OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry

Advanced GCE **A2 7882**

Advanced Subsidiary GCE **AS 3882**

Mark Schemes for the Units

January 2010

3882/7882/MS/R/10J

Oxford Cambridge and RSA Examinations

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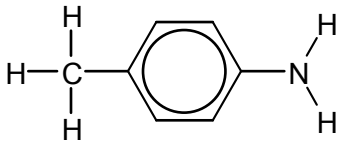
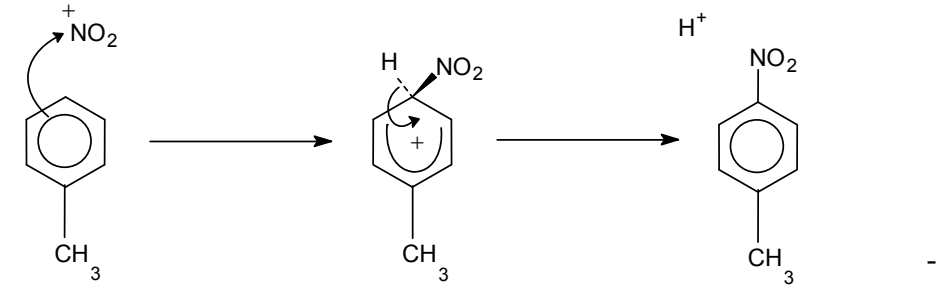
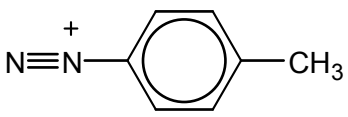
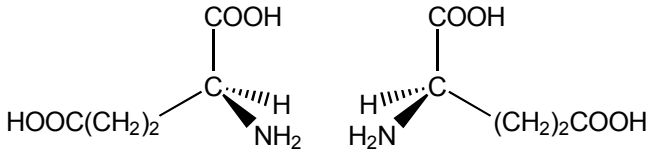
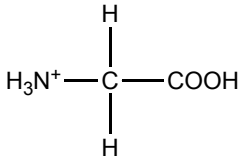
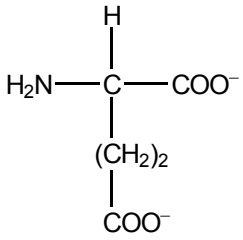
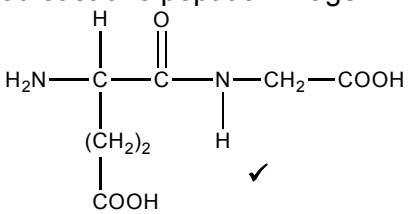
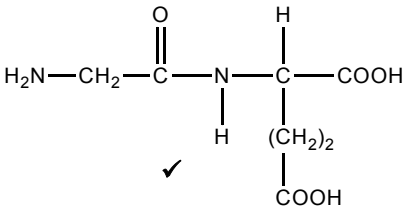
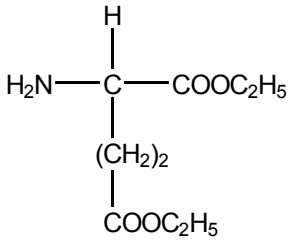
Advanced GCE Chemistry (7882)

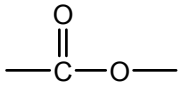
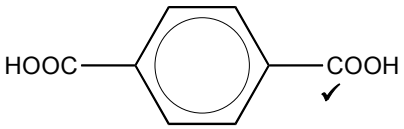
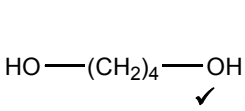
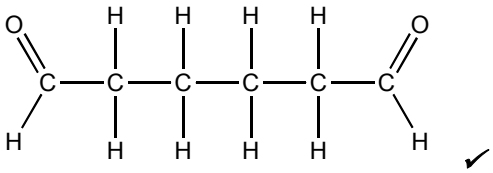
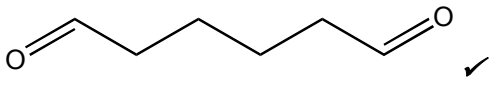
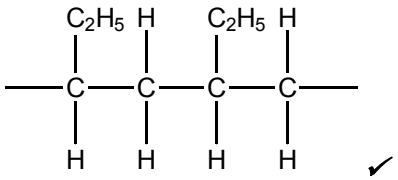
Advanced Subsidiary GCE Chemistry (3882)

MARK SCHEME FOR THE UNITS

2814 Chains, Rings and Spectroscopy

Qu.	Expected answers	Marks
1 (a)	 allow $-NH_2$ and $-CH_3$ not fully displayed here	1
(b)	**Stage 2** **reagents:** conc. HNO_3 **and** conc H_2SO_4 ✓ **conditions:** warm / reflux / stated temp (allow 30–60 °C) ✓ Allow NO_2^+ to give H^+ **balanced equation:** $HNO_3 + C_6H_5CH_3 \longrightarrow CH_3C_6H_4NO_2 + H_2O$ ✓ **Stage 3** **reagents:** Sn / Fe **and** conc HCl ✓ **conditions:** heat/reflux ✓ **balanced equation:** $CH_3C_6H_4NO_2 + 6[H] \longrightarrow CH_3C_6H_4NH_2 + 2H_2O$ ✓ **Mechanism for stage 2** $HNO_3 + H_2SO_4 \longrightarrow NO_2^+ + H_2O + HSO_4^-$ ✓  - curly arrow from π ring to NO_2 ✓ correct intermediate ✓(no methyl group loses this mark) curly arrow from C–H bond back to re-form π ring ✓ correct products ✓ (allow ECF on no methyl group here)	11
	Quality of Written Communication Answer is well organised and clearly identifies: stage 1 as **substitution** / **nitration and** stage 2 as **reduction** / **redox** (allow **hydrogenation**) ✓	1
(c) (i)	 allow $^+N{=}N-$, $-N_2^+$ or $-N_2Cl$ but not $^+N{\equiv}N-$	1
(ii)	**C atoms:** 17 **H atoms:** `14	2
		16

Qu.	Expected answers	Marks
2 (a)	$H_2NCH(R)COOH$ ✓ (allow any order as long as CH not split)	1
(b)	glutamic acid has / glycine does not have ... a chiral carbon / four different groups attached to a carbon ✓ glutamic acid forms two non-superimposable (mirror images) / is asymmetric ✓  allow ECF on side group errors correct 3-D diagram of one isomer of glutamic acid ✓ attempt at a 3-D diagram to show the other isomer ✓ allow poor connectivity here	4
(c) (i)	 ✓ allow poor connectivity here too	1
(ii)	 one COO^- ✓ rest of the molecule ✓	2
(d)	at least one peptide linkage ✓ allow CONH  ✓  ✓ or the dipeptide formed using the glutamic acid side chain	3
(e) (i)	(conc) H_2SO_4 ✓ allow HCl or H^+ .... but not anything with H_2O present	1
(ii)	 one ester group ✓ rest of the structure ✓	2
		14

Qu.	Expected answers		Marks
3 (a)	 circled ✔	allow the right hand carbon included	1
(b) (i)	hexan(e)dioic acid	ignore -1,6-	1
(ii)	 ✔  ✔	do not allow C_6H_4 here do not allow OH̤ here	2
(c) (i)	 ✔	must be fully displayed here allow one mark for two correct structures of hexanal	
	 ✔		2
(ii)	$C_6H_{10}O_2 + 2[O] \longrightarrow C_6H_{10}O_4$	allow correct structural / displayed / skeletal formula	1
(iii)	(O–H) absorption appears at 2500–3300 (cm^{-1})		1
(d)	 ✔		1
(e)	**ecoflex®** = condensation **and poly(but-1-ene)** = addition		1
(f)	atactic has side chains on <u>random</u> sides ✔	do not allow just 'regular' / 'irregular', nor just 'groups'	
	isotactic has side chains on the same side **AW** ✔	allow one mark for a correct (2D or 3D) diagram of isotactic with at least 6C if not scored in words	2
			12

<table>
<tr><th>Qu.</th><th>Expected answers</th><th></th><th>Marks</th></tr>
<tr><td>4 (a)</td><td>mol of CO_2 = 6 × 2.5 × 1$\tilde{0}^{-3}$ / 1.50 × 10^{-2} ✓
1.50 × 10^{-2} × 24000 = 36(0) cm^3 ✓

