OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry

Advanced GCE **A2 7882**

Advanced Subsidiary GCE **AS 3882**

Mark Schemes for the Units

January 2008

3882/7882/MS/R/08J

Oxford Cambridge and RSA Examinations

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CONTENTS

Advanced GCE Chemistry (7882)

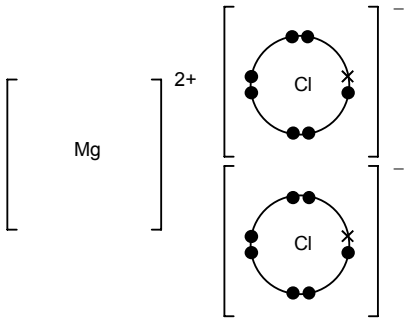
Advanced Subsidiary GCE Chemistry (3882)

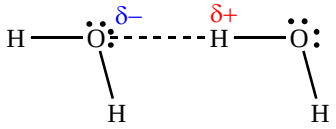
MARK SCHEME FOR THE UNITS

2811 Foundation Chemistry

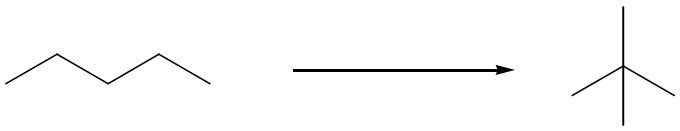
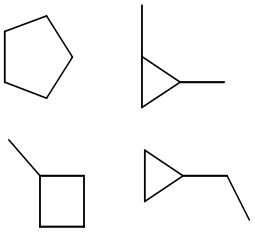
Question No.			Max Mark
1)	(a)(i)	atoms of same element/same atomic number/same number of protons ….. with different numbers of neutrons/different masses ✓	[1]
	(ii)	isotope protons neutrons electrons ^{10}B 5 5 5 ✓ ^{11}B 5 6 5 ✓	[2]
	(b)(i)	weighted mean mass of an atom/average mass of an atom/average mass of the naturally occurring isotopes ✓ compared with carbon-12 ✓ 1/12th of mass of carbon-12/on a scale where carbon-12 is 12 ✓ *mass of 1 mole of atoms of an element compared with 1/12th the mass of 1 mole of carbon-12 is an alternative* *"mass of the atoms of the element that contains the same number of atoms as are in 1 mole of carbon-12" ⟶ 2 marks (mark lost because of mass units)*	[3]
	(ii)	more of ^{11}B (than ^{10}B) ✓	[1]
	(c)(i)	H_3BO_3 + 3K ⟶ B + 3KOH ✓	[1]
	(ii)	B changes from (+)3 ✓ to 0 ✓ 'oxidation number decreases' with no numbers scores one mark (*must be in terms of ox no. Ignore electrons*) *Mark independently*	[2]
	(d)	**X** = 120° ✓ 3 bonded pairs / 3 bonds ✓ **Y** = 104-105° ✓ 2 lone pairs *AND* (2 bonded pairs *OR* 2 bonds) ✓ electron **pair** repulsion (anywhere) / electron **pairs** get as far apart as possible (anywhere) / lone **pairs** repel (more) / **bonds** repel ✓ *Any reference to **atoms repelling** contradicts 'repel mark'*	[5]
			15

2)	(a)(i)	heating or thermal decomposition of limestone/$CaCO_3$/ correct equation: $CaCO_3 \longrightarrow CaO + CO_2$ ✓	**[1]**
	(ii)	farming: neutralising acid soils/reduces acidity of soil ✓	**[1]**
	(b)(i)	$Ca(OH_2)(aq) + 2\,HNO_3(aq) \longrightarrow Ca(NO_3)_2(aq) + 2\,H_2O(l)$ ✓	**[1]**
		2 sig fig minimum throughout	
	(ii)	$0.0105 \times 22.45/1000 = 2.36 \times 10^{-4}$ ✓ (calc: 2.35725×10^{-4})	**[1]**
	(iii)	ans to (ii) / 2 = 1.18×10^{-4} ✓ (calc: 1.178625×10^{-4})	**[1]**
	(iv)	ans to (iii) x 40 = 0.00472 ✓ (calc: 0.0047145 ⟶ 0.00471)	**[1]**
	(v)	$Ca(NO_3)_2$ = 40.1 + (14 + 48) x 2 = **164.1** (accept 164) / x = 272.1 – 164.1 = **108** ✓ x = 6 / $Ca(NO_3)_2.6H_2O$ ✓ If candidate has based this part on $Ca(OH)_2$, '$11H_2O$' would score 1 mark consequentially If (272.1 – incorrect calculated value for $Ca(NO_3)_2$), then 2nd mark can be achieved consequentially but a whole number is required.	**[2]**
	(c)	$Ca(s) + 2H_2O(l) \longrightarrow Ca(OH)_2(aq) + H_2(g)$ ✓ for balanced equation ✓ for state symbols of correct species in equation	**[2]**
	(d)(i)	$Ca^+(g) \longrightarrow Ca^{2+}(g) + e^-$ equation ✓ state symbols must be (g), (g) but can be for any attempted equation losing electron(s) ✓	**[2]**
	(ii)	mol Ca = 5.00/40.1 or 0.125 (0.12468379) ✓ 1 mol Ca requires 578 + 1145 = 1723 (kJ) ✓ so energy required = answer above derived from IE data x 0.125 1723 x 0.125 = 215 (kJ) 3 sig figs ✓ eg Use of 1145 only gives 143 kJ consequentially (would score 2)	**[3]** **[4]**
	(iii)	**Assume 'down the group'** ionisation energy decreases ✓ atomic radii increases / there are more shells ✓ there is more shielding ✓ *'**more**' is essential* attraction decreases / increased shielding and distance outweigh the increased nuclear charge ✓	
			19

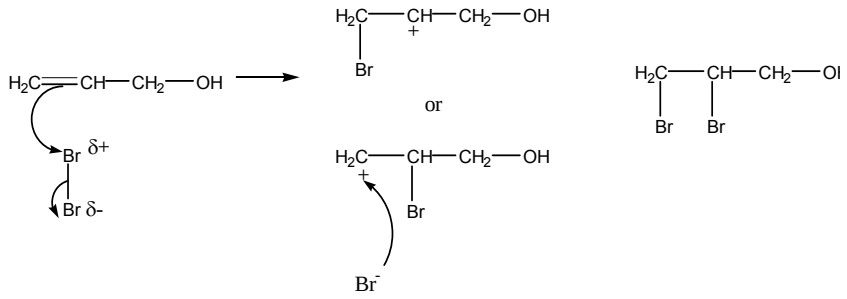
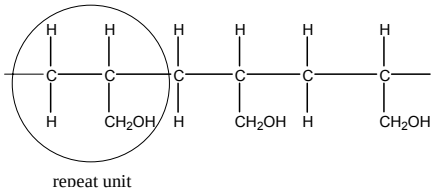
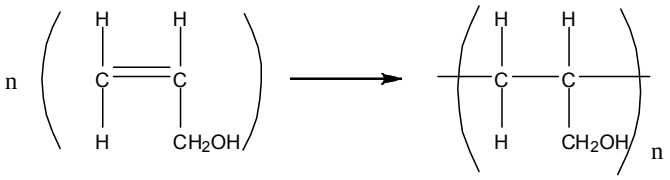
3)	(a)	$1s^2 2s^2 2p^6 3s^2 3p^5$ ✓	**[1]**
	(b)(i)	 ✓ for correct dot-and-cross ✓ for charges allow Mg with a 'full' shell; also ignore any inner shells	**[2]**
	(ii)	Mg conducts as there are free/delocalised/mobile electrons ✓ *not just 'sea of electrons'* $MgCl_2$(s) does not conduct as no free/delocalised/mobile electrons or ions or charge carriers ✓ $MgCl_2$(aq) conducts as ions move ✓ $MgCl_2$ dissolves because water is a polar solvent ✓ *Any 3 observations above*	**[3] max**
	(c)	increasing nuclear charge/number of protons ✓ electrons added to same shell /same or similar shielding ✓ electrons experience greater attraction or greater pull ✓	**[3]**
	(d)	moles Cl_2 = 145/24000 = 6.04 x 10^{-3} mol ✓ *accept 0.006 mol* Cl_2 is in excess as 0.00604 > 0.005 mol Cl_2 / Cl_2 is in excess as 0.01208 > 0.01 mol Cl_2 ✓ *Explanation using equation required for 2nd mark* *ora*	**[2]**
	(e)	*Precipitation* Add $AgNO_3$ / Ag^+ (could be in equation) ✓ NaCl/Cl^- → white precipitate / dissolves in dilute NH_3 ✓ NaBr/Br^- → cream precipitate / dissolves in conc NH_3 or precipitate does not dissolve in dilute NH_3 ✓ not 'Cl' or 'Br' or 'chlorine' or 'bromine' ……. but ecf for a second occurrence $Ag^+ + Cl^- \longrightarrow AgCl$ ✓ or equation for Br^- or a full equation, *state symbols not required* eg: $AgNO_3 + NaCl \longrightarrow AgCl + NaNO_3$ 'precipitate' is required at least once – could be from : white **precipitate** or cream **precipitate** or AgCl**(s)**	**[4]**
	OR	*Displacement* Add chlorine / Cl_2 (could be in equation) ✓ (but not Cl) NaCl ⟶ no change/no reaction/pale green ✓ NaBr ⟶ goes orange/yellow/brown ✓ *If candidate mentions formation of a **precipitate** do not award observation mark* $2Br^- + Cl_2 \longrightarrow Br_2 + 2Cl^-$ ✓ or a full equation, *state symbols not required* eg: $2NaBr + Cl_2 \longrightarrow 2NaCl + Br_2$	
			16

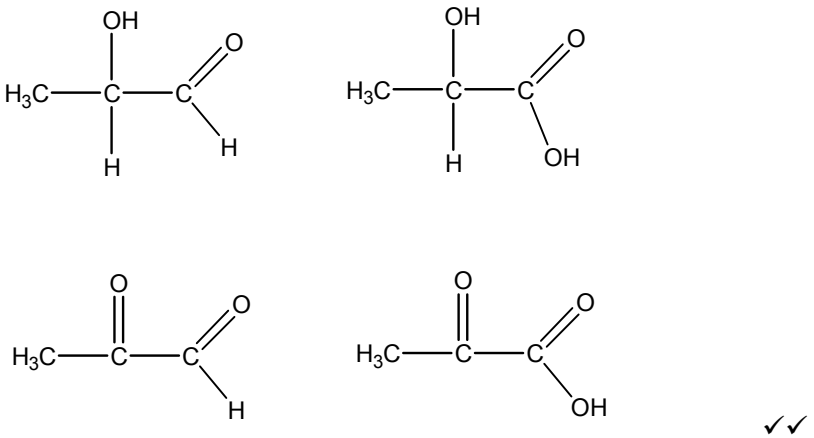
4)	(a)	H_2O: Hydrogen bonding shown in words or in diagram: H bonding from O of 1 H_2O molecule to H of another ✓ dipoles shown or described ✓ with lone pair of O involved in the bond ✓  Two properties from: Ice is less dense/lighter than water/floats on water/ max density at 4°C ✓ explanation: H bonds hold H_2O molecules apart / open lattice in ice / H-bonds are longer ✓ Higher melting/boiling point than expected ✓ *Not just high* Accept: 'unusually high/strangely high/relatively high' explanation: H bonds need to be broken ✓ must imply that intermolecular bonds are broken High surface tension ✓ explanationstrength of H bonds across surface ✓ *mark 2 properties only: max 4*	**[3]** **[4]**
	(b)	CH_4: van der Waals' forces / interactions based on instantaneous/temporary/transient interactions ✓ HCl: (permanent) dipole – (permanent) dipole interactions ✓ intermolecular forces are stronger in HCl than in CH_4 / more energy required to break the intermolecular forces in HCl than in CH_4 ✓	**[3]**
		At least two sentences that show legible text with accurate spelling, punctuation and grammar so that the meaning is clear.✓ (Mark this from anywhere within Q4)	**[1]**
			11

