2816/2: Coursework II (Coursework)

General Comments

An increasing number of Centres used the coursework option to assess their Candidates' practical skills. The majority applied the published criteria reliably and within the tolerance allowed for the assessment. The Moderators were grateful for the generally high standard of presentation of the work and for the careful annotations that had been included on the scripts. There is however still a significant number of teachers who appear to be uncertain of the standards expected. Mostly this is apparent for the awarding of marks in which a Candidate has made a point to insufficient depth to be acceptable. For example, skill E (Evaluation) should extend beyond stating that a burette would be read more carefully or that a solid would not be spilled and so on. These are normal laboratory precautions and not improvements. It should also be appreciated that repeating an experiment many times does not necessarily produce a better result if the failing is procedural.

Although no penalty was applied this year, references, which are a requirement of skill P7a, should be precise and refer to the particular page in a book or give a detailed web reference. P7a must not be awarded if Candidates 'spelling, punctuation and grammar' are not of sufficient standard. This should be taken to include the correct use of sub- and super- scripts – a frequent error in work that has been word-processed. Candidates should be advised to be careful how numerical data are rounded during the course of a calculation. There was a large number of instances in which the answer quoted was substantially inaccurate as a result and, in these cases, A7b could not be justified.

The listing of hazards likely to be encountered in performing an experiment is still an area of misunderstanding. It is not intended that the full contents of a hazcard should be copied but rather a clear assessment should be made in the context of the experiment being performed. So dilute hydrochloric acid may well be an irritant but it does not fume nor is it best described as corrosive. Diluting it from 2 mol dm^{-3} to a less concentrated solution does require care but it is not a hugely dangerous procedure. Likewise listing the problems of handling a solid is irrelevant when the experiment involves a solution which is provided. The Moderators rarely penalised these statements but it was felt that Centres might advise Candidates more carefully.

Some packages of work received included the form CEF 2813/6 which is used to answer a coursework enquiry but should not be included at the examination stage. The necessary paperwork is a copy of the MS1 form, the Coursework Summary Form (CSF 2813/6) and the Centre Authentication Form. Individual Candidate Authentication Forms should **not** be included but held instead at the Centre.

Comments on Individual Skills

Many of the issues highlighted in the AS report under 2813/2 are equally relevant to the A2 coursework and problems with skill E are still apparent with Candidates often failing to focus on key issues. The evaluations of both the iron sulphate and copper sulphate exemplars are both quite difficult to do and many of the moderated scripts failed to provide a clear commentary on the significant errors in the experiment. There was also a tendency to assume that if the answer obtained agreed with the textbook value there could be no potential weaknesses in the procedure followed. To award E5b and E7b Candidates should have considered measurement errors and also any problems that might occur during and after the thermal decomposition.

Skill P was usually rigorously marked but in the exemplar 'Identification of an Organic Unknown' the Moderators came across a significant number of cases in which erroneous flow charts had been credited with full marks. To achieve P7b, experimental detail must also be accurate and, for example, the failure to acidify dichromate would not allow this level to be achieved.

The 'Determination of a Rate Equation also causes some problems. Candidates sometimes fail to refer to the teacher demonstration in a meaningful way and do not always identify the correct graphs to plot, often confusing an 'initial rate' procedure with a 'continuous run'. For the former, it is incorrect to plot graphs of concentration v time and then take gradients or measure the half-life. This is an area of considerable confusion which more significantly affects the assessment of skill A since it will lead to an analysis which is clearly flawed.

2816/03: Practical Examination II (Practical Examination)

General Comments

There was a wide variety in the quality of performance on this paper. The Plans were generally well written, although many candidates confined their answer to the basics of the method. Many candidates word-processed their answers, but a significant minority appear unable to write sub-scripts or super-scripts. On the Practical Test, the section on test tube tests in Parts 1 and 2 was not well answered by many candidates. Clearly many students would benefit from more practice at this type of exercise. The titration and subsequent calculation were performed with a greater degree of success. Many candidates found the first half of the Evaluation relatively straightforward, but the second half proved to be more testing.

Teachers and lecturers are asked to remind their candidates to write/type on only one side of the paper when writing the Plan. In addition, it is very helpful if Tests and Plans are attached using treasury tags (not with pieces of string that can easily become untied) with the Practical Test on top.

Comments on Individual Questions

Plan Most candidates followed the guidance given in the task set and were able to describe the basics of the back-titration procedure with clarity. Candidates were asked to include details of suitable quantities of reagents in the Plan, and this aspect of the task discriminated effectively between candidates. It was expected that candidates would justify the quantities they selected, not merely assume their "recipes" were suitable. Many good candidates were able to pick up the three marks on offer for this, while weaker candidates, at best, only rationalised their choice of quantities. Many candidates present calculations algebraically. While a clear and unambiguous calculation presented in this way may score marks, many candidates are not able to make their presentation of symbols sufficiently clear for marks to be given. If Examiners cannot follow a calculation (or are, for example, not convinced that the candidate would use appropriate units), they do not award marks. Calculations with "specimen" numbers are always preferable! Many candidates showed a calculation to calculate the concentration of the aqueous chlorine, but this effort was wasted as the task set did not require this.