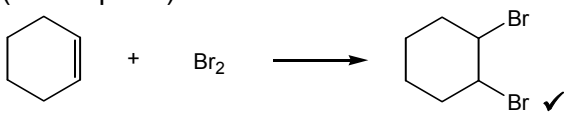
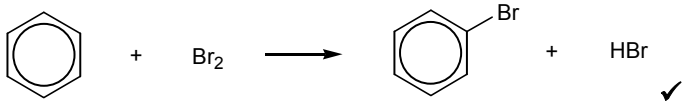
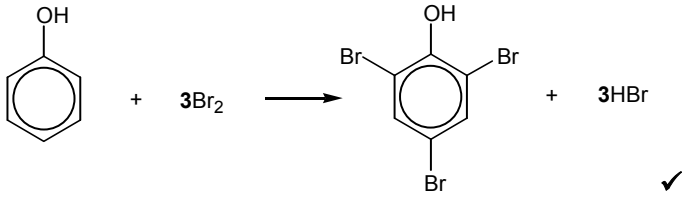
mol of H_2O = 3 × 2.5 × 10^{-3} / 7.50 × 10^{-3} ✓
7.50 × 10^{-3} × 18 = 0.135 / 0.14 g ✓</td><td></td><td>4</td></tr>
<tr><td>(b) (i)</td><td>carboxylic acid / (CO)OH (protons)</td><td></td><td>1</td></tr>
<tr><td>(ii)</td><td>D replaces OH protons / OH protons are labile ✓
peak (for OH protons) disappears ✓</td><td></td><td>2</td></tr>
<tr><td>(iii)</td><td>(E is the correct structure because …)

peaks Y and Z are each due to two (equivalent) protons AW✓

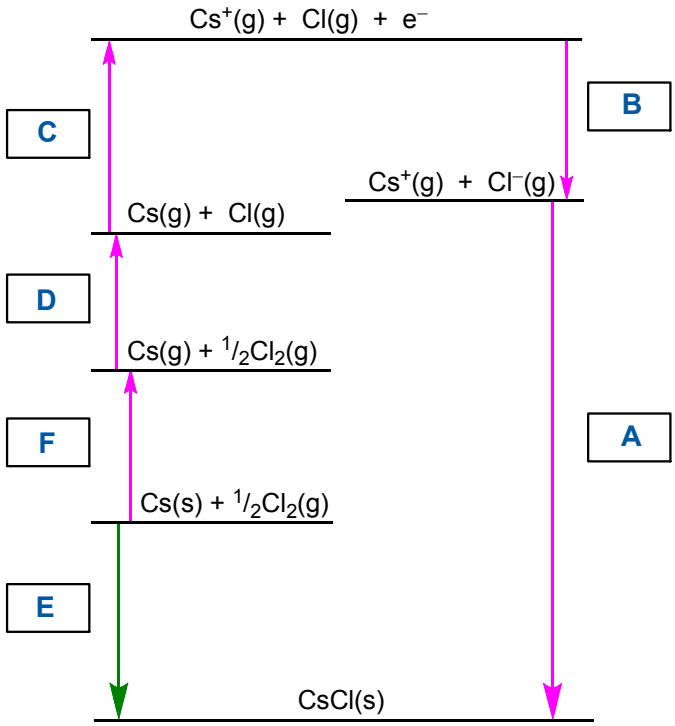
<table><tr><th></th><th>comparing peak areas</th><th>comparing the number of peaks</th></tr><tr><td>structure E either of: ✓</td><td>peaks Y and Z are caused by CH_2 and two CH</td><td>has three environments / H_a, H_b, H_c are labelled on the structure</td></tr><tr><td>structure F either of: ✓</td><td>would give one peak areas 3:1</td><td>would give four peaks (inc. COOH)</td></tr></table></td><td>no marks if they choose structure F</td><td>3</td></tr>
<tr><td colspan="3"></td><td>10</td></tr>
</table>

Qu.	Expected answers		Marks
5 (a)	alkene / C=C double bond ✓	do not allow just C=C / CHO	
	aldehyde / carbonyl ✓		2
(b) (i)	same structural/displayed formula but different 3D/spatial arrangement ✓	allow same order of bonds if same atoms specified	1
(ii)	circles alkene at position 2 ✓		
	(double bond has) restricted rotation ✓ (allow 'does not rotate')		
	both C in the double bond must be bonded to 2 different atoms / groups / this molecule has four distinguishable groups **AW** ✓		3
(c)	$C_{10}H_{16}O + 13½O_2 \longrightarrow 10CO_2 + 8H_2O$		1
(d) (i)	$NaBH_4$/ $LiAlH_4$ (in ether)		1
(ii)	$C_{10}H_{16}O + 2[H] \longrightarrow C_{10}H_{18}O$		1
(e) (i)	CN^- ✓	allow use of R or a bond to represent the side chain	
	curly arrow from lone pair of $:CN^-$ to C of carbonyl ✓		
	dipoles on carbonyl **and** curly arrow to show breaking of the π-bond ✓		
	intermediate ✓		
	curly arrow from O^- to H in HCN/ H^+/ H_2O ✓		5
(ii)	**type of reaction:** hydrolysis ✓		
	reagent: suitable named acid – e.g. H_2SO_4 / HCl ✓		
	contidtions: evidence of water – e.g. (aq)/dil **and** heat/reflux ✓		3
			17

Qu.	Expected answers		Marks
6	M_r = 72 ✓ correct peak shown on diagram or described ✓		
	Compound A is a ketone (because positive test with 2,4-DNPH and negative result with Tollens') ✓ **A** must be $CH_3CH_2COCH_3$ / butanone ✓	allow minor errors in naming(e.g. missing 'di' '2,2' if the structure is correct	
	Compound B n.m.r has all Hs in the same environment/equivalent/one type **AW** ✓ molecular formula is C_5H_{12} / any valid structure ✓ **B** must be $C(CH_3)_4$ / 2,2-dimethylpropane ✓ (subsumes previous mark)	allow ECF from the wrong M_r only where it still makes chemical sense	
	Compound C is a carboxylic acid / contains COOH **AW** (because i.r. shows O–H / COOH at 2500–3300 cm^{-1} and C=O at 1680–1750 cm^{-1}) ✓ structure of any carboxylic acid shown ✓ **C** is CH_2=CHCOOH ✓ (subsumes previous mark)		**10**
			10

Qu.	Expected answers		Marks
7	**reaction with cyclohexene**		
	(electrophilic) addition ✓	allow 'added', 'adds' etc	
	 ✓	allow molecular formulae in the equations	
	(π-)electrons are localised / not delocalised ✓		
	reaction with benzene		
	(electrophilic) substitution ✓		
	 ✓	allow Br^+ to give H^+ in the equation	
	(π-)electrons are delocalised ✓		
	reaction with phenol		
	(electrophilic) substitution ✓		
	 ✓		
	lone pair of electrons from O are delocalised around the ring ✓		
	explaining reactivity in the context of any compound		
	valid discussion of relative electron density (around the ring) ✓		
	valid discussion of relative polarisation of the bromine **or** the (electrostatic) attraction of electrophiles to the ring ✓		
		any 10 out of 11 marks	**10**
QWC	Mark for at least two sentences or bullet points in context with correct spelling, punctuation and grammar ✓		**1**
			11

2815/01 Trends and Patterns

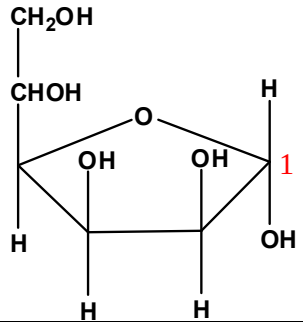
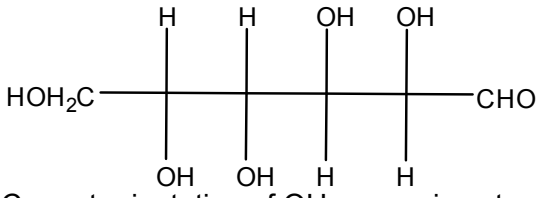
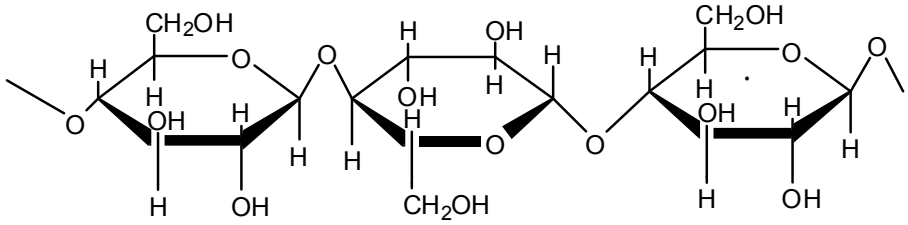
Qu.	Expected answers	Marks	Additional guidance
1 (a)	 6 correct labels: 3 marks 4 correct labels: 2 marks 3 correct labels: 1 mark	3	**Allow** values (except **A**)
(b)	= –443 =+76 + 376 + 122 + –349 + Lattice enthalpy ✓ Lattice enthalpy = –668 (kJ mol^{-1}) ✓	2	**Allow** ECF from **(a)** 668 = 1 mark
(c)	Lattice enthalpy of NaCl would be more exothermic than that of CsCl / lattice enthalpy is greater in magnitude / ORA ✓ Na^+ is smaller than Cs^+ / Na^+ has a larger charge density than Cs^+ / ORA ✓ NaCl has stronger ionic bonding / stronger attraction between the positive and negative ion ✓	3	Not bigger or smaller lattice enthalpy NOT larger charge Correct particles must be used e.g. not Na has a smaller radius All comparative
		8	