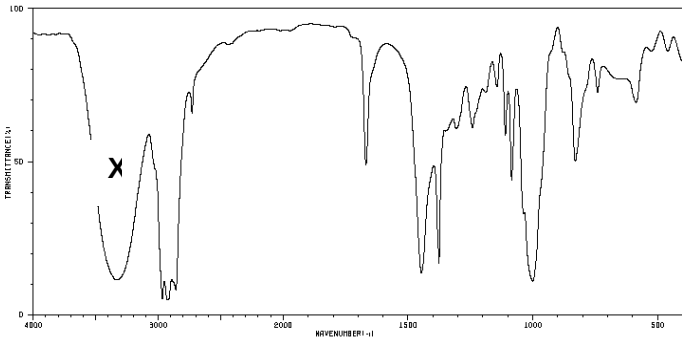
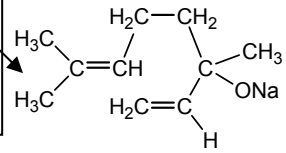
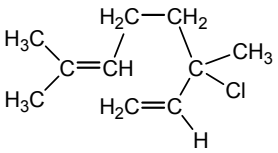
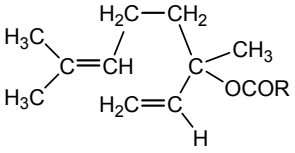
2812 Chains and Rings

Question No.			Max Mark
1a	i	boiling point increases with increased chain length/M_r ✓ more surface interaction/electrons/van der Waals/intermolecular forces ✓	**2**
	ii	boiling point decreases with increased branching ✓ less surface contact/cannot pack as close/fewer van der Waals/fewer intermolecular forces ✓	**2**
	iii	59 – 68 °C ✓	**1**
b	i	1 mark for pentane ✓and one for 2,2-dimethylpropane✓  allow 1 mark if not skeletal but both correct.	**2**
	ii	C_5H_{12} → any of:  + H_2 any of these scores both mark ✓✓ or any correct structural formula, clearly showing a cyclic compound $C_5H_{12} \longrightarrow C_5H_{10} + H_2$ ✓ scores 1 mark only pentane ⟶ cyclopentane or less without the H_2 – scores 1 mark	**2**
	iii	better fuels/burn more efficiently/increases octane rating/used as a fuel additives/reduces knocking(ignite less easily) ✓ do not allow "*easier to burn*" as this is the same as pre-ignition	**1**

Question No.			Max Mark
2a		C-H bond energy is large ✓ alkanes/C-H bonds are non-polar ✓ hence alkanes are not attracted / not attacked by nucleophiles or electrophiles ✓ 2 from 3 allow 1 mark for *"no double bond therefore will not react with electrophiles"*	**2**
b	i	(molecule/atom/particle *(not ion)* that) contains an unpaired/single/lone electron ✓ (not free electron)	**1**
	ii	homolytic/homolysis	**1**
	iii	uv/sunlight/high temperature/ >200^{o}C✓ (**not** just heat or hot or high temp + high pressure)	**1**
	iv	$CH_3CH_2CH_3 + Cl\bullet \longrightarrow CH_3CH_2CH_2\bullet + HCl$ ✓ $CH_3CH_2CH_2\bullet + Cl_2 \longrightarrow CH_3CH_2CH_2Cl + Cl\bullet$ ✓	**2**
	v	$CH_3CH_2CH_2\bullet + CH_3CH_2CH_2\bullet$ ($\longrightarrow C_6H_{14}$)/explained in words but must refer to propyl (not propane) free radicals ✓ *if correct equation ignore "propane free rads"*	**1**
c	i	$CH_3CH_2CH_3$ /$C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$ ✓	**1**
	ii	Possibility of forming CO/ incomplete combustion/good ventilation allows complete combustion ✓	**1**

Question No.			Max Mark
3a	i	hydrogen ✓ Ni/Pt/Rh/Pd ✓	2
	ii	H_2O/steam ✓ H_3PO_4 / H_2SO_4 ✓	2
	iii	HBr/ NaBr + H_2SO_4 / NaBr + H^+ ✓	1
b		 curly arrow from π-bond to $Br^{\delta+}$ ✓ correct dipoles on Br-Br + curly arrow from Br-Br bond to $Br^{\delta-}$ ✓ correct intermediate(allow primary/secondary carbonium ion or bromonium ion) ✓ curly arrow from Br^- to C^+/ carbonium ion ✓	4
c	i	 backbone of 6 carbon atoms as shown ✓ repeat unit identified ✓ *do not penalize linkage to –CH_2OH side chain*	2
	ii	 monomer and repeat unit correctly shown ✓ correct position on the n_s✓ n $CH_2CHCH_2OH \longrightarrow (CH_2CHCH_2OH)_n$ gets both marks n $C_3H_6O \longrightarrow (C_3H_6O)_n$ gets both marks *do not penalize linkage to –CH_2OH side chain*	2
	iii	poly(prop-2-en-1-ol)/polyprop-2-en-1-ol ✓	1

3d	i	$CH_3CH_2CH_2OH + 2\,[O] \longrightarrow CH_3CH_2COOH + H_2O$ ✓✓ $C_3H_7OH + 2\,[O] \longrightarrow C_2H_5COOH + H_2O$ ✓✓ $C_3H_8O + 2\,[O] \longrightarrow C_3H_6O_2 + H_2O$ ✓✓ correct product CH_3CH_2COOH scores 1 ✓ if aldehyde is made but the equation is correctly balanced $CH_3CH_2CH_2OH + [O] \longrightarrow CH_3CH_2CHO + H_2O$ scores 1 ✓ do not allow C_3H_6O or CH_3CH_2COH	2
	iii	 ✓✓ Any two of the above. The first two have a chiral centre and if they draw two correct optical isomers with 'wedge-shaped' bonds award both marks.	2

Question No.			Max Mark
4a	C : H : O 6.5 : 11.7 : 0.65 ✓ 10 : 18 : 1 hence = $C_{10}H_{18}O$ ✓ M_R /120 + 18 +16 = 154 ✓	154 x 77.9/100 = 120 = 10 Cs 154 x 11.7/100 = 18 = 18 Hs 154 x 10.4/100 = 16 = 1 O hence = $C_{10}H_{18}O$ gets all 3 marks✓✓✓	**3**
b i	contains a (C=C) double bond/ an alkene/ C≡C/ alkyne/ unsaturated ✓		**1**
ii	uses correctly 159.8/ 160 as M_r of Br_2 ✓ 3.196 ÷ 159.8 = 0.02 mole of Br_2 ✓ 0.04 ✓ecf (used 80 instead of 160)		**2**
iii	compound must have **two** C=C double bonds/ **one** C≡C triple bond ✓		**1**
c			**1**
d i	linalool ✓		**1**
ii	It's the only tertiary alcohol/ the others would be oxidized/are primary alcohols ✓		**1**
iii	reacts with Na/ PCl_5/$SOCl_2$ /RCOCl ✓ H_2 or HCl or SO_2 ✓ correct organic product  or  or  mark ecf to d (i)		**3**

Na compound
H_2
Na alkoxide

worth 1 mark

<table>
<tr><th colspan="2">Question No.</th><th colspan="3"></th><th colspan="2">Max Mark</th></tr>
<tr><td>5</td><td>a</td><td colspan="3">There are two possible methods but marks common to both are

add Ag^+/ $AgNO_3$ ✓

warm/heat in (water bath)/ warm to a specified temp between 30 – 70 ^oC ✓

equi-molar quantities of RX/ same number of drops of RX/ same amount of RX✓

precipitate formed/goes cloudy ✓</td><td colspan="2">4</td></tr>
<tr><td></td><td></td><td>if $AgNO_3$ dissolved in ethanol ✓

must monitor rate ✓of ppt</td><td>if using NaOH must be followed by HNO_3 before adding the $AgNO_3$ ✓

must monitor amount ✓of ppt</td><td></td><td>2</td></tr>
<tr><td></td><td></td><td colspan="2">C-I is fastest and C-Cl is slowest /correct order ✓

because

C-Cl bond strongest/shortest & C-I weakest/longest/ refers to the strength of the bonding in named halogens ✓

$Ag^+ + X^- \longrightarrow AgX$ ✓

$R\text{-}X + OH^-/ H_2O \longrightarrow R\text{-}OH + X^-/ HX$ ✓</td><td></td><td>4

max = 8</td></tr>
<tr><td></td><td></td><td colspan="2">SPAG – two correct sentences in which the meaning is clear.</td><td></td><td>1</td></tr>
<tr><td colspan="6">9</td></tr>
</table>

2813/01 How Far? How Fast?/Experimental Skills 1 Written Paper

Question No		Max Mark
1) (a)	$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ ✓	[1]
(b)	energy = $mc\Delta T$/ 150 x 4.18 x 42 ✓	
	=26.3 (kJ) ✓	[2]
(c)	number of moles = $\frac{0.600}{16}$ = 0.0375 ✓	[1]
(d)	enthalpy = $\frac{26.3}{0.0375}$ = 701 (kJ mol^{-1}) ✓	
	ΔHc = - 701 (kJ mol^{-1}) ✓ negative sign can be scored as stand-alone mark	[2]
		[Total: 6]

Question No		Max Mark
2(a)(i)	the (total) enthalpy change (for a reaction) is independent of the route taken owtte ✓	[1]
(ii)	$N_2(g) + 2H_2(g) \rightarrow N_2H_4(l)$ ✓	[1]
(iii)	cycle ✓ $\Delta H + 51 = 2(-241)$ ✓ $\Delta H = -533$ (kJ) ✓	[3]
(iv)	products are non-toxic/ not greenhouse gases/ occur naturally in the atmosphere/ no carbon dioxide is formed ✓	[1]
(b)(i)	any 2 from reaction is occurring in a closed system ✓ rate of forward reaction = rate of reverse reaction ✓ macroscopic properties/ suitable named macroscopic property remains constant ✓	[2]
(ii)	bonds broken = 2(C=O) + 4(H-H) = 3354 (kJ) ✓ bonds made = 4(C-H) + 4(O-H) = 3508 (kJ) ✓ enthalpy change = -154 (kJ) ✓	[3]
(iii)	low temperature ✓ because the (forward) reaction is exothermic ✓ (ecf possible from (ii)) high pressure ✓ because there are more moles (of gas) on the LHS ✓	[4] [Total: 15]