On this Plan, relatively few candidates commented on specific issues related to the accuracy of their procedure. A range of ideas would have been credited, but relatively few candidates ventured beyond a basic description. Examples of acceptable precautions include ensuring that the relatively slow reaction of chlorine with iron(II) ions was complete, preventing or inhibiting oxidation of the iron(II) ions by air prior to the titration, explanation of the choice of acid to acidify the manganate(VII) ions and standardisation (or freshly making up) of the solution of manganate(VII) ions.

It was expected that most candidates would choose a manganate(VII) ion titration since this type is referred to on the specification. Some candidates researched a dichromate(VI) titration, but usually failed to find out about some of the conditions under which such a titration is done. A few candidates used an iodine-thiosulphate titration. Marks awarded for such a method were "capped" since this method did not involve a back-titration.

Test **Part 1** Many candidates are not well trained in making observations. As a minimum they should state any colour changes and indicate the state of the product (solution, precipitate, gas etc). Throughout this section confusion between iodide and iodine and between ions and molecules was common. Many candidates lost marks by using inaccurate terminology. In part (d), better candidates realised that the hydroxide ions from NaOH neutralised the hydrogen ions on the right hand side of the reaction equation.

Part 2 Responses to this question were very disappointing. Even some candidates who scored well in other parts of the paper could only muster two or three marks. In part (a), reference to the fact that the red/brown product was a solution (or even a suspension or precipitate) was often missed. Most responses to part (b) omitted to state specifically that this red/brown colour was iodine. Correct half-equations for conversion of iodide ions to iodine were not all that common. Although a number of candidates stated that iodide ions were oxidised, most did not attempt to justify this statement to show that they were not just making a lucky guess. On the "safety" question a small number of candidates over-stated the hazard of hydrogen peroxide, despite the fact that the hazard symbol was displayed at the top of the page.

Part 3 Most candidates carried out this titration of aqueous iodine with aqueous sodium thiosulphate very accurately. Centres are reminded of the importance of accurate supervisor's results so that their own students' accuracy can be reliably assessed. Candidates should not use their trial titration for calculating the mean, nor should they quote the mean as (say) 23.275 cm^3: instead this should be rounded **up** to 23.30 cm^3 (rather than 23.28 cm^3) because the burette is read only to the nearest 0.05 cm^3.

Part 4 It was pleasing that many candidates were able to carry out the calculation successfully. One of the more common mistakes made was in part (e), taking the M_r of iodine as 127. Despite the instruction to give all answers to three significant figures, many candidates did not do so, sometimes due to confusion between "significant figures" and "decimal places". Even the best candidates are sometimes tempted to write (say) 0.00049 as an answer when what they ought to have written was 0.000490.

Part 5 It was encouraging that some weaker students were able to answer the Evaluation questions on page 10 well. In (c), although many answers were good, few appreciated the significance of the fact that **two** weighings are needed to determine the mass of sodium thiosulphate. In (e), many candidates wrote at some length about accuracy precautions, whereas the answer should have focused on repeated readings that were consistent. When answering part (g), candidates' confusion between iodine and iodide came to the fore once again. Only the most able candidates were able to answer the question unambiguously without penalising themselves through self-contradiction and muddled expression.

Unit Threshold Marks – 3882 AS Chemistry

June 2005 Assessment Session

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2811	Raw	60	49	43	37	31	26	0
	UMS	90	72	63	54	45	36	0
2812	Raw	60	46	40	34	28	22	0
	UMS	90	72	63	54	45	36	0
2813A	Raw	120	95	85	75	65	56	0
	UMS	120	96	84	72	60	48	0
2813B	Raw	120	95	85	75	65	56	0
	UMS	120	96	84	72	60	48	0
2813C	Raw	120	89	79	69	59	50	0
	UMS	120	96	84	72	60	48	0

Unit Threshold Marks – 7882 Advanced GCE Chemistry

June 2005 Assessment Session

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2814	Raw	90	69	61	53	45	37	0
	UMS	90	72	63	54	45	36	0
2815A	Raw	90	70	62	54	47	40	0
	UMS	90	72	63	54	45	36	0
2815B	Raw	90	70	62	54	46	39	0
	UMS	90	72	63	54	45	36	0
2815C	Raw	90	72	64	57	50	43	0
	UMS	90	72	63	54	45	36	0
2815D	Raw	90	71	62	53	45	37	0
	UMS	90	72	63	54	45	36	0
2815E	Raw	90	69	61	53	45	37	0
	UMS	90	72	63	54	45	36	0
2816A	Raw	120	95	85	75	66	57	0
	UMS	120	96	84	72	60	48	0
2816B	Raw	120	95	85	75	66	57	0
	UMS	120	96	84	72	60	48	0

2816C	Raw	120	89	78	67	57	47	0
	UMS	120	96	84	72	60	48	0

Syllabus 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

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

	A	**B**	**C**	**D**	**E**	**U**	**Total Number of Candidates**
3882	19.7	38.5	56.4	72.1	85.1	100.0	12,849

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

	Maximum Mark	**A**	**B**	**C**	**D**	**E**	**U**
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**
7882	27.7	52.3	71.9	85.9	95.4	100.0	9295

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