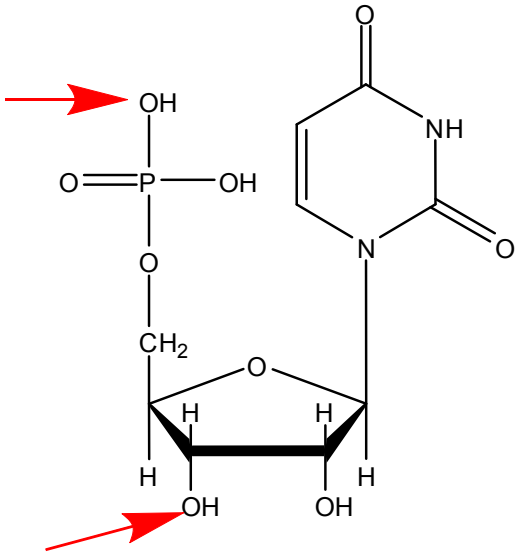
Qu.	Expected answers	Marks	Additional guidance
2 (a)	Number of outer shell electrons increases (by one) / uses (one) more outer electron in bonding / (maximum) oxidation number increases (by one) ✓	1	
(b)	Bonding NaCl and $MgCl_2$ – ionic AND Structure NaCl and $MgCl_2$ – giant ✓ Bonding $AlCl_3$ and $SiCl_4$ – covalent AND Structure $AlCl_3$ and $SiCl_4$ – simple ✓	2	
(c)	NaCl has a higher melting point than $SiCl_4$ ✓ ORA $SiCl_4$ has intermolecular forces / van der Waals forces of attraction / instantaneous dipole–induced dipole attractions ✓ NaCl has attraction between positive ion and negative ion / NaCl has electrostatic attraction between ions ✓ Forces that are broken are stronger in NaCl than in $SiCl_4$ ✓	4	ONLY on correct forces
(d)	NaCl gives a colourless solution AND with a pH of 7 ✓ $NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$ / NaCl(aq) ✓ NaCl dissolves or dissociates in water ✓ $SiCl_4$ white precipitate formed / steamy fumes AND with a pH of 0–6 ✓, $SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$ / $SiCl_4 + 4H_2O \rightarrow Si(OH)_4 + 4HCl$ ✓ $SiCl_4$ is hydrolysed ✓	6	**Allow** neutral **NOT** react **Allow** value between 0 and 6 **Allow** variants on hydrated SiO_2
		13	

Qu.	Expected answers	Marks	Additional guidance
3 (a)	Oxidation: oxidation number of O changes from –1 to 0 ✓ Reduction: oxidation number of O changes from –1 to –2 ✓	2	Allow 1 mark for either 2 correct ON changes (1 ox I red) OR correct ref to ox and red from their ON changes
(b) (i)	$2MnO_4^- + 6H^+ + 5H_2O_2 \longrightarrow 2Mn^{2+} + 8H_2O + 5O_2$ Correct reactants and products and balanced (but can include e^- on both sides and H^+ on both sides. ✓ Correct balanced equation with no electrons shown and H^+ only on left hand side ✓	2	**Allow** correct multiples of equation **Ignore** state symbols
(ii)	Moles of MnO_4^- = $\frac{23.35 \times 0.0150}{1000}$ / 3.5025×10^{-4} / 3.50×10^{-4} / 3.5×10^{-4}✓ Moles of H_2O_2 = 2.5 × moles of MnO_4^- / 8.75×10^{-4} / 8.76×10^{-4}✓ Concentration of H_2O_2 = $\frac{8.75 \times 10^{-4} \times 1000}{25.0}$ = 0.035(0) (mol dm^{-3}) ✓ correct answer = 3 marks	3	**Allow** ECF within the question
(c)	sodium hydroxide / potassium hydroxide / hydroxide ions / potassium thiocyanate / ammonium thiocyanate / thiocyanate ions ✓ observation: orange-red / brown / brown-red / foxy-red ppt with NaOH(aq) or (blood) red with KSCN / NH_4SCN / SCN^- ✓	2	**Allow** formulae Colour AND ppt needed (not red or orange) Not ppt
		9	

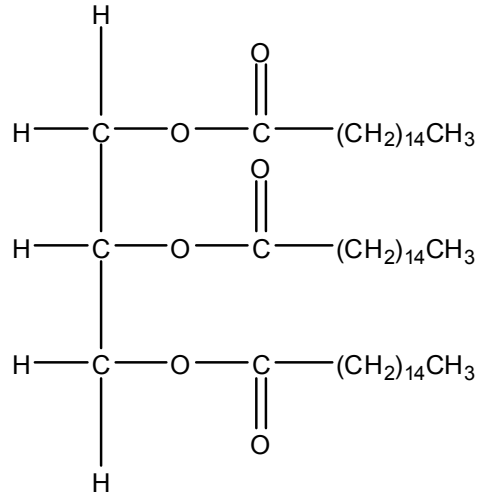
Qu.	Expected answers	Marks	Additional guidance
4 (a)	$1s^2 2s^2(2)p^6 3s^2(3)p^6(3)d^9$ ✓ (Cu is a transition element since Cu^{2+} has an) incomplete d sub-shell / AW ✓	2	
(b)	complex ion: metal/TE atom / ion surrounded by ligands ✓ ligand: a species able to donate a pair of electrons ✓ to form a dative covalent / co-ordinate bond ✓ ligand substitution: 2 examples with colour change and equation , eg $[Cu(H_2O)_6]^{2+}$ and NH_3 ✓ $[Cu(H_2O)_6]^{2+} + 4NH_3 \longrightarrow [Cu(H_2O)_2(NH_3)_4]^{2+} + 4H_2O$ ✓ blue dark blue ✓ $Cu(H_2O)_6]^{2+}$ and Cl^- ✓ $[Cu(H_2O)_6]^{2+} + 4Cl^- \longrightarrow [CuCl_4]^{2-} + 6H_2O$ ✓ blue yellow/green ✓ octahedral ✓ with shape drawn out, eg $[Cu(H_2O)_6]^{2+}$ ✓ Must have 2 bonds in plane of paper, 2 out of paper and 2 into paper Or 4 in plane of paper, one out of paper and one into paper. tetrahedral ✓ with shape drawn out, eg $[CuCl_4]^{2-}$ ✓ Must have at least 1 bond in plane of paper, 1 out of paper and 1 into paper with last bond one of three types above.	3 5 from 6 4	**Allow** 2 marks for a corectly balanced equation **Allow** other correct examples If incorrect metal mark equations only **Allow** other correct examples Ignore bond angles
	Quality of Written Communication (1) At least 2 complete sentences in which the meaning is clear.✓	1	
		15	