Question No		Max Mark
3(a)	a proton donor/ an H^+ donor ✓	[1]
(b)(i)	$CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$/ $CuO(s) + 2H^+(aq) \rightarrow Cu^{2+}(aq) + H_2O(l)$/ $O^{2-} + 2H^+(aq) \rightarrow H_2O(l)$ all formulae and balancing ✓	
	$Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$/ $Na_2CO_3(s) + 2H^+(aq) \rightarrow 2Na^+(aq) + CO_2(g) + H_2O(l)$/ $CO_3^{2-} + 2H^+(aq) \rightarrow CO_2(g) + H_2O(l)$ all formulae and balancing ✓	
	state symbols in both equations (ignore ss on CuO and Na_2CO_3) ✓	[3]
(ii)	high activation energy/ strong ionic bonds present (in copper oxide)/ high lattice enthalpy (in copper oxide) ✓	[1]
(iii)	bubbling/ effervescence ✓	[2]
	solid disappears/solid dissolves/ blue or green solution formed ✓	
(c)(i)		[1]
(ii)	completely dissociated/ completely ionised ✓	[1]
(iii)	$HClO_4 \rightarrow H^+ + ClO_4^-$ ✓	[1]
(iv)	$Mg + 2H^+ \rightarrow H_2 + Mg^{2+}$ ✓	[2]
	no difference in rate ✓	
	the **concentration** of H^+ is the same ✓	[Total: 12]

Question No		Max Mark
4)	a catalyst provides an alternative pathway that has a lower activation energy ✓ more particles/ collisions exceed the activation energy/ more successful collisions occur ✓ diagram to show 2 profiles with initial and final energies together ✓ two different energy humps with catalysed labelled as lower curve ✓ E_a labelled on both/ labelled on one and statement E_a (cat) < E_a ✓ equation ✓ catalyst named ✓ equation ✓ catalyst named ✓ examples include $N_2 + 3H_2 \rightarrow 2NH_3$ ✓ iron ✓ any alkene + H_2 → corresponding alkane ✓ nickel/platinum ✓ $2SO_2 + O_2 \rightarrow 2SO_3$ ✓ vanadium(V) oxide ✓ $2CO + 2NO \rightarrow 2CO_2 + N_2$/ $4CO + 2NO_2 \rightarrow N_2 + 4CO_2$ ✓ platinum/ palladium/rhodium ✓ equation for cracking/ reforming/ isomerisation of any alkane ✓ platinum/ zeolites ✓ adsorption ✓ bonds weakened ✓ products desorbed ✓	[2] [3] [4] [3] [Total: 12]

2813/03 How Far? How Fast?/Experimental Skills 1 Practical Examination

PLAN Skill P (16 marks out of 19 available)

T Titration method – 8 marks

T1 Makes up a standard solution of $NaHCO_3$
Known mass ***and*** distilled water ***and*** use of volumetric flask required [1]

T2 Nitric acid diluted by a factor of 10, 20, 25, 40 or 50 before titration [1]
Pipette must be used for measurement of the 2M acid

T3 Equation for reaction given: $NaHCO_3 + HNO_3 \rightarrow NaNO_3 + CO_2 + H_2O$
and justification of quantities so that both solutions have [roughly] equal concentrations
or calculation of mass of $NaHCO_3$ required for reaction with nitric acid [1]

T4 Use of pipette and burette to measure solutions in titration procedure [1]
Solutions can be used either way round

T5 Two consistent titres (***or*** within 0.1 cm^3) obtained [1]

T6 Suitable indicator chosen ***and*** correct final colour at end-point stated [1]
Litmus and universal indicators are not acceptable.

T7 Correct calculation of relative formula mass of $NaHCO_3$ from specimen data [1]
*T7 can be awarded for **any** correct calculation of M_r*

T8 Detailed calculation of relative formula mass of $NaHCO_3$ from specimen data [1]
T8 can be awarded in addition to T7 if the following conditions are met
- *Both HNO_3 and $NaHCO_3$ were diluted/made up into solution*
- *The calculation uses specimen figures*
- *Working/explanation is very clearly explained*

G Gas measurement procedure – 7 marks

Measurement of mass loss is an acceptable alternative method

G1 Use <u>excess</u> HNO_3 acid and a known/weighed mass of solid $NaHCO_3$ [1]

G2 **Diagram** showing collection using a gas syringe ***or*** inverted burette ***or*** measuring cylinder [1]
Do not award G2 if heating used or there is no bung or an unworkable collection.

G3 Ignition tube used ***and*** simple explanation (to keep reagents apart/prevent loss of gas)
or simple procedural note (tilt/shake to mix to start reaction) [1]
Alternative separation methods (eg a divided flask) s are acceptable

G4 Measure volume of gas when no more produced/ fizzing ceases /syringe stops moving [1]

G5 Specimen calculation shown to justify [maximum] mass of $NaHCO_3$ used [1]
Mass of solid must be deduced from capacity of gas collecting vessel

G6 Calculation shown to deduce a suitable [minimum] volume/concentration of nitric acid [1]

G7 One accuracy precaution
Either repeat whole experiment ***and*** take mean of readings [1]
Or use of gas syringe reduces loss of carbon dioxide caused by its solubility in water

S Safety, Sources and QWC – 4 marks

S1 Nitric acid (2M) is corrosive ***and*** one of the following precautions
- if spilt, rinse/wash away spill with plenty of water
- dilute before use [in the titration] to reduce hazard level
- wear gloves [1]

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" or equivalent*

S3 **QWC**: text is legible and spelling, punctuation and grammar are accurate [1]
*There are less than **six** different errors in legibility, spelling, punctuation or grammar.*

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

- *Is a word count given and within the limits 500 – 1000 words?*
- *Are scientific language, formulas and units used correctly*
- *Are descriptions logical and without excessive irrelevant/repeated material?*

PART B PRACTICAL TEST

Part 1 Experiment with $NaHCO_3$ [15 marks]

One table of readings drawn showing both sets of four readings labelled and listed [1]
- Mass of weighing bottle (empty) ***and*** mass of weighing bottle + K
- Initial temperature ***and*** minimum/final temperature

All masses recorded to two decimal places (or 3 dp consistently), with unit (somewhere) ***and*** all measured temperatures recorded to **one** decimal place, with unit (somewhere) [1]

Calculation of mean temperature fall ***and*** mean mass used, both correct [1]
Mean mass should be quoted to two decimal places
Mean temperature should be to one decimal place

Accuracy marks, based on mean temperature drop of supervisor. [2]
- If within 0.8°C of supervisor's result → 2 marks
- If within 1.3°C of supervisor's result → 1 mark

(a) **(i)** Temperature drop/change (***or*** candidate's mean figure quoted) [1]

(ii) Heat absorbed correctly calculated to 2 or 3 sig fig (= *105 x temp drop*) [1]

(b) *M*r of $NaHCO_3$ = 84 (***or*** appropriate A_r values shown added together) [1]

Mean number of moles of $NaHCO_3$,correctly calculated [1]

(c) ….. + $2CO_2$ + $2H_2O$ (***and*** **no** other balancing figures) [1]

State symbols (all correct: s – aq – aq – g – l) [1]
Mark is conditional to both chemical formulae in equation being correct

(d) **Method mark:** for dividing heat by no of moles ***and*** multiplying by 2 [1]

Enthalpy change, correctly calculated = $^{(a)(ii)}/_{(b)} \times {}^{2}/_{1000}$ [1]
Answer will be approx +33 kJ (for 2 moles $NaHCO_3$)

(e) **Safety**: credit any **two** answers from the following [2]

- Use colder acid ***or*** reduce the initial temperature of the acid
- Reduce the concentration of acid ***or*** add water to the acid.
- Use the solid in lump form ***or*** use coarser powder.

Part 2 Experiment with Na_2CO_3 **[12 marks]**

Table of readings drawn ***and*** two sets of four readings shown [1]

Both mass readings to 2 dp with units and both temperature readings to 1 dp [1]
A technical error penalized in Part 1 is not penalized again in Part 2

Calculation of mean temperature rise and mean mass used, both correct [1]

Accuracy: Both of candidate's temperature rises are within 0.5°C of each other [1]

Accuracy marks awarded compared to supervisor's mean value. [2]
If within 0.8°C of supervisor's result → 2 marks
If within 1.3°C of supervisor's result → 1 mark

(a) Heat produced correctly calculated (= 105 x temp rise) [1]

(b) *M*r of Na_2CO_3 = 106 (***or*** appropriate Ar values added) [1]

Mean number of moles of Na_2CO_3 used. [1]

(c) …… → $Na_2SO_4 + CO_2 + H_2O$ (***and*** **no** balancing figures) [1]

(d) Enthalpy change, correctly calculated = $^{(a)}/_{(b) \times 1000}$ [1]

Correct answer to 2 or 3 sig figs, ***and*** negative sign shown [1]
Answer should be approx - 46 kJ mol^{-1}

Part 3 Enthalpy of decomposition[3 marks]

(a) (i) Two <u>downward</u> arrows drawn, with tips pointing to bottom box [1]

(a) (ii) Arrows correctly labelled with candidate's own values (***or*** with values on the Qn paper) [1]

(b) ΔH = (+)95.2 kJ (using figures given) ***or*** about +79 kJ from candidate's results [1]
Award the mark only for the correct answer, which is ***1(d)*** *–* ***2(d)****.*

Part 4 Evaluation [14 marks]

(a) *Award marks from the best **two** strands*
NO mark for reference to small quantities of reagents or heat capacity of thermometer

- Heat lost/gained [to/from surroundings] [1]

  Conduction (allow "through sides") ***or*** convection (allow "out of top") [1]

  Use a lid ***or*** cover the container
  or use a thicker cup/ cotton wool surround/ extra insulation [1]

- Inaccuracy of thermometer (***or*** it only reads to 0.5/1.0^{o}C) [1]

  High <u>percentage</u> error in measurement [1]

  Use a more accurately calibrated thermometer/reading to [less than] 0.2^{o}C [1]

- Loss of [acid] spray [1]

  Use a lid ***or*** a taller cup [1]

- Fizzing/production of gas still occurring when final reading taken [1]

  Reaction is not complete [1]

  Stir more thoroughly ***or*** use a finer powder ***or*** speed up reaction [1]

(b) Temperature rise would be lower/less than before [1]

Twice as much water to be heated up, so temp rise would be half as much [1]

(c) (i) No of moles of H_2SO_4 required [= no of moles of Na_2CO_3] = 0.018/0.019 [1]

Minimum volume of sulphuric acid needed = 18 cm^3, but 25 cm^3 used, which is excess.
or number of moles of sulphuric acid present = 0.025, but only 0.018 mol needed [1]

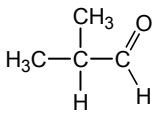
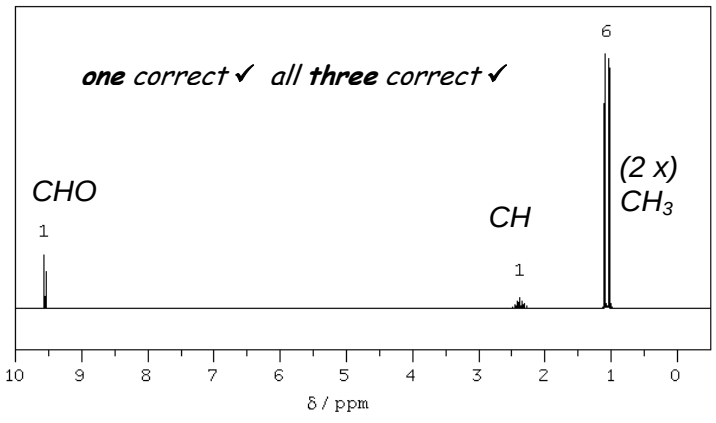
(c) (ii) To ensure that <u>all</u> of the carbonate reacted. [1]

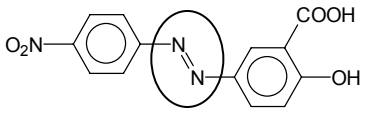
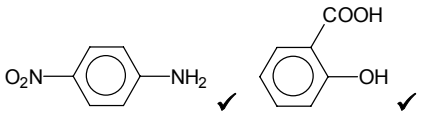
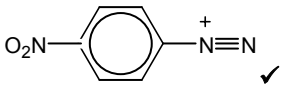
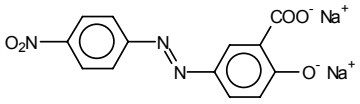
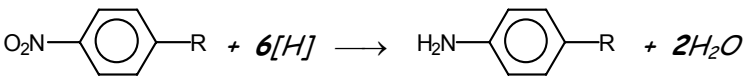
To speed up the reaction in the later stages/reduce overall time that reaction takes [1]

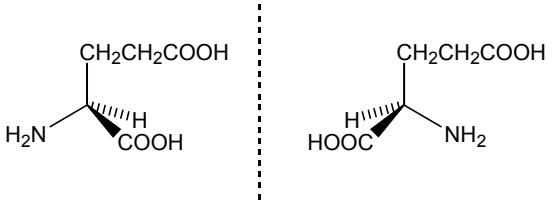
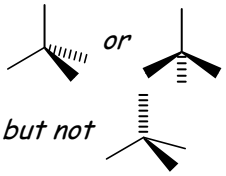
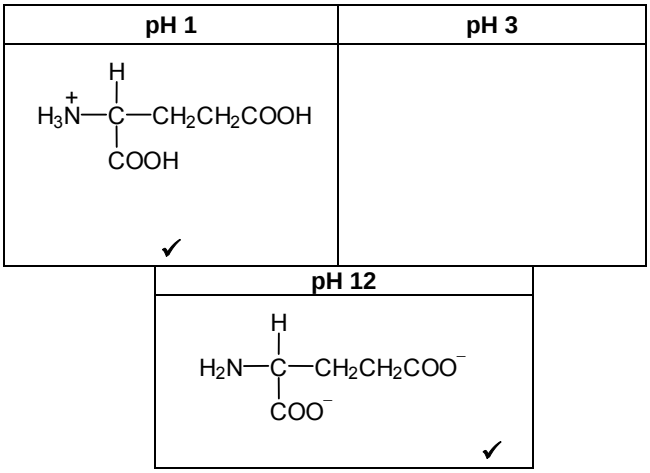
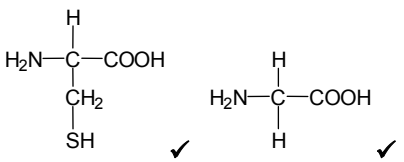
(d) Any 2 points [2]

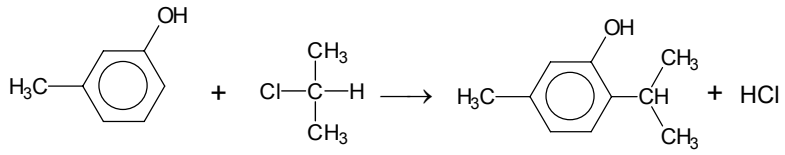
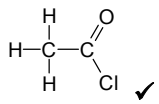
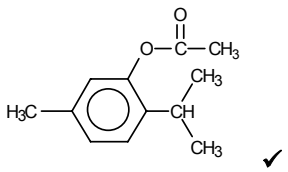
- Decomposition requires heat to be supplied, which would be difficult to measure
- It is not easy to measure the temperature of a powder/solid
- Decomposition reaction is at higher temperature than standard conditions /about 25^{o}C
- Difficult to tell when decomposition reaction was complete

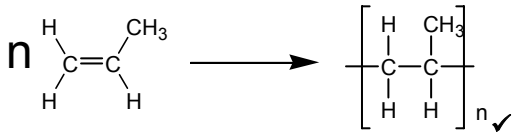
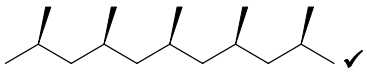
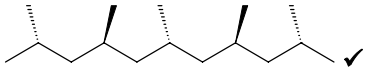
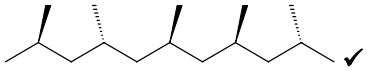
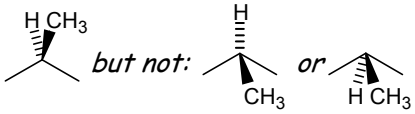
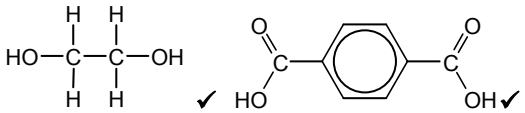
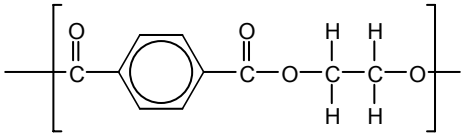
2814 Chains, Rings and Spectroscopy

Qu. No.		Marks
1 (a)	*2-methylpropanal* ✓ *$CH_3COCH_2CH_2CH_3$* *$CH_3CH_2COCH_2CH_3$* ✓	[2]
(b)	*75 – 130 (°C)* ✓ *(actual value is 103°C)*	**[1]**
(c) (i)	*yellow/orange/red solid/precipitate* ***AW*** ✓	**[1]**
(ii)	*reference to the identical bp (of pentanones) / unique mp (of derivatives)* ✓	**[1]**
(d)	*72* ✓	**[1]**
(e) (i)	*the number/ratio of protons of each 'type'/in each environment* ***AW*** ✓	**[1]**
(ii)	*(they both) have one neighbouring proton / are next to CH* ✓	**[1]**
(iii)	*any unambiguous formula of 2-methylpropanal* ✓ *eg* 	**[1]**
(iv)	*allow any unambiguous labelling to link the correct protons to the peak – eg*  ***one*** *correct* ✓ *all* ***three*** *correct* ✓ *CHO* *CH* *(2 x) CH_3* 1 1 6 10 9 8 7 6 5 4 3 2 1 0 δ / ppm *max 1 mark ecf from the wrong structure for:* *CHO from any aldehyde* *2 x CH_3 from pentan-3-one or methylbutanone* *CH from methylbutanone*	**[2]**
		[Total: 11]

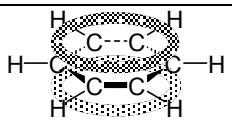
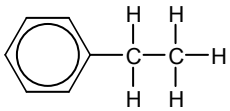
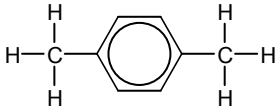
Qu. No.		Marks
2 (a)		**[1]**
(b)	 ✓ ✓ *(add to the amine)* *$NaNO_2$ / HNO_2 and HCl* ✓ *<10°C* ✓  ✓ *then add the phenol alkaline conditions **AW*** ✓ *the + charge must be on the correct N atom* *allow ecf on missing or wrong NO2 position*	**[6]**
(c)	 *allow ONa or just O^-, but **NOT** O-Na* *one group ionised* ✓ *both groups ionised and rest of structure* ✓	**[2]**
(d) (i)	*Tin and (conc) HCl* ✓ *allow other suitable reducing agents (but **not** $NaBH_4$)*	**[1]**
(ii)	 *correct product* ✓ *rest of the equation* ✓	**[2]**
		[Total: 12]

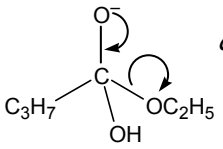
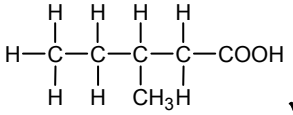
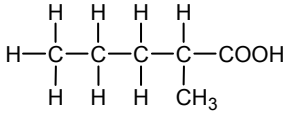
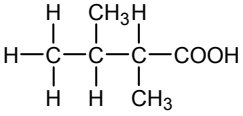
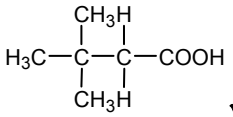
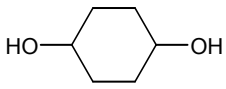
Qu. No.		Marks
3 (a)	*chiral centre / four different groups around a carbon / asymmetric carbon / non-superimposable mirror images* ✓ *diagram – eg*  *one correct 3-D diagram of glutamic acid* ✓ *mirror image / other stereoisomer* ✓	*for the 3-D shape, allow:*  *allow ecf on 3-D errors*	**[3]**
(b)	 		**[2]**
(c) (i)	 	*allow any valid ionisation*	**[2]**
(ii)	*condensation* ✓		**[1]**
(iii)	*heat with (aqueous) acid/base* ✓ *(allow name/formula for any suitable acid/base)*	***not*** *conc H_2SO_4, HNO_3 and weak acids/bases*	**[1]**
			[Total: 9]

Qu. No.		Marks
4 (a)	*antiseptic / kills bacteria / disinfectant **AW*** ✓	[1]
(b) (i)	 ✓ ✓ *allow use of the bromoalkane*	[2]
(ii)	*$FeCl_3$ / $AlCl_3$* ✓	[1]
(c)	*(molecular formula = $C_{10}H_{14}O$) so M_r = 150* ✓ *allow ecf throughout* *mass thymol per dm^3 = $3.0 \times 10^{-3} \times M_r$ = 0.45 (gdm^{-3}) /* *moles of thymol in $400cm^3$ = $3.0 \times 10^{-3} \times 0.4$ = 1.2×10^{-3} (mol)* ✓ *mass per $400\ cm^3$ = 0.45×0.400 / = $1.2 \times 10^{-3} \times M_r$* *= **0.18** (g) or ecf to at least 2 sig figs* ✓ *do **not** allow if rounded to 0.2 g*	[3]
(d) (i)	 ✓	[1]
(ii)	*$SOCl_2$ / PCl_5* ✓ *$CH_3COOH + SOCl_2 \longrightarrow CH_3COCl + SO_2 + HCl$ /* *$CH_3COOH + PCl_5 \longrightarrow CH_3COCl + POCl_3 + HCl$* ✓ *equation must relate to the reagent chosen*	[2]
(iii)	 ✓ *allow any unambiguous structure*	[1]
(iv)	*no (broad) peak at 3230-3550(cm^{-1})* ✓ *peak at 1680-1750(cm^{-1})* ✓ *allow any named wavenumber within the ranges*	[2]
		[Total: 13]