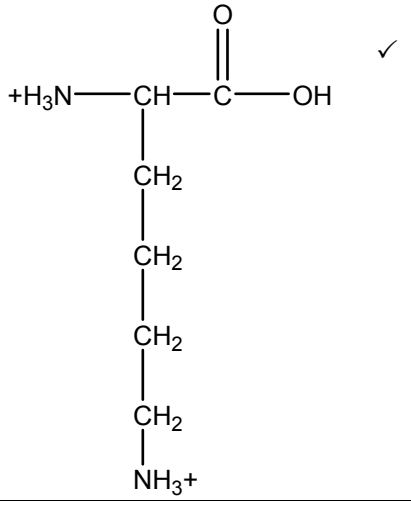
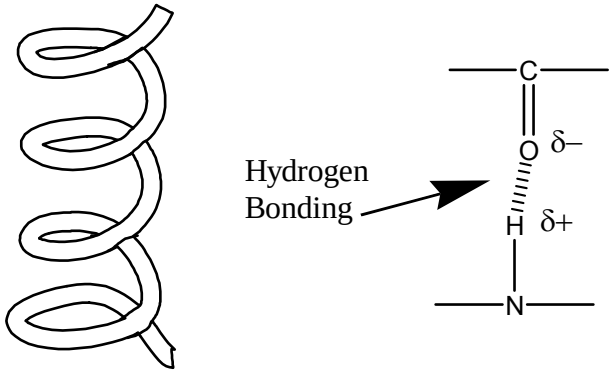
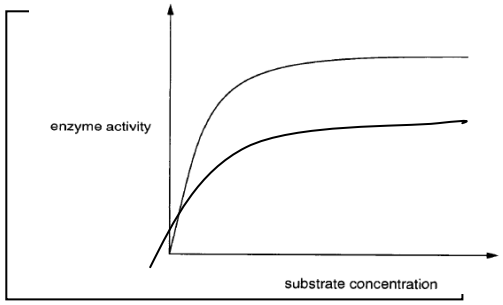
2815/02 Biochemistry

Qu.	Expected answers	Marks
1(a)(i)	Empirical formula = CH_2O ✓ accept COH_2	1
1(a)(ii)	α-mannose has the OH on carbon 1 below the plane of the ring whereas β-mannose has the OH on carbon 1 above the plane of the ring structure. ✓ or alternative diagram  	1
1(a)(iii)	 Correct orientation of OH groups is not required.	1
1(a)(iv)	Carbonyl (or aldehyde) ✓ ECF from **(iii)** for ketone but not carboxylic acid Hydroxyl (or alcohol) ✓	2
(b)	Mannose has many exposed –OH groups which can hydrogen bond with water ✓ Hydrogen bond shown on diagram/ many hydrogen bonds possible ✓	2
(c)(i)	Correct atoms and bonds for two glycosidic links ✓ Correct orientation for both β-glycosidic bond ✓  Independent marks. Allow omission of ring C–Hs	2
(c)(ii)	Cellulose fibres are the major structural component/support ✓ of plant stems	1
		10

Qu.	Expected answers	Marks
2(a)(i)	positions 3 and 5 One mark for each correct position ✓✓  	2
2(a)(ii)	The monomer would be found in RNA **(NO MARK)** The base is uracil ✓ and the sugar is D-Ribose ✓	2
2(a)(iii)	Hydrogen bonding ✓ between complementary base pairs or (A/T and C/G) ✓ allows the two DNA strands to form a double helix ✓. The bases are held inside ✓ the helix and hence protected. **(ANY THREE POINTS FROM THE FOUR POSSIBLE)**	3

2(b)	mRNA synthesised from DNA in the nucleus leaves the nucleus via a nuclear pore. The mRNA carries the codes for individual amino acids in triplets of bases ① **(Mark – The role of mRNA)** Protein synthesis takes place at a ribosome in the cytoplasm ② **(Mark – The site of protein synthesis)** The ribosome binds to the mRNA at a start codon / the codon AUG initiates the chain/ the chain is terminated when the ribosome reaches a stop codon ③ **(Mark – Chain initiation or start codon / Chain termination or stop codon)** t-RNA binds an amino acid at one end of its structure and has a <u>triplet of bases</u> at the other. ④ **(Mark – structure of tRNA)** At the ribosome t-RNA molecules provide the amino acids for each mRNA triplet code <u>in turn</u>/there are six exposed bases at any one time/two tRNA molecules at a time attached in the ribosome so two amino acids can be joined together.) This mark can be earned from a clear diagram. ⑤ **(Mark - role of tRNA)** The t-RNA molecules bind to the mRNA strand by complementary base pairing involving hydrogen bonds Or The amino acids are joined together by the formation of peptide linkages ⑥ **(Mark – bonding between complementary bases or amino acids)** Quality and organization of scientific terms Use of 4 suitable scientific terms such as codon / triplet / amino acids / ribosomes / cytoplasm / bases / hydrogen bonds	**6** **1**
		14

Qu.	Expected answers	Marks
3(a)	Ester bond drawn out correctly in at least one case ✓ Rest of the structure correct ✓ 	2
3(b)	There are van der Waals' (or induced dipole – induced dipole) forces ✓ between triglycerides. Van der Waals' forces can form between the long triglyceride chains ✓ and non polar solvents like hexane – making them soluble. Triglycerides are non polar ✓ and so cannot form hydrogen bonds ✓ with water making them insoluble in polar solvents. Any three of the four marking points.	3
3(c)	in animals .....protection round organs / insulation / energy storage / hormone function ✓ in plants.....food storage in seeds / waxy cuticles on leaves / cell membranes ✓	2
		7

Qu.	Expected answers	Marks
4(a)	Four ✓	1
4(b)(i)	Protease enzyme ✓	1
4(b)(ii)	aqueous hydrochloric acid and heat ✓	1
4(b)(iii)	 ✓	1
4(c)	 The α-helix ✓ is stabilised by hydrogen bonds ✓ between C=O on one part of chain and N–H lower down structure. Or suitable labelled diagram(s)	2
4d(i)	**X** = Hydrogen bonding ✓ **Y** = Disulphide bridge ✓ **Z** = van der Waals' ✓	3
4d(ii)	van der Waals' ✓ or **Z**	1
4e(i)	Active sites are saturated with substrate ✓	1
4e(ii)	Curve less steep and flattens at lower activity ✓ 	1
4e(iii)	It binds to the enzyme outside of the active site ✓ It deforms the active site and prevents the substrate from binding ✓	2
		14

2815/04 Methods of Analysis and Detection

Qu.		Expected answers		Marks
1(a)	(i)	**molecular ion** - caused by unfragmented molecular ion/ unfragmented molecule/ highest *m*/*e* value ✓ **base peak** – most abundant ion/ greatest intensity ✓ – **not** tallest/biggest		**2**
	(ii)	unstable/completely fragmented/easily broken down ✓		**1**
	(iii)	CH_2OH^+/ CH_3O^+ ✓		**1**
(b)		**mass spec** both will have a peak at *m*/*e* 31 (for CH_2OH^+) or M^+ at 76✓ different fragment ions/pattern/ identifies specific ion in one and not the other for e.g. Present in **A** but not propan-1,2-diol possible peaks at *m/e* OR Present in propan-1,2-diol but not **A** *m/e* 15 for CH_3^+ / 59 for $CH_3CHOHCH_2^+$ **infra-red** both have O–H peak between 3230–3550 OR both have C–O peak at 1000–1300 ✓ compound **A** has C=O peak at 1680–1750 or peak for OH in COOH at 2500–3300 ✓ **n.m.r.** both have OH in region 3.5–5.5 (ppm) ✓ propan-1,2-diol has 3 other peaks, compound **A** only two/ identifies a specific chemical shift found in one and not the other for example 11.7 for *A* for C=O – OH not in propan-1,2-diol /explains the difference in splitting patterns✓		**2** **2** **2**
				10

Qu.		Expected answers		Marks
2(a)		peak in UV/VIS region /~150–700 (nm) which tails off after visible region/low at ~800 (nm) ✓		1
(b)	(i)	(groups of atoms/structural feature that) absorbs UV &/or visible radiation/light/energy ✓		1
	(ii)	OH/ arene/NH/C=O or COOH/five-membered ring containing N/ double bonds - any 4 for 2 marks, any 2 for 1 mark ✓✓ Each Circle must not cover more than pne group		2
(c)	(i)	aqueous acid ✓ NOT conc H_2SO_4 or conc HNO_3 heat/reflux for ≥ 6 hours ✓		2
	(ii)	chromatography/electrophoresis ✓		1
	(iii)	use a known sample of tryptophan ✓ & compare R_f values✓/ use UV light✓ and it should absorb UV and appear as a dark spot/ ninhydrin/I_2 i.e. locating agent✓	3	Max 2
				9