Qu. No.		Marks
5 (a) (i)	 ✓	**[1]**
(b)	*2-D or 3-D diagram of polypropene to show side chains on the same side labelled* ***isotactic*** *- eg*  ✓ *2-D or 3-D diagram of polypropene to show side chains on alternating sides labelled* ***syndiotactic*** *- eg*  ✓ *2-D or 3-D diagram of polypropene to show side chains on random sides labelled* ***atactic*** *– eg*  ✓ *at least one of the diagrams also shows correct 3-D orientation* ✓ *for 3-D, skeletal as shown, or with labelling of H and CH_3 on the skeletal structure - .eg* 	**[4]**
(c) (i)	*correct structures – eg*  ✓ ✓	**[2]**
(ii)	 *ester group* ✓ *correct repeat bracketed* ✓	**[2]**
		[Total: 9]

Qu. No.		Marks
6 (a) (i)	*ammonia* ✓	[1]
(ii)	*(nucleophilic) substitution* ✓	[1]
(iii)	*$LiAlH_4$ / Na in ethanol* ✓	[1]
(iv)	*reduction / (nucleophilic) addition* ✓	[1]
(b)	✓ ✓ $C_6H_5CH_2CH_2NH_2 + CH_3COCl \longrightarrow C_6H_5CH_2CH_2NHCOCH_3 + HCl$ *(or use of the acid anhydride to give ethanoic acid as the other product)* *allow ecf on H_2O as the product from ethanoic acid*	[2]
(c)	***basicity*** *a base is a proton acceptor **AW*** ✓ *lone pair on N (is used to accept the H^+) / dative bond to H^+* ✓ *any of the first three marks can come from a suitable diagram* ***phenylamine*** *phenylamine has lone pair (partially) delocalised around ring* ✓ *so the electron pair is less easily donated / H^+ is less attracted (to the N) **AW*** ✓ ***2-phenylethylamine*** *electrons are pushed towards the N / positive inductive effect **AW*** ✓ *so the electron pair is more easily donated / H^+ is more attracted to the N **AW*** ✓ *the electron density is lower on the N (for phenylamine) / higher (for phenylethylamine)* ✓ ***any 6 out of 7 marks***	[6]
	quality of written communication *at least two sentences with correct spelling, punctuation and grammar* ✓	[1]
		[Total: 11]

Qu. No.			Marks
7 (a)	 *overlap of p-orbitals* ✓	*any of the first three marks can come from a good diagram*	
	above and below the ring ✓		
	(π) electrons are spread / delocalised around the ring ✓		
	C-C bonds are: same length/strength / in between single and double / σ-bonded ***AW*** ✓		**[4]**
	Quality of written communication *mark for correct use of the terms: pi /π* ***and*** *delocalised* ✓		**[1]**
(b)	**B** *contains 9.43% H,* *so moles of C = 7.55, moles H=9.4,* *so CH ratio is: 1 : 1.25*		
	empirical formula = C_4H_5 ✓	*allow* C_8H_8 *to* $C_{11}H_{11}$ *as ecf from CH,*	
	use of M_r *and empirical formula to get molecular formula of* **B** = C_8H_{10} ✓		
	structure of **B** *= ethylbenzene or any dimethylbenzene eg*  	*correct structure of* **B** *gets the 2nd and 3rd marks*	
	or ecf for a valid structure from an incorrect M_r ✓		
	so **A** = C_2H_5X / CH_3X *(depending on their structure)* ✓ *or ecf from an incorrect aromatic structure of* **B**	*X = Cl or Br*	**[4]**
			[Total: 9]

Qu. No.		Marks
8 (a) (i)	*ethyl butanoate* ✓	[1]
(ii)	$CH_3CH_2\ CH_2COO\ C_2H_5 + H_2O \longrightarrow CH_3CH_2CH_2COOH + C_2H_5OH$ ✓ *(allow use of molecular formulae)*	[1]
(iii)	$C_3H_7COO^-\ Na^+ + C_2H_5OH$ ✓ *allow ONa or just O^-, but **NOT** O-Na*	[1]
(b) (i)	 *one mark for each curly arrow* ✓✓	[2]
(ii)	*movement of an electron pair* ✓	[1]
(iii)	*donates a (lone) pair of electrons (to the C=O)* ✓	[1]
(c)	*allow any unambiguous structure or name* *3-methylpentanoic acid*  ✓ *2-methylpentanoic acid*  ✓ *2,3-dimethylbutanoic acid*  ✓	[3]
(d)	 ✓	[1]
(e) (i)	 ✓	[1]
(ii)	*3 peaks* ✓ *areas 1:1:4* ✓ *allow 2:2:8*	[2]
		[Total: 14]

2815/01 Trends and Patterns

Mark Scheme Page 1 of 5	Unit Code 2815/01	Session January	Year 2008	Version Final	
Question	**Expected answers**			**Marks**	**Additional guidance**
1 (a)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$ **and** iron has an incompletely filled d-orbital (1)			1	**Allow** $[Kr]3d^6$ incomplete 3d sub-shell / incomplete d sub-shell
(b) (i)	$[Fe(H_2O)_6]^{2+}$ (1)			1	**Allow** other correct complex ions If answer blank credit can be obtained from (ii)
(ii)	Octahedral shape with indication of three dimensions (1); 90^o (1)			2	Must have at least two wedges, dotted lines or construction lines **Allow** three dimensions if at least two bond angles of 90^o are shown that clearly demonstrate 3D **If two different bond angles** do not award bond angle mark unless correct 90^o and 180^o **Allow** ecf from other complex ions even if they do not contain iron. This may include tetrahedral or square planar arrangements
(iii)	Ligand donates an electron pair / ligand donates a lone pair / iron accepts a lone pair / iron accepts electron pair (1); Dative (covalent) / coordinate (1)			2	**Allow** ecf from wrong complex
(c)	$[Fe(H_2O)_6]^{3+} + SCN^- \rightarrow [Fe(H_2O)_5SCN]^{2+} + H_2O$ (1); Yellow / orange to (blood) red (1)			2	

Mark Scheme Page 2 of 5	Unit Code 2815/01	Session January	Year 2008	Version Final	
Question	**Expected answers**			**Marks**	**Additional guidance**
1 (d)	$FeCl_2$ gives green (grey) ppt and $FeCl_3$ gives foxy red or orange red or brown-red ppt (1); $Fe^{2+}(aq) + 2OH^-(aq) \rightarrow Fe(OH)_2(s)$ / $Fe^{3+}(aq) + 3OH^-(aq) \rightarrow Fe(OH)_3(s)$ (1)			2	**Allow** solid instead of ppt / use state symbol from equation if ppt not written If give two equations both must be correct **Allow** equations which give $Fe(OH)_2(H_2O)_4$ or $Fe(OH)_3(H_2O)_3$
(e)	Cr goes from +3 to +6 which is oxidation (1); Fe goes from +6 to +3 which is reduction (1)			2	**Allow** one mark for correct identification of all oxidation numbers if other marks not scored
(f)	$2FeO_4^{2-} + 10H^+ \rightarrow 2Fe^{3+} + 3/2O_2 + 5H_2O$ Correct reactants and products (1); Balanced (1)			2	**Allow** correct multiples
				Total = 14	

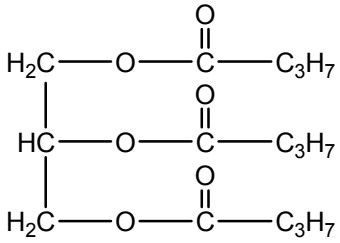
Mark Scheme Page 3 of 5	Unit Code 2815/01	Session January	Year 2008	Version Final	
Question	**Expected answers**			**Marks**	**Additional guidance**
2 (a)	$2Na^+(g) + O^{2-}(g) \rightarrow Na_2O(s)$ (1); Enthalpy change when one mole of solid Na_2O is made from its gaseous ions (1)			2	**Allow** energy released **Not** energy required **Allow** ionic compound / ionic solid / salt / ionic lattice State symbols from equation can be used if states missing from definition
(b)	Correct formulae (1); Correct state symbols (1); Labelled energy changes • Lattice enthalpy • Enthalpy change of formation • Atomisation of magnesium • Atomisation of oxygen • First and second ionisation energy of magnesium (can be labelled together) • First and second electron affinity of oxygen (can be labelled together) Six correct (3); Four or five correct (2); Two or three correct (1)			5	**Allow** use of acceptable symbols for each enthalpy change eg ΔH_f If arrows missing from cycle penalise once only
(c)	(MgO more exothermic because) Oxide ion smaller than carbonate ion / oxide ion has a higher charge density than carbonate ion (1); So oxide ion has a stronger attraction to magnesium ion / carbonate ion has a weaker attraction (1)			2	**Allow** ora **Penalise** use of incorrect particle only once in this question
(d) (i)	$CaCO_3 \rightarrow CaO + CO_2$ (1)			1	**Ignore** state symbols
(ii)	Magnesium ion smaller than calcium ion / magnesium ion has a higher charge density / ora (1); Magnesium ion distorts the carbonate ion more than calcium ion / magnesium ion causes more polarization of the carbonate ion (1)			2	**Allow** ora **Penalise** use of incorrect particle only once in this question
				Total = 12	

Mark Scheme Page 4 of 5	Unit Code 2815/01	Session January	Year 2008	Version Final	
Question	**Expected answers**			**Marks**	**Additional guidance**
3 (a)	**Colourless to purple or (pale) pink (1)**			1	**allow** it goes pink / it goes purple **not** just pink / just purple
(b)	Moles of MnO_4^- = 3.81×10^{-4} (1); Moles of ethanedioic acid = 9.525×10^{-4} (1) / 2.5 × moles of MnO_4^-; Relative formula mass = 126 (1) / 0.120 ÷ moles of ethanedioic acid; **x** = 2 / (M_r – 90) ÷ 18 (1)			4	**Allow** ecf throughout
(c)	$(COO)_2Mg$ / $Mg(OOC)_2$ (1)			1	**Allow** $(COO^-)_2Mg^{2+}$ / $Mg^{2+}(^-OOC)_2$
				Total = 6	
4	**Structure and Bonding** Correct 'dot and cross' diagram for $SiCl_4$ (1); Correct 'dot and cross' diagram for $MgCl_2$ (1): Correct charges – Mg^{2+} and Cl^- (1); $SiCl_4$ – simple molecular / simple covalent (1); $MgCl_2$ – giant ionic (1)			5	Charges on ions are independent of 'dot and cross' diagram
	Melting Points $MgCl_2$ – (strong electrostatic) attraction between ions (1); $SiCl_4$ – (weak) Van der Waals forces / temporary dipole-temporary dipole interaction / induced dipole-induced dipole interaction (1) Correct use of strong and weak – must be linked to the correct force / bond (1)			3	**Allow** ionic bonds / ionic lattice / 'is ionic' (1) **Allow** intermolecular forces / description of an intermolecular (1)
	Action of water $PCl_5 + 4H_2O \rightarrow 5HCl + H_3PO_4$ (1) Steamy fumes produced / acidic solution produced / vigorous reaction / exothermic (1) $MgCl_2$ + aq → Mg^{2+}(aq) + $2Cl^-$ (aq) / dissolves / magnesium ions polarises water molecules (1) Makes a colourless solution / neutral solution (1)			4	**Allow** any pH between 6 and 7

Mark Scheme Page 5 of 5	Unit Code 2815/01	Session January	Year 2008	Version Final	
Question	**Expected answers**			**Marks**	**Additional guidance**
4	**Quality of written communication** Answer must address the question set and include at least **three** of the following terms in the correct context • Hydrolysis • Covalent • Ionic • van der Waals • Intermolecular • Dipole • Electrostatic • Dissolution • Electron • Molecule / molecular • Lattice • Giant • Simple • Exothermic • Intramolecular • Dissociate			1	
				Total = 13	

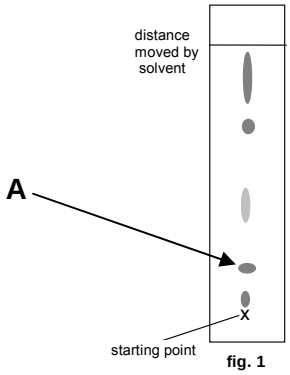
2815/02 Biochemistry

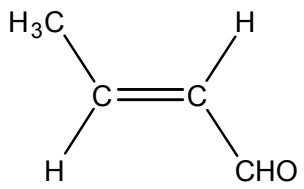
Question No.			Max Mark
1)	(a)	*Ribose with attached base ✓ and phosphate ✓. The correct position for attachment of base (position 1) /phosphate (position 5) ✓. Numbers not required if the diagram is clear. A diagram alone is enough. The sugar must be unambiguously ribose in a diagram, not cyclopentane versions.*	[3]
	(b)	Find six points from the following: • ① *Mention of t-RNA and m-RNA molecules ✓* • ② *triplets of bases on m-RNA code for each amino acid ✓* • ③ *Each t-RNA carries amino acid on one end corresponding to base triplet at the other ✓. AW* • ④ *t-RNA attaches to m-RNA using base triplet which is complementary to base triplet on the m-RNA ✓* • ⑤ *Attachment by hydrogen bonding ✓(No need for number of bonds)* • ⑥ *Hydrogen bonding is between complementary base pairs CG and AU ✓ Details not required.T is incorrect.* • ⑦ *Amino acids are linked into polypeptide at the ribosome in the order prescribed by m-RNA/enzymically ✓.* *AW throughout. Candidates who describe* transcription *can earn a max of 4 marks through ecf on points 4,5,6 and 7 above . Marks may be found from diagrams.* *QWC Correct use of three of the following terms: complementary, hydrogen bonding, ribosome, t-RNA, m-RNA, base triplet, polypeptide ✓*	[7]
2)	(a)	*Condensation ✓*	[1]
	(b)	*the glycosidic link is 1β-4 link to left hand glucose/ the sugar involved is β–glucose ✓. AW*	[1]
	(c)(i)	*Using enzyme /use of cellobiase (accept cellulose) ✓.* *Using acid / heating with aqueous acid ✓.*	[2]
	(ii)	$C_{12}H_{22}O_{11} + H_2O \longrightarrow 2C_6H_{12}O_6$ ✓	[1]
	(d)	*Cellobiose has many sites/hydroxyl groups available ✓ for hydrogen bonding to water. ✓ Correct diagram, such as that below, of hydrogen bonding to water (partial charges not needed)is acceptable for the second mark. They may do this on a structure of cellobiose if they wish.* *eg R- O-H….OH_2* *Cellulose has many OH groups tied up in glycosidic links ✓ and others are involved in internal hydrogen bonding with adjacent/parallel chains ✓. A good diagram may earn one of these marks.*	[4]

3) (a) (i)	*A correct ester group ✓. The rest ✓.* 	**[2]**
(ii)	*Ester ✓.*	**[1]**
(iii)	*Energy source/storage AW ✓.* *Insulation/protection of organs ✓.*	**[2]**
(iv)	*van der Waal's attraction ✓ between the non-polar hydrocarbon chains in triglyceride and non-polar solvent molecules ✓. AW.*	**[2]**
(b) (i)	*Any four from:* *High pH means that sidechain amino groups are largely present as NH_2 /unionised ✓. COO^- to COOH is incorrect.* *This disrupts ionic attraction ✓ between COO^- and NH_3^+ ✓(in tertiary structure), changing the shape of the active site. ✓.* *Denaturation. ✓*	**[4]**
b (ii)	*Sodium butanoate/ butanoate ions ✓. Accept a clear structure unless accompanied by the wrong.* *Not soap.*	**[1]**
(c)	*ristearin does not fit active site so well ✓. AW.*	**[1]**
(d) (i)	*An inhibitor that competes for/binds at the active site. ✓*	**[1]**
(ii)	*Orlistat has similar ester group(s) ✓ which can bind(at active site) using dipole:dipole/hydrogen ✓* *Or hydrocarbon tails ✓ to triglycerides which can bind(at active site) using van der Waals forces/IDID ✓. AW*	**[2]**
(e)	*To hydrolyse/dissolve/break down fats/ triglycerides/lipid ✓. AW*	**[1]**

4)	(a)	*The sequence of amino acids in a peptide/protein chain.*✓	**[1]**
	(b)	Diagram should show helical chain with C=O and NH groups In the chain✓, hydrogen bonded C=O …. HN ✓	**[2]**
	(c) (i)	Contains amide/peptide links in the chain/polyamide/involves 2-aminoacids✓	**[1]**
	(ii)	No H on N for hydrogen bonding.✓ AW	**[1]**
	(iii)	Any two points✓✓. AW • Sidechains not attached to the 2-carbon.(Accept attached to N) • Sidechains in synthetic compound not found in natural protein • No chiral centres. • Only 2 types of R group rather than 20. • Regular repeating structure in this polymer not in protein.	**[2]**
	(iv)	By van der Waals attraction ✓ between non-polar groups such as the benzene rings✓. Or dipole-dipole attraction between the ether groups. Mark the first answer if they offer two alternatives, but max 1 if the correct answer comes second. No marks for three or more answers.	**[2]**

2815/04 Methods of Analysis and Detection

Question No.		Expected Answers	Max Mark
1a	i	**paper**: mobile = solvent/water ✓ stationary = solvent/water trapped in paper /cellulose ✓ **tlc**: stationary = SiO_2/Al_2O_3 or cellulose ✓ separation = adsorption if either SiO_2/Al_2O_3 or partition if cellulose used as stationary phase✓ **glc**: mobile = (carrier) inert gas /He/ Ar/ N_2✓ separation = partition ✓	2 2 2
	ii	R_f = distance moved by solute/spot/component / distance moved by solvent ✓	1
	iii	 fig. 1 2nd spot up indicated unambiguously ✓	1
b	i	component **A** because it is the first to emerge/shortest time from injection/shortest retention time ✓	1
	ii	attempts to use areas ✓ calculates the areas of all three peaks eg 0.5 x 20 x 4 + 30 x 2 x 0.5 + 10 x 2 x 0.5 **or** use of mm measurements from graph or ratio of 40 :30:10 or 1.6: 1.5: 0.4 ✓ % = 37.5 – 43% (allow max. of 4 sig. figs) ✓	3
Total			12

Question No.	Expected Answers	Max Mark
2a i	^{13}C ✓	**1**
ii	$n = \frac{M+1 \times 100}{M \times 1.1}$ i.e. Use of M/M + 1 ✓ $= \frac{4.2 \times 100}{95.3 \times 1.1} = 4$ ✓ (So 4.4 carbons = 1 mark)	**2**
iii	M_r = 70 (from mass spectrum) ✓ contains 4 Cs and an O = 48 + 16 = 64 ✓ (70 -64 = 6 Hs) hence formula = C_4H_6O ✓	**3**
b	$CH_3CH=CHCHO$ **OR**  must show all three components: C=C, C=O and CH_3CH ✓	**1**
c	(A structural feature within an organic molecule which) absorbs UV/visible/both UV and visible radiation / light ✓	**1**
d	more adjacent/linked/across molecule chromophores/delocalization of electrons, therefore more **<u>conjugation</u>** ✓ decreases energy gap/absorbs at lower energy/ absorbs at longer wavelength/ absorbs at lower frequency✓ more likely to absorb in visible region ✓	**3**
e	ues f=c/λ to calculate frequency ✓ or E = hc/λ 3.23×10^{-19}(J)✓	**2**
	Total	**13**

Question No.		Expected Answers	Max Mark
3a		restriction enzymes ✓	**1**
b	i	DC) voltage applied / Potential difference (AC = CON) **OR** reference to buffer ✓ The fragments are attracted to the positive electrode/ all the fragments are negative ✓	**2**
	ii	separation depends on the fragments' mass ✓ and charge ✓	**2**
c		**Two from:** It makes the X ray film fog or it exposes the x ray film ✓ Because it is radioactive ✓ Stick to/ exchanges with mini-satellite sequences of the DNA fragments (AW) ✓	**2**
d		F1 - any three matching bands ✓	**1**
			Total **8**

<table>
<tr><th>Question No.</th><th>Expected Answers</th><th colspan="2">Max Mark</th></tr>
<tr><td>4a</td><td>Infra-red:

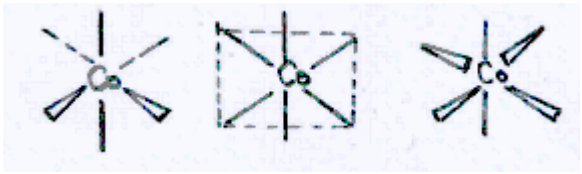
Both have C=O within 1680–1750 cm^{-1}✓
Both have C–O within 1000–1300 cm^{-1}✓
X and Y have O–H in range 2500–3300cm^{-1}/ broad
Only Y has an absorption at 3100–3500 cm^{-1} for the N–H ✓
Both have different fingerprint regions ✓

max = 4
Mass spec:

X and Y have different M peaks, X == 88 and Y = 89 ✓
X and Y have different ratios for the M : M + 1 peaks ✓
Suitable suggestions about similar fragments
eg CH_3CH^+ at 28, $COOH^+$ at 45, $CHCOOH^+$ at 58, $CH_3CHCOOH^+$ at 73 ✓
Suitable suggestions about different fragments
eg X has $CH_3CHCH_3^+$ at 43 or $(CH_3)_2CHCO^+$ at 71
Y has H_2NNCH^+ at 29 or $H_2NCHCH_3^+$ at 44 or $CH_3(NH_2)CHCO^+$ at 72 or NH_2^+ at 16✓
In last 2 marks positive charge is needed once on a fragment, or max of 1 mark to be awarded</td><td colspan="2">8</td></tr>
<tr><td>b</td><td>Mark vertically
<table><tr><td></td><td>Shift</td><td>Splitting</td><td>Relative peak</td></tr><tr><td>CH_3O</td><td>3.3 – 4.3</td><td>singlet</td><td>3</td></tr><tr><td>$-CH_2-CO-$</td><td>2.0 – 2.9</td><td>quartet</td><td>2</td></tr><tr><td>CH3-C-</td><td>0.7 – 1.6</td><td>triplet</td><td>3</td></tr><tr><td></td><td>✓</td><td>✓</td><td>✓</td></tr></table></td><td colspan="2">3</td></tr>
<tr><td>QWC</td><td>Uses two correct scientific terms such as fingerprint region, wavenumber, absorption, molecular ion or correct units such as cm^{-1}, m/e</td><td>QWC</td><td>1</td></tr>
<tr><td colspan="2"></td><td>Total</td><td>12</td></tr>
</table>