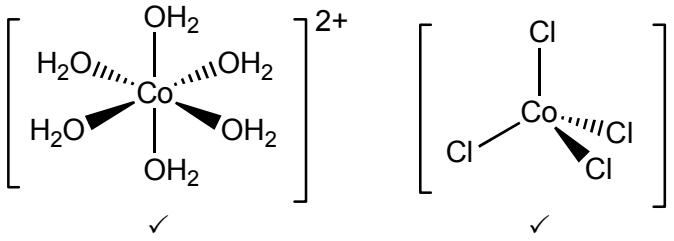
Qu.		Expected answers		Marks
3(a)	(i)	Uses correct axes scales (using at least half of the available grid) and labels including units (axes can be either way around) ✓ all points correctly plotted within half a square with correct (straight) line ✓		2
	(ii)	$[K^+]$ in diluted sample = 4.5×10^{-3} (mol dm^{-3}) range of 4.3–4.6 ✓ ECF from graph $[K^+]$ in patient's blood = 10 x $4.5 \times 10^{-3} = 4.5 \times 10^{-2}$ (mol dm^{-3}) ✓ ECF from reading		2
(b)		$f = 7.43 \times 10^{14}$ ✓ i.e. use of c/λ $E = 4.92 \times 10^{-19}$ (J)/ 4.92×10^{-22} (kJ) ✓ ($E = hcL/\lambda$) answer = 296.38 (kJ mol^{-1}) ✓ = 296 (kJ mol^{-1}) ✓ Correct answer = 4 marks		4
				8

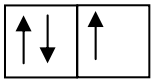
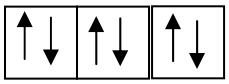
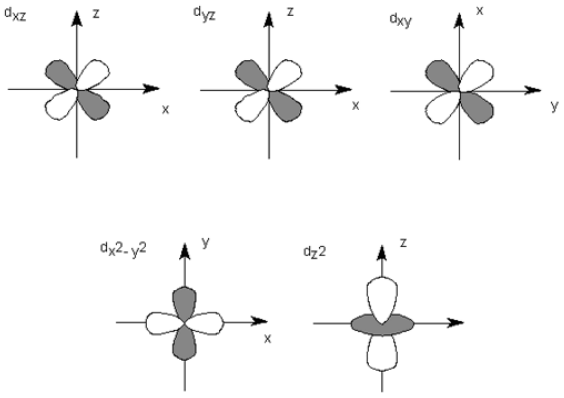
2

Qu.	Expected answers		Marks
4(a)	**partition** solute moves/is distributed between mobile & stationary phases/solvents / the solute has different solubilities in the mobile phase and stationary phase ✓ **adsorption** solute /sticks to stationary phase/ different components have different affinities towards the stationary phase ✓		**2**
(b)	1. DNA is broken into fragments by restriction enzymes✓ 2. fragments move through gel/porous material ✓ 3. fragments move to positive electrode (as all fragments are negative) ✓ 4. separation depends on mass of fragment ✓ 5. controlled by pH/buffer ✓ 6. bands transferred/blotted to (nylon) membrane ✓ 7. heat treated to give single strand ✓ 8. ^{32}P probes/isotopes added ✓ 9. sample exposed to X-rays (to make bands visible) **any 6 from 9**		**6 max**
QWC	At least two sentences, correctly used where the meaning is clear.		**1**
			9

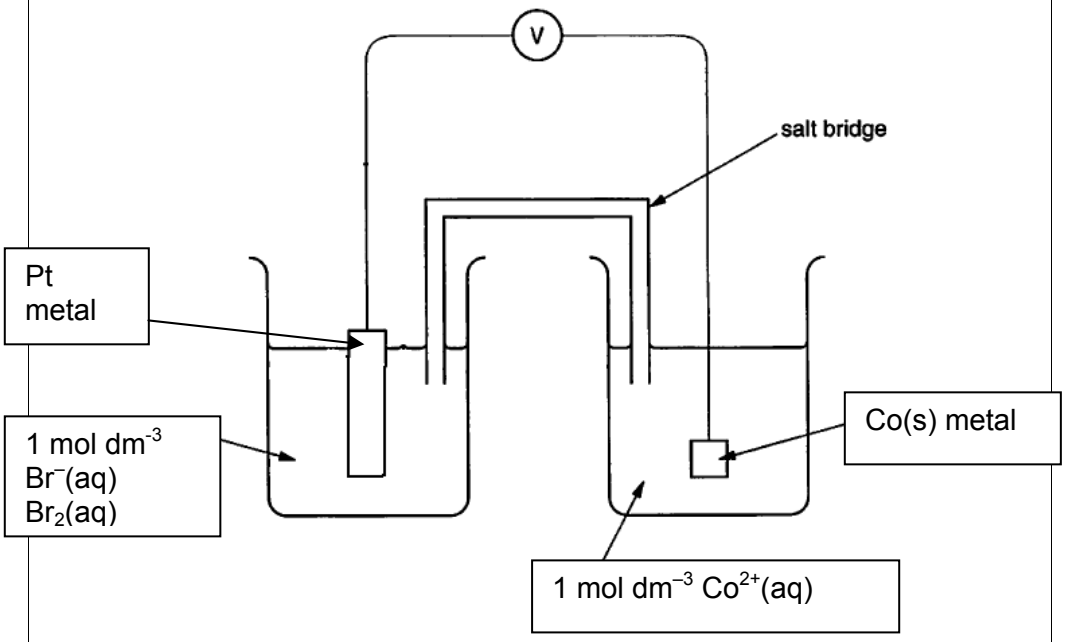
Qu.	Expected answers		Marks
5(a)	C_5H_{12} has mass = 72.0936 ✓ C_4H_8O has mass = 72.0573 ✓		2
(b)	i.r. shows strong C=O peak at 1720 cm^{-1} / between 1680 and 1750 ✓ n.m.r. show 3 proton environments ✓ Total number of protons = 8 ✓ Singlet at δ = 2.1 ppm shows 3H / RCH_3CO (with no adjacent Hs) ✓ Triplet at δ = 1.0 ppm shows 3H/ RCH_3 (with no 2 adjacent Hs) ✓ Quartet at δ = 2.5 ppm shows 2H / RCH_2CO (with 3 adjacent Hs) ✓ Any 1 correct splitting pattern explanation✓ Compound **T** is $CH_3CH_2COCH_3$ ✓		**7 max**
			9

2815/06 Transition Elements

<table>
<tr><th>Qu.</th><th>Expected answers</th><th>Marks</th></tr>
<tr><td>1(a)</td><td>A reaction in which one electron pair donor / ligand ✓ is replaced / displaced/swapped/exchanged ✓ by another (not substituted)</td><td>2</td></tr>
<tr><td>1(b)</td><td> 
✓ ✓
Charge not required
Allow other 3-D representations.</td><td>2</td></tr>
<tr><td>1(c)(i)</td><td>$[Co(NH_3)_6]^{2+}$ ✓
E for forward reaction is less positive / more negative ✓ (not lower)
Reverse reaction / oxidation is more likely to occur ✓</td><td>3</td></tr>
<tr><td>1(c)(ii)</td><td>Ammonia is a <u>stronger ligand</u> than water / ammonia
forms <u>stronger bonds</u> / ammonia is a <u>stronger base</u> /
ammonia can donate its lone pair more easily ✓</td><td>1</td></tr>
<tr><td>1(d)</td><td>
<table>
<tr><td></td><td>$VO_2^+(aq)$</td><td>$VO^{2+}(aq)$</td><td>$V^{3+}(aq)$</td><td>$V^{2+}(aq)$</td></tr>
<tr><td>oxidation state of vanadium</td><td>+5 ✓</td><td>+4 ✓</td><td>+3</td><td>+2</td></tr>
<tr><td>colour</td><td>yellow</td><td>blue ✓</td><td>green</td><td>lilac/purple/ violet/mauve/ lavender ✓</td></tr>
</table>
</td><td>4</td></tr>
<tr><td></td><td></td><td>12</td></tr>
</table>

Qu.	Expected answers	Marks
2(a)(i)	+2 / 2^+ /2 ✓	1
2(a)(ii)	Amount in moles = *cv*/1000 Amount of $S_2O_3^{2-}$ in moles = $\frac{0.500 \times 23.50}{1000}$ = 0.01175 /0.0118 mol ✓ Lose mark if give answer as 0.012 but allow 5 ECF marks in **(iii)**	1
2(a)(iii)	Ratio is 2:1 Amount of I_2 in moles = 0.01175/2 = 0.0058765 mol ✓ Ratio is 2:1 Amount of Cu^{2+} in moles = 0.0058765 × 2 = 0.01175 mol ✓ (Both steps not required can be combined into one step) Mass of copper in 25 cm^3 = 0.01175 × 63.5 / 0.746 g ✓ Mass of copper in 250 cm^3 = 10 × 0.746 g = 7.46 g % Copper = $\frac{7.46}{8.95} \times 100$ = 83.36% ✓ Answer to 3 sig figs = 83.4% ✓ Answer is 83.7% if 0.0118 is used. Allow ECF from **(ii)** (Not all steps required final answer would score 5 marks, whereas 83.36% would score 4 marks)	5
2(b)(i)	Two boxes at higher energy ✓ Correct electron arrangement ✓  	2
2(b)(ii)	d_{xy} , d_{yz}, d_{xz} – Lower level ✓ $d_{(x2-y2)}$ and d_{z2} – Higher level ✓  NB d_{z2} orbital must be shown on *z* axis	2

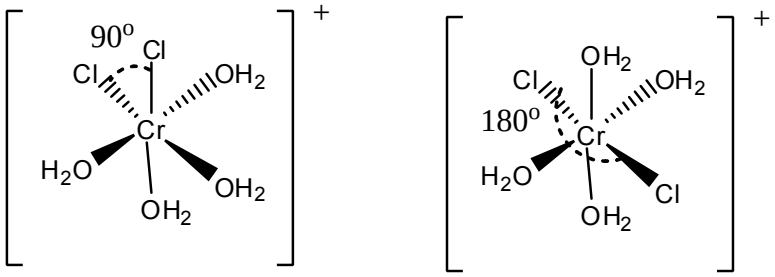
2(c)	Brass used for musical instruments / plumbing and electrical applications, rifle and pistol ammunition / coins / ornaments / door furniture *OR* Bronze used to make coins / statues / door furniture / medals *OR* Cupronickel used to make coins ✓ (Accept any reasonable use)	**1**
		12

Qu.	Expected answers	Marks
3(a)(i)	 Co(s) and Co^{2+}(aq) ✓ Br_2(aq) and Br^-(aq) ✓ State symbols not needed but do not accept Br_2(g) Pt metal ✓ Salt bridge + voltmeter + complete circuit ✓ All solutions at 1 mol dm^{-3} ✓	5
3(a)(ii)	1.37 V ✓ (Ignore sign)	1
3(a)(iii)	Co(s) + Br_2(aq) ⟶ Co^{2+}(aq) + $2Br^-$(aq) ✓ (State symbols not needed)	1
3(a)(iv)	Reduction occurs at the Br_2 / Br^- electrode ✓ Bromine changes oxidation state from 0 to –1 ✓ or Bromine accepts / gains electrons so is being reduced or E is more positive so reaction more likely to occur from left to right / forwards	2
3(b)	MnO_4^- only ✓/ acidified MnO_4^- / H^+ and MnO_4^- The standard cell potential has to be positive and with MnO_4^- cell potential is +0.16 V whereas with $Cr_2O_7^{2-}$ cell potential is –0.03 V ✓ Allow idea that MnO_4^- is a better oxidizing agent than Cl_2 but $Cr_2O_7^{2-}$ is not	1 1
		11

Qu.	Expected answers	Marks
4		2

	$CrCl_3$	H_2O
mass	2.380	1.62
Relative formula mass	158.5	18
Moles	0.015	0.09 ✓
Mole Ratio	= 0.015 / 0.015	= 0.09 / 0.015
	1	6

The value of *x* in the formula is 6 ✓

	stereoisomers are molecules of the same structural formula but with a different spatial arrangement of their atoms ✓  cis-isomer ✓ trans-isomer ✓ Isomers must be correctly labelled. ✓ Bond angles not required. Charges must be correct but if no charge or wrong charge allow ECF on second diagram. Ignore any reference to optical isomerism	4
	When a solution of chromate(VI) is reacted with acid ✓ the dichromate(VI) ion is formed. $2CrO_4^{2-}(aq) + 2H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(l)$ ✓ or $2CrO_4^{2-}(aq) + H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + OH^-(aq)$ or $2CrO_4^{2-}(aq) + H_2O(l) \rightleftharpoons Cr_2O_7^{2-}(aq) + 2OH^-(aq)$ State symbols not needed. Allow correct equations in either direction A colour change will occur in this reaction as the solution changes from yellow to orange. ✓ If colours are with equation, it must be clear that candidates know which is chromate(VI) and which is dichromate(VI)	3
	Two complete sentences using correct spelling, punctuation and grammar, discussing the chemistry of chromium where the meaning is clear. ✓	1
		10

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

Qu.	Expected answers	Marks
1(a)(i)	$K_p = \frac{(pSO_3)^2}{(pSO_2)^2 \times (pO_2)}$ ✓	1
(ii)	equilibrium is (well) to right ✓ **a lot** more products than reactants ✓	2
1(b)(i)	*effect on equilibrium position* moves to left because ……. forward reaction is exothermic / reverse reaction is endothermic / K_p decreases ✓ *effect on partial pressure of $SO_3(g)$* decreases because …… equilibrium has moved to left **OR** reverse / K_p decreases ✓	2
(ii)	*effect on equilibrium position* moves to right because fewer gas moles on right ✓ *effect on partial pressure of $SO_3(g)$* increases because ……. equilibrium has moved to right / more products **OR** SO_3 ✓	2
1(c)	$3.0 \times 10^2 = \frac{p\,(SO_3)^2}{25^2 \times 125}$ **OR** $p\,(SO_3) = \sqrt{(3.0 \times 10^2 \times 25^2 \times 125)}$ ✓ = 4841 kPa ✓ (4841.1229183) *Accept rounding back to 4800 kPa* $\%(SO_3) = 100 \times 4841 / (4841 + 25 + 125) = 97\%$ ✓	3
1(d)(i)	$2ZnS + 3O_2 \longrightarrow 2ZnO + 2SO_2$ ✓✓ ZnS, O_2 as reactants **and** SO_2 as a product: 1st mark. ZnO **and** balance: 2nd mark	2
(ii)	ZnS is more available than S. ✓	1
		13

Qu.	Expected answers	Marks
2(a)	$H_2O_2 + 2I^- + 2H^+ \longrightarrow I_2 + 2H_2O$ equation includes H_2O_2, I^-, H^+ as reactants and I_2 as product ✓ equation balanced ✓	**2**
2(b)(i)	order = 1 with respect to I^- ✓ When $[I^-]$ doubles, rate doubles ✓ order = 0 with respect to H^+ ✓ When $[I^-]$ doubles, rate doubles **OR** when $[I^-]$ quadruples, rate quadruples ✓	**4**
2(b)(ii)	rate = $k\,[H_2O_2]\,[I^-]$ ✓ *[ECF from **(i)**]*	**1**
2(b)(iii)	From one of experiments, e.g. Experiment 1: $k = \frac{5.75 \times 10^{-6}}{0.05 \times 0.01}$ ✓ $= 1.15 \times 10^{-2}$ ✓ $dm^3\ mol^{-1}\ s^{-1}$ ✓ *[ECF from **(ii)**]. Accept 1.2 × 10^{-2}*	**3**
2(c)(i)	$2H_2O_2 \longrightarrow 2H_2O + O_2$ ✓	**1**
2(c)(ii)	1 dm^3 $H_2O_2 \longrightarrow$ 40 dm^3 O_2 ✓ amount of $O_2 = \frac{40}{24}$ **OR** 1.67 mol ✓ concentration of $H_2O_2 = \frac{2 \times 40}{24} = 3.3$ mol dm^{-3} **OR** 2 × 1.67 = 3.34 ✓ *Accept 3.3•*	**3**
		14