2815/06 Transition Elements

Mark Scheme Page 1 of	Unit Code	Session	Year	Version
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)	(+)3	1
(b)	Two lone pairs of electrons	1
	Forming (two) dative / co-ordinate bonds (with a central metal ion)	1
(c)	Geometric / cis and trans	1
	Cis and trans isomers drawn using an appropriate 3-d convention as shown. 	2
	Optical	1
	Cis isomer chosen	1
	Two non superimposable mirror images drawn using an appropriate 3-d convention. (see above) (ignore any charges)	1
(d)		1
	Green (accept yellow-green / blue-green)	1
	All colours are absorbed except green (and yellow) / green (and yellow) is transmitted/reflected.	Total: 11

Mark Scheme Page 2 of	Unit Code	Session	Year	Version
Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument			

Question	Expected Answers	Marks
2 (a)	Chromium forms <u>oxide</u> on surface	1
	Oxides are impervious to water and air / prevent iron reacting with water and/or oxygen (do not credit chromium plating)	1
(b)	Green / violet	1
(c) (i)	Orange to yellow	1
(ii)	Acid / H^+ combines with OH^-	1
	Equilibrium moves to left to produce more OH^- Accept equation showing H^+ reacting with CrO_4^{2-} as an alternative with suitable explanation	1
(d) (i)	$3Mn^{2+} + Cr_2O_7^{2-} + 2H^+ \rightarrow 3MnO_2 + 2Cr^{3+} + H_2O$	
	Correct 3:1 ratio	1
	Balanced with no electrons and H^+ / H_2O cancelled	1
(ii)	$E^\ominus$ for reaction is + 0.10 V / is positive / the manganese system is less positive so it will supply electrons ora	1
(iii)	Activation energy is too large / not standard conditions/ rate of reaction is too slow / $E^\ominus$ for reaction is too small ora	1
		Total: 10

Mark Scheme Page 3 of	Unit Code	Session	Year	Version
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)	Emf / voltage / potential difference of a cell	1
	Comprising a half cell combined with a standard hydrogen electrode	1
	Temp 298K / 25^{o}C, pressure 100kPa / 1 atmosphere /10^{5} Pa, Concentration 1 mol dm^{-3} / 1M (all 3 needed)	1
(b) (i)	Solution A – 1M HCl / 0.5M H_2SO_4	1
	Solid B – platinum / graphite (allow carbon)	1
(ii)	Arrow on wire (or very close to wire) pointing from hydrogen half cell to $S_2O_8^{2-}$ / SO_4^{2-} half cell	1
(iii)	$S_2O_8^{2-} + H_2 \rightarrow 2SO_4^{2-} + 2H^+$	
	Correct species (allow electrons on either / both sides)	1
	Balanced (no electrons)	1
(c)	M_r of $Na_2S_2O_8$ = 238.2	1
	M_r of Na_2SO_4 = 142.1	1
	Use 23.82g of $Na_2S_2O_8$ and 14.21g of Na_2SO_4 (allow 1 mark for suggesting 0.1 moles of each reagent)	1
(d)	$E^{\ominus}$ will increase	1
	Equilibrium will shift from left to right for $S_2O_8^{2-}$ / SO_4^{2-} (allow equilibrium will move towards products)	1
		Total: 13

Mark Scheme Page 4 of	Unit Code	Session	Year	Version
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	V^{2+} +2 lilac / violet / purple V^{3+} +3 green VO^{2+} +4 blue VO_2^+ / VO_3^- +5 yellow Correct formulae scores 2, correct colours scores 2. deduct 1 mark for each incorrect formula up to a max of 2. Deduct 1 mark for each incorrect colour up to max of 2 (colours linked to oxidation state)	4
	For reduction: Choses higher oxidation state ion going to lower oxidation state ion	1
	Suitable balanced equation $2VO_2^+ + 4H^+ + Zn \rightarrow 2VO^{2+} + 2H_2O + Zn^{2+}$ Alternatives : $VO_2^+ \rightarrow V^{3+}$, $VO_2^+ \rightarrow V^{2+}$, $V^{3+} \rightarrow V^{2+}$ etc	1
	For oxidation: Choses lower oxidation state ion going to higher oxidation state ion.	1
	Suitable balanced equation: $5V^{2+} + 3MnO_4^- + 4H^+ \rightarrow 5VO_2^+ + 3Mn^{2+} + 2H_2O$ Alternatives: $V^{2+} \rightarrow V^{3+}$, $V^{3+} \rightarrow VO^{2+}$, $V^{3+} \rightarrow VO_2^+$ etc NB: correct balanced equations can score both marks in each of the above	1
	Vanadium (V) oxide / V_2O_5 is the catalyst for the Contact Process / making sulphuric acid	1
	$2SO_2 + O_2 \rightleftharpoons 2SO_3$	1
	Quality of written communication: One mark awarded for correct spelling, punctuation and grammar in at least two complete sentences	1
		Total: 11

2816/01 Unifying Concepts in Chemistry/ Experimental Skills 2 Written Paper

Question No.		Max Mark
1) (a)(i)	The contribution of a gas to the total pressure in a gas mixture/ mole fraction x total pressure/ the pressure a gas (in a mixture) would exert by itself ✓	[1]
(ii)	488.60/489 kPa ✓	[1]
(b)(i)	$K_p = \frac{p\,CH_3OH(g)}{p\,CO(g) \times p\,H_2(g)^2}$ ✓ *state symbols not required*	[1]
(ii)	$K_p = \frac{488.6}{3.80 \times 7.60^2} = 2.226 / 2.23$ ✓ kPa^{-2} ✓ **Mark consequentially using value from (a)(ii)** Common ecfs from (a)(ii): 3.8 ⟶ 0.0173 481 ⟶ 2.19 125 ⟶ 0.570 11.4 ⟶ 0.0519	[2]
(c)	**Higher Pressure** Equilibrium ⟶ right as fewer moles on right hand side ✓ Faster rate as …… ……concentration increases/causing more collisions✓ High pressures/temperatures are expensive (to generate) /cause potential safety problems (with walls of containers) ✓ **Higher Temperature** Faster rate …….from more energetic/successful collisions: ✓ Equilibrium → left…….. because Kp decreases ✓ Idea of a high enough temperature for reasonable rate without compromising equilibrium yield ✓ **Catalyst** (Speeds up reaction) lowering activation energy/ less time to reach equilibrium (saving production costs or energy)/ allows reaction to take place at a lower temperature/using less energy ✓ **Quality of Written Communication** organises relevant information clearly and coherently, using specialist vocabulary where appropriate and linking at least one change with a reason ✓	[3] [3] [1] → **6 max** [1]
		12

2)	(a)(i)	**H^+(aq)**: Exp 3 has 2 x $[H^+(aq)]$ as Exp 1 and rate has increased by 4✓ so order = 2 with respect to $H^+(aq)$ ✓	**[2]**
		BrO_3^-(aq): Exp 2 has 2 x $[BrO_3^-]$ as Exp 1 and rate increases by 2 ✓ so order = 1 with respect to $BrO_3^-(aq)$ ✓	**[2]**
		Br^-(aq): Exp 4 has 3 x $[BrO_3^-(aq)]$ as Exp 1 which increases rate by 3 and Exp 4 has 2 x $[Br^-(aq)]$ as Exp 1 rate has increased by 6 so doubling $[Br^-(aq)]$ doubles rate ✓ so order = 1 with respect to $Br^-(aq)$ ✓	**[2]**
	(ii)	rate = $k\,[H^+]^2\,[BrO_3^-]\,[Br^-]$ ✓	**[1]**
	(iii)	$k = \frac{\text{rate}}{[H^+]^2\,[BrO_3^-]\,[Br^-]} \;/\; \frac{1.68 \times 10^{-5}}{0.30^2 \times 0.05 \times 0.25}$ ✓ = 0.0149/0.015 ✓ units: $dm^9\ mol^{-3}\ s^{-1}$ ✓ answer to 2 or 3 sig figs ✓ (calculator: 0.0149333333) **mark consequentially from (a)(ii)** common ecfs: From expt 1: rate = $k\,[H^+]^2\,[BrO_3^-] \longrightarrow 0.00373\ dm^6\ mol^{-2}\ s^-$	**[4]**
	(b)	gradient at t=0/start ✓	**[1]**
	(c)	Overall equation has different stoichiometry/number of moles to rate equation ✓	**[1]**
			13

3)	(a)	partially dissociates/ionises ✓	**[1]**
	(b)	$CH_3COO^-(Na^+)$ /(sodium) ethanoate ✓	**[1]**
	(c)	Equations with H_2 and CO_2 produced ✓ $Na_2CO_3 + 2CH_3COOH \longrightarrow 2CH_3COONa + CO_2 + H_2O$ ✓ $Mg + 2CH_3COOH \longrightarrow (CH_3COO)_2Mg + H_2$ ✓	**[3]**
	(d)(i)	amount of NaOH used = 0.200 x 22/1000 = 4.4 x 10^{-3} / 0.0044 ✓ concentration = 0.0044 x 1000/25 = 0.176/0.18 mol dm^{-3} ✓	**[2]**
	(ii)	metacresol purple because …… indicator has a pH range coinciding with steepest part of titration curve / 7-10 / equivalence point ✓	**[1]**
	(e)	$n(CH_3COOH) = n(C_2H_5OH) = 79.2/46 = 1.72$ ✓ (calculator: 1.72173913) $[CH_3COOH] = 1.72 \times 1000/750 = 2.29$ mol dm^{-3} ✓ (calculator: 2.295652174) $K_a = \frac{[H^+]\,[CH_3COO^-]}{[CH_3COOH]}$ ✓ $= \frac{[H^+]^2}{[CH_3COOH]}$ $[H^+] = \sqrt{(K_a \times [CH_3COOH])} = \sqrt{(1.70 \times 10^{-5} \times 2.29)}$ ✓ $= 6.24 \times 10^{-3}$ mol dm^{-3} ✓ (calculator: $6.247086277 \times 10^{-3}$) pH = $-\log(6.24 \times 10^{-3})$ = 2.20/2.21 ✓ (calculator: 2.204322496) **No square root → 4.41: does not score 4th and 5th marks** **No scaling from 750 cm^3 → 2.27: does not score 2nd mark** **Use of 60 instead of 46 → 2.26: does not the 1st mark**	**[2]** **[4]**

(f)(i)	CH_3COONa / NaOH / Na ✓	**[1]**
(ii)	equilibrium: CH_3COOH □ CH_3COO^- + H^+ ✓ CH_3COOH reacts with added alkali / $CH_3COOH + OH^- \rightarrow$ / added alkali reacts with H^+ / $H^+ + OH^- \rightarrow H_2O$✓ $\rightarrow H_2O + CH_3COO^-$ / Equil $\rightarrow$ right (to counteract change) ✓ CH_3COO^- reacts with added acid or H^+ ✓ Equil $\rightarrow$ left (to counteract change) ✓ Large amounts/reservoirs/ of HA and A^- ✓	**[5 max]**
		20