Qu.	Expected answers	Marks
3(a)(i)	$I_2(aq) + H_2S(g) \longrightarrow 2HI(aq) + S(s)$ species and balance ✓ state symbols: accept (s) for I_2; (aq) for H_2S ✓	2
(ii)	moles HI = $\frac{47.2}{128}$ = 0.36875 mol ✓ *accept rounding back to 0.369 mol* [HI] = $\frac{0.36875 \times 1000}{225}$ = 1.64 mol dm^{-3} pH = –log 1.64 = –0.21 ✓	2
3(b)(i)	$CH_3COOH \rightleftharpoons H^+ + CH_3COO^-$ ✓ *Equilibrium sign is required*	1
(ii)	$K_a = \frac{[H^+(aq)]\ [CH_3COO^-(aq)]}{[CH_3COOH(aq)]}$ **OR** $[H^+] = \sqrt{([CH_3COOH]\ [K_a])}$ ✓ $[H^+] = \sqrt{\{(1.70 \times 10^{-5}) \times (2.74 \times 10^{-3})\}} = 2.16 \times 10^{-4}$ mol dm^{-3} ✓ *(or 2 marks if no expression given before)* $pH = -\log[H^+(aq)] = -\log 2.16 \times 10^{-4} = 3.67$ ✓ *ECF: pH Must be from both $[CH_3COOH]$ AND K_a* ***DO NOT ALLOW** 3.7* *If no square root, ECF answer = 7.33*	3
(iii)	$HI + CH_3COOH \rightleftharpoons I^- + CH_3COOH_2^+$ ✓ acid 1 base 2 base 1 acid 2 ✓ *Mark acid base pairs ECF from equation showing ethanoic acid as proton donor*	2
3(c)(i)	$NaHCO_3$ is an alkali or base / neutralises acid ✓ $HCOOH + NaHCO_3 \longrightarrow HCOONa + CO_2 + H_2O$ ✓ Allow H_2CO_3 instead of $CO_2 + H_2O$	2
(ii)	vinegar is acidic ✓ neutralises alkali in wasp sting ✓	2
(iii)	$[H^+] = \frac{K_a \times [HCOOH(aq)]}{[HCOO^-(aq)]} = \frac{1.60 \times 10^{-4} \times 0.75}{1.92}$ **OR** 6.25×10^{-5} mol dm^{-3} ✓ $pH = -\log[H^+] = -\log(7.5 \times 10^{-5}) = 4.20 / 4.2$ ✓ *ECF: pH Must be from $[CH_3COOH]$, $[CH_3COO^-]$ **AND** K_a* *If fraction inverted, ECF answer = 3.39*	2
		16

Qu.	Expected answers	Marks
4(a)	moles of NaOH = $\frac{0.152 \times 19.80}{1000}$ / 3.01×10^{-3} mol ✓ moles of acid = 3.01×10^{-3} mol ✓ (3.0096×10^{-3}) moles of acid in flask = $4 \times 3.00 \times 10^{-3} = 1.20 \times 10^{-2}$ mol ✓ (0.0120384) molar mass of compound = $\frac{\text{mass}}{n} = \frac{1.368}{1.20 \times 10^{-2}} = 114$ ✓ Molecular formula = $C_6H_{10}O_2$ ✓ A six carbon carboxylic acid (e.g. hexanoic acid) shown (bod) ✓ Any 2 possible **structural** isomers ✓✓ eg: $CH_3CH_2CH_2{=}CH(CH_3)COOH$ $CH_3CH_2{=}CH(CH_3)CH_2COOH$ *Accept structural formulae or displayed formulae as long as they are unambiguous.*	8
4(b)	**Rate–concentration graphs** Zero order: horizontal line ✓ First order: straight rising line going through origin ✓ Second order: curve rising upwards going through origin OR straight line in a rate vs $conc^2$ graph ✓ correct labeled axes shown once ✓ *Marks can be obtained by three clear sketch graphs* **pH curves** Sketch graph with a sharp rise for strong acid and strong base with line vertical part of curve centred at about pH 7 Must be some indication of pH numbers fitting the vertical part of curve ✓ Sketch graph with a sharp rise for strong acid and strong base with line vertical part of curve centred at a pH greater than 7 Must be some indication of pH numbers fitting the vertical part of curve ✓ **Vertical** section in strong/strong graph is larger than **vertical** section for weak/strong graph **AND** pH curve for weak starts at higher pH than for strong ✓ correct labeled axes shown once ✓ (For *x* axis, accept 'volume **OR** amount of what is added')	8
QWC	For pH titration pH curve, a statement that the colour change of suitable indicator range matches the vertical section ✓	1
		17

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

Plan: Skill P – 16 marks

Two methods are required.
*One must be a titration **(T)** and the other based on a gravimetric procedure **(E or P).***
Measuring the volume of hydrogen is not permitted.
*Both methods require the iron to be dissolved in acid to give $Fe^{2+}(aq)$.(**D**)*

D Dissolving the iron – 5 marks

D1 Adds mixture to excess sulphuric acid of stated concentration **[1]**
Concentration used must be between 0.1 – 5.0 mol dm^{-3} (incl)

D2 Weighs solid mixture ***and*** reacts with acid until fizzing ceases
or weighs solid mixture ***and*** reacts with hot acid until reaction finishes **[1]**

D3 Equation for reaction given ($Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$)
and realises that copper does not react with (***or*** dissolve in) the acid **[1]**

D4 Calculates minimum volume of acid used needed for the reaction **[1]**

D5 Filters [to remove copper] to obtain the iron(II) sulphate solution
and gives two precautions to ensure accuracy of procedure **[1]**

- *washes all traces of the mixture into the funnel with distilled water*
- *uses fine-grained filter paper (**or** multiple sheets)*
- *reduced pressure/Buchner filtration*
- *after filtration, uses distilled water to wash all aq $FeSO_4$ into the filtrate*

T Titration method – 5 marks

T1 Titrates with $KMnO_4$ used in burette
and gives correct balanced/ionic equation for reaction **[1]**
$KMnO_4$ concentration must lie between 0.01 and 0.25 mol dm^{-3} (incl)
$MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$

T2 Transfers all aqueous iron(II) salt into volumetric flask
and makes up to mark with distilled water **[1]**

T3 Pipettes solution of Fe^{2+} into flask ***and*** adds excess H_2SO_4 **[1]**

T4 States the end-point final colour *(pink **or** pale purple)*
and repeats to obtain consistent/concordant titres (**or** within 0.1 cm^3)**[1]**

T5 Specimen calculation from titration to determine the % by mass of Fe **[1]**
Penalise use of Fe = 56 in the second calculation

E Evaporation method – 5 marks

E1 Pipettes known volume of solution into a receptacle
or weighs metal mixture then reacts with named acid
and evaporates to remove all [solution] water
or evaporates until saturated (*owtte*) ***and*** leaves to crystallise **[1]**

E2 Realises that residue /crystals are hydrated iron(II) sulphate
and quotes the "$FeSO_4.7H_2O$" formula **[1]**

E3 Heating gently on water/steam bath or in oven to dry
and gives <u>one</u> reason for gentle heat ***or*** heats to constant mass **[1]**
- *Gentle heat avoids spitting of solid*
- *It avoids dehydration of hydrated iron(II) salt*
- *It avoids decomposition of the anhydrous residue*

E4 Weighs evaporating basin before use
and weighs the evaporating basin + residue/crystals at end **[1]**

E5 Calculation to show how % of iron is calculated from mass of residue **[1]**
Allow a calculation that assumes residue is anhydrous iron(II) sulphate

P Precipitation method – 5 marks

P1 Pipettes known volume of iron(II) salt solution into a beaker/flask
or weighs metal mixture then reacts with named acid
and adds <u>excess</u> of a suitable reagent (eg NaOH) to precipitate the Fe^{2+} **[1]**

P2 Gives the [ionic] equation for the precipitation reaction
and calculates minimum volume (or mass) of reagent needed **[1]**

P3 Weighs filter paper at start (before filtration)
and weighs filter paper + precipitated residue at end **[1]**

P4 Dries the residue by heating gently ***and*** to constant mass **[1]**
Accept use of a desiccator as a suitable alternative drying method

P5 Calculation to show how % of iron is calculated from mass of residue **[1]**

S Safety, Sources and QWC - 4 marks

S1 Safety: One correct relevant hazard ***and*** a specific safety procedure described. **[1]**
Hazard quoted must be related to the reaction described
Precautions must be more than just specs/goggles/lab coats.

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*
- *Accept one specific reference to "Hazcards"*

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

Allow up to five different errors in legibility, spelling, punctuation or grammar.
Treat a type of ICT mistake in text (eg cm3)as one error.

S4 **QWC**: information is organised clearly and coherently

[1]

Are the following three bullets all followed?

- *Is a word count given and within the limits 450 - 1050 words?*
  Photocopied/downloaded material counts in the total
- *Is scientific language used correctly?*
  No S4 if there is more than one error - eg "strong" for "concentrated".
- *Is most of the written material relevant to the task set?*

NOTE: 19 marks are available - maximum 16 awarded

Practical Test (Part B)

Part 1 (12 marks)

Mass readings **[1]**

- Both mass readings must be listed, with unit (g) shown for each
- All three masses should be recorded consistently to two (or three) decimal places
- Labelling of masses must have minimum words, "bottle/container"
- Subtraction to give mass of **E** must be correct, and unit given.