4)	(a)	mass of H_2S per day = 100 x 10^6 x 1.80/100 = 1.80 x 10^6 g / 1.8 tonnes ✓ *n*(H_2S) per day = 1.8 x 10^6 /34.1 = 5.3/5.28 x 10^4 ✓ (calculator: 52785.92375) Same number of moles H_2SO_4 formed, mass H_2SO_4 = 5.28 x 10^4 x 98.1 = 5.18 x 10^6 g / 5.18 tonnes ✓ (Rounding in previous stage may give 5.19/5.2 = accept.	**[3]**
	(b)	step 1 $2H_2S + 3O_2 \longrightarrow 2SO_2 + 2H_2O$ / $H_2S + O_2 \longrightarrow SO_2 + H_2$ ✓ step 2: $2H_2S + SO_2 \longrightarrow 3S + 2H_2O$ / $4H_2S + 2SO_2 \longrightarrow 6S + 4H_2O$ ✓ overall: $6H_2S + 3O_2 \longrightarrow 6S + 6H_2O$ / $2H_2S + O_2 \longrightarrow 2S + 2H_2O$ ✓	**[3]**
	(c)	In step 1, S (oxidised) from –2 to +4 ✓ In step 2, S in H_2S (oxidised) from –2 to 0 ✓ S in SO_2 (reduced) from +4 to 0 ✓	**[3]**
	(d)	$H_2S + CO_3^{2-} \rightleftharpoons HCO_3^- + HS^-$ ✓ acid 1: H_2S; base 1: HS^- ✓ acid 2: HCO_3^-; base 2: CO_3^{2-} ✓	**[3]**
	(e)	$CH_3CH_2CH_2CH_2SH$ ✓ A reagent chosen that would react with a butane-1-thiol (eg O_2, Na, alcohol, HBr, H_2SO_4, PCl_5) ✓ correct equation for chosen reagent ✓	**[3]**
			15

2816/03 Unifying Concepts in Chemistry/Experimental Skills 2 Practical Examination

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

T The redox titration (8 marks)

T1 Makes up a known solution of hydrated iron(II) salt [1]
Weighing, use of distilled water and volumetric flask must all be specified.

T2 Pipette a known volume of solution iron(II) salt into a conical flask and acidifies. [1]
Sulphuric acid must be specified

T3 Aqueous KMnO4 (of specified/known concentration) used in the burette [1]
Concentration used must be between 0.01 and 0.1 mol dm-3

T4 Correct end colour *(allow pink or light purple)* [1]

T5 Titrate until two consistent titres are obtained [1]

T6 Equation for redox reaction involved [1]
$MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2$

T7 Calculation (using titration data) of the Mr of hydrated salt. [1]

T8 Calculation of the value of ***x*** [1]
This calculation may also be shown as part of the answer to strand G
This mark requires the actual Mr of anhydrous salt (= 152 or 151.9) to be quoted

G Gravimetric method involving precipitation (7 marks)

G1 Use known mass of iron(II) salt ***and*** dissolve in distilled water [1]

G2 Add <u>excess</u> of aqueous barium chloride ***or*** sodium hydroxide etc. [1]

G3 Filter mixture using <u>pre-weighed</u> filter paper
or centrifuge the mixture in pre-weighed tube [1]

G4 **Two** accuracy precautions
- calculation of quantity (mass <u>*or*</u> volume/concentration) of precipitant needed
- stir mixture or heats[gently] to coagulate precipitate *(reason needed)*
- use fine grade filter paper ***or*** uses reduced pressure/Buchner filtration
- wash residue with [distilled] water
- weigh residue to constant mass [to ensure dryness]
- repeat whole experiment to obtain consistent results [1]

G5 Dry residue [and filter paper] in an oven/desiccator ***and*** weigh it [1]

G6 Equation/ionic equation for the precipitation reaction [1]

G7 Show clearly how relative formula mass ***(or x)*** can be calculated from mass data [1]
Calculation must show the Mr of solid precipitated: BaSO4 = 233 : Fe(OH)2 = 89.8

S Safety, sources and qwc (4 marks)

S1 Hazard ***and*** safety measure stated for barium chloride or sodium hydroxide. [1]

S2 **Two sources** quoted in the text ***or*** at end of Plan. [1]
*Book references **must** have chapter or page numbers*
Internet reference must go beyond the first slash of web address

S3 **QWC**: text is legible ***and*** spelling, punctuation and grammar are accurate [1]
Accept not more than five different error types in legibility, spelling, punctuation or grammar.

S4 **QWC**: information is organised clearly and coherently [1]
- *Is a word count given and within the limits 450 – 1050 words?*
- *Is scientific language used correctly? (One error is allowed without penalty).*
- *Is the description of the two experiments logical and clear?*

Mark Scheme: A2 Practical Test (Part B)

Part 1: Page 3 Skill I - 14 marks

Mass readings [1]

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

Presentation of titration data [2]

(All four bullets correct → 2 marks: If three points correct → 1 mark)

- Correctly labelled table (initial, final and difference - *aw*) used to record burette data
  *A table grid (or tabular format) **must** be used, with lines drawn.*
- All accurate burette data (including 0.00) are quoted to 0.05 cm^3
- All subtractions are correct *(these must be checked)*
- **Units**, cm^3 or ml, must also be given *(**once** in or alongside the table is sufficient).*

Self-consistency of titres [1]

- Both of the candidate's accurate titres (as used for the mean) should agree within 0.10 cm^3.

Mean titre correctly calculated [1]

Use of the trial is acceptable if it closer than one of the "accurate" readings

Accuracy – [7 marks]

Work out, using the steps below, what the adjusted candidate's titre (T) would have been if the candidate had used the same mass of Y as the supervisor.

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

T is within 2.00 cm^3 of mean supervisor's value	[1]
T is within 1.50 cm^3 of mean supervisor's value	[2]
T is within 1.00 cm^3 of mean supervisor's value	[3]
T is within 0.80 cm^3 of mean supervisor's value	[4]
T is within 0.60 cm^3 of mean supervisor's value	[5]
T is within 0.40 cm^3 of mean supervisor's value	[6]
T is within 0.25 cm^3 of mean supervisor's value	[7 marks]

Spread penalty

("Spread" is defined by the titres used by the candidate to calculate the mean)
If the closest titres have a spread > 0.40 cm^3, deduct 1 mark from the accuracy mark.
If the closest titres have a spread > 0.60 cm^3, deduct 2 marks.

Handling of chemicals **[2 marks]**

*Any **two** points from*

- Add a suitable named reducing agent [1]
- Use a dilute solution of the reducing agent [1]
- Wash with plenty of water [1]

Part 2: Pages 4 + 5 **Skill A** **[12 marks]**

Answers to (a) and (c) must be correctly expressed to 3 sig fig.

(a) M_r of $H_2C_2O_4.2H_2O$ = 126 [1]

Concentration (mol dm^{-3}) = $^{mass}/_{126}$ × 4 [1]

(b) Answer to **(a)** × 0.025 [1]

(c) $n(KMnO_4)$ weighed = $^{3.5}/_{158}$ [1]

$n(KMnO_4)$ used = $^{3.5}/_{158}$ x $^{titre}/_{1000}$

Answer correctly calculated from candidate's own data [1]

(d) **(i)** $^{(b)}/_{(c)}$ × 2 [1]
Answer should be 5, but the mark is for calculation from candidate's data.

(ii) (+)7 [1]

(+)2 *(positive sign must be shown)* [1]

(iii) Total OS change *or* number of e^- transferred for two Mn species = 2 x 5 [1]

5 moles of ethanedioic acid contain 10 carbon atoms
Therefore each C atom increases OS by 1 unit [1]
A correct balanced equation 2:5 (giving CO_2) would score both marks

(e) Carbon dioxide ***or*** CO_2 [1]

Part 3: Page 6 **Test tube test** **[4 marks]**

(a) White precipitate/suspension formed [1]

(b) **(i)** Precipitate is calcium ethanedioate [1]

(ii) $Ca^{2+}(aq) + C_2O_4^{2-}(aq) \rightarrow CaC_2O_4(s)$ [1]

Correct state symbols, if the species are correct [1]

Part 4: Pages 7 + 8 **Skill E** **[14 marks]**

(a) **3 marks** available (but 2 on question paper)

High temperature speeds up reaction [1]

Particles move faster/ collide more often/ have more successful collisions [1]

More particles have energy greater than the activation energy [1]

(b) Ethanedioic acid cannot evaporate ***or*** <u>only</u> water evaporates [1]

Number of moles of ethanedioic acid in flask does not change
or water is not a reagent in the titration [1]

Number of moles of $KMnO_4$ required is unchanged/ titre is unaffected [1]

(c) Pipette: $^{0.06}/_{25}$ x 100 = 0.24% [1]

Vol flask: $^{0.2}/_{250}$ x 100 = 0.08% [1]

The volumetric flask is the more accurate [1]

(d) Sulphuric acid is used in excess [1]

Therefore exact/precise volume used does not matter [1]

(e) **4 marks**
*Any **four** points from the ideas below.*

- Brown colour would obscure the pink colour at the end point of the titration
  or brown colour makes the end point colour change difficult to see [1]
- Burette reading at end point /final burette reading would be inaccurate [1]
- Formation of MnO_2 means that the "wrong" reaction is taking place
  or brown colour means that MnO_4^- is not [all] being reduced to Mn^{2+} [1]
- It would be difficult to know/measure how much MnO_2 was formed [1]
- Reacting mole ratio is 3:2 [instead of 5:2]
  or decrease in oxidation state of Mn is by 3 [instead of 5] [1]
- A greater volume /too much $KMnO_4$ would be required [to react with the acid] [1]
- Titre values would be inconsistent and unreliable [1]
  This mark is conditional on a sensible preceding explanation

Grade Thresholds

Advanced GCE Chemistry (3882/7882)
January 2008 Examination Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2811	Raw	60	46	40	34	28	23	0
	UMS	90	72	63	54	45	36	0
2812	Raw	60	48	42	36	30	25	0
	UMS	90	72	63	54	45	36	0
2813A	Raw	120	98	88	78	68	59	0
	UMS	120	96	84	72	60	48	0
2813B	Raw	120	98	88	78	68	59	0
	UMS	120	96	84	72	60	48	0
2813C	Raw	120	93	83	73	63	54	0
	UMS	120	96	84	72	60	48	0
2814	Raw	90	71	63	56	49	42	0
	UMS	90	72	63	54	45	36	0
2815A	Raw	90	70	63	56	49	42	0
	UMS	90	72	63	54	45	36	0
2815C	Raw	90	74	66	59	52	45	0
	UMS	90	72	63	54	45	36	0
2815E	Raw	90	73	66	59	52	45	0
	UMS	90	72	63	54	45	36	0
2816A	Raw	120	98	87	76	66	56	0
	UMS	120	96	84	72	60	48	0
2816B	Raw	120	98	87	76	66	56	0
	UMS	120	96	84	72	60	48	0
2816C	Raw	120	94	82	71	60	49	0
	UMS	120	96	84	72	60	48	0

Specification Aggregation Results

Overall threshold marks in UMS (ie after conversion of raw marks to uniform marks)

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

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

	A	B	C	D	E	U	Total Number of Candidates
3882	11.7	35.0	56.6	79.7	95.8	100	556
7882	18.4	51.2	74.1	89.6	96.0	100	212

768 candidates aggregated this series

For a description of how UMS marks are calculated see:
http://www.ocr.org.uk/learners/ums_results.html

Statistics are correct at the time of publication.

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