Presentation of titration data **[2]**

(8 bullets correct = 2 marks: 6 or 7 bullets correct = 1 mark)

- Table grid drawn
- Correctly labelled table (initial, final and difference *owtte*) used to record data
- All burette data quoted to 0.05 cm^3 (including 0.00) *(integer loses extra "bullet")*
- All subtractions are correct *(each error loses one "bullet")*
- A minimum of three sets of burette readings are given
- Units, cm^3 or ml, are given as headings (or with each reading)
- No burette readings above 50 cm^3
- Titration readings are not inverted *and* initial reading is not shown as 50.00

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

- Two of candidate's **accurate** titres are within 0.10 cm^3.

Mean titre **[1]**

- Suitably calculated, with unit given, to 2 d.p *(but allow 0.025 or 0.0725*)
  A labelled trial reading may be used (if suitable) ***or*** *ignored*
  If three readings are used, they must be within 0.1 cm^3

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

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 *E as the supervisor.

- ***Award the mark shown as follows.***

$$T = \text{candidate's mean titre} \times \frac{\text{supervisor's mass}}{\text{candidate's mass}}$$

T is within 1.20 cm^3 of supervisor's mean value	**[1]**
T is within 1.00 cm^3 of supervisor's mean value	**[2]**
T is within 0.80 cm^3 of supervisor's mean value	**[3]**
T is within 0.60 cm^3 of supervisor's mean value	**[4]**
T is within 0.40 cm^3 of supervisor's mean value	**[5]**
T is within 0.25 cm^3 of supervisor's mean value	**[6]**

Spread penalty

This is based on the titres actually used by the candidate to calculate the mean.

- *If the titres have* a *spread of* 0.40 *cm*^{3} *or more, deduct* 1 *mark.*
- *If the titres have* a *spread of* 0.80 *cm*^{3} *or more, deduct* 2 *marks.*
- *If the titres have* a *spread of* 1.20 *cm*^{3} *or more, deduct* 3 *marks from accuracy.*

Safety

One sensible **safety precaution** stated ***and*** explained briefly

Accept any sensible precaution, such as use of spectacles or pipette filler.
The precaution must be ***related*** *to one of the irritant/harmful materials.*

Part 2 (Calculation) (12 marks)

All answers are required to 3 sig fig, but penalise this once only

Page 5 - 6 marks

(a) M_r of $KMnO_4$ = 158 **[1]**

$[KMnO_4] = {}^{2.85}/_{158} = 0.0180$ mol dm^{-3} **[1]**
No ECF to wrong M_r within (a)

(b) $n(KMnO_4) = 0.0180 \times {}^{\text{mean titre}}/_{1000}$ *(Method mark)* **[1]**
Answer = 4.2 x 10^{-4} mol or 0.00042 approx (if no working shown)

(c) $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ **[1]**

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

(ii) $MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O$ **[1]**

Page 6 - 6 marks

(e) $n(Fe^{2+})$ in 250 cm^3 = 5 x 10 x "**b**" **[1]**
Method mark.

Amount of Fe^{2+} = 0.0210 mol **[1]**
Correct answer scores this mark = 0.901 x 10^{-4} x titre.

(f) $M_r = {}^{\text{mass of salt used}}/_{\text{moles of Fe2+ used}}$ (correct numbers substituted) **[1]**
Method mark

M_r calculated correctly from data obtained *(should be 392)* **[1]**

(g) **[2*X* =**] 392 ***(or*** answer "**f**") – 96 –152 – 108 = 36 **[1]**
M_r – 356 is sufficient to earn this mark

A_r of ***X*** = ${}^{36}/_2$ = 18.0 **[1]**
This answer may be integral, without incurring the sig fig penalty

Part 3: Test-tube tests (6 marks)

(a) 2 marks

Green precipitate/solid formed **[1]**

$Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$ **[1]**

(b) 4 marks

No colour change (***or*** solution goes slightly yellow) when adding peroxide to **E** **[1]**

Brown /rust coloured/red-brown /dark orange precipitate obtained with NaOH **[1]**

Iron(II)/ Fe^{2+} has been oxidised to iron(III)/ Fe^{3+} ***or*** $Fe^{2+} - e^- \rightarrow Fe^{3+}$
or hydrogen peroxide has oxidised Fe^{2+}
or fizzing due to oxygen liberated **[1]**

Final ppt is iron(III) hydroxide ***or*** $Fe^{3+} + 3OH^- \rightarrow Fe(OH)_3$ **[1]**

Part 4: Evaluation (14 marks)

18 marking points are available, but maximum 14 on the section.

(a) 4 marks

$n(Fe(OH)_2) = {}^{0.08}/_{89.8}$ [= 0.00089(1) mol] **[1]**
Method mark. Use of 55.8 or 89.8 is required.
Allow all answers to 2,3 or 4 sig fig

M_r of **E** = ${}^{0.45}/_{0.00089}$ = 505 (or 506) **[1]**

M_r of $\mathbf{X_2}$ = 506 - 356 **[1]**

A_r of **X** = (75 or) 74.5 **[1]**

(b) 5 marks

A 2 d.p. balance is inaccurate for a small mass of solid
or calculates % error for the balance for any reading **[1]**

Suggests using a 3 or 4 dp balance *(not just 'more accurate')* **[1]**

Use of the two measuring cylinders **is** sufficiently accurate **[1]**
*Reference to **both** is needed for this mark*

NaOH is in excess, so the exact volume does not matter **[1]**

H_2O is not a reagent ***or*** extra water doesn't alter no of moles of reagent(s) **[1]**

(c) 4 marks (maximum)

*Mark the best **two** ideas. Ignore all incorrect/irrelevant ideas*
Many marking parts in (c) and)(d) are interchangeable

Error in mass

Use larger mass of **E** to reduce [percentage] error **[1]**
Calculations/words to explain reduced % error (in mass of **E** ***or*** of residue) **[1]**

Any two comments about problems of filtration

Use water to help transfer all solid into funnel during filtration **[1]**
Use Buchner/suction filtration **[1]**
Wash/rinse the residue in the funnel after filtration **[1]**

Some solid may not be retained by filter paper **[1]**
Use fine-grained filter paper **[1]**

Discussion of heating

Risk of decomposition of $Fe(OH)_2$ to give FeO [during initial heating] **[1]**
Heat gently/ keep temperature low **[1]**

The paper and residue may not be dried completely **[1]**
Re-heat the residue to constant mass **[1]**

Oxidation *(any 2 points)*

$Fe(OH)_2$ can be oxidised [by air] to $Fe(OH)_3$ *(owtte)* **[1]**
This oxidation is quicker in alkaline conditions/ high pH **[1]**
Carry out reaction in atmosphere of nitrogen ***or*** in vacuo **[1]**

(d) 5 marks (max) *(but **two** marks awarded must relate to reliability)*

Burette/pipette is more accurately calibrated **[1]**
% error for either piece of equipment calculated correctly **[1]**
Do not allow a % error calculation for a measuring cylinder

<u>Colour change</u> gives accurate indication of the end of the reaction in the titration **[1]**

Three weighings in the gravimetric method lead to a high <u>cumulative</u> error **[1]**

A larger mass of solid was weighed in the titration [than in gravimetric expt].... **[1]**

.... % errors for weighing **E** compared in **both** experiments **[1]**

Titration experiment was repeated (***or*** gravimetric experiment was not) **[1]**

Consistent titres (***or*** within 0.1 cm^3) indicate reliability **[1]**
*The word "reliability" **must** be used to earn this mark*

Grade Thresholds

Advanced GCE Chemistry (3882/7882)
January 2010 Examination Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2814	Raw	90	69	61	54	47	40	0
	UMS	90	72	63	54	45	36	0
2815A	Raw	90	74	67	60	53	47	0
	UMS	90	72	63	54	45	36	0
2815C	Raw	90	74	67	60	54	48	0
	UMS	90	72	63	54	45	36	0
2815E	Raw	90	75	68	61	54	47	0
	UMS	90	72	63	54	45	36	0
2816A	Raw	120	97	86	76	66	56	0
	UMS	120	96	84	72	60	48	0
2816B	Raw	120	97	86	76	66	56	0
	UMS	120	96	84	72	60	48	0
2816C	Raw	120	89	78	68	58	48	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	4.5	9.1	27.3	54.5	100	100	23
7882	12.3	46.4	71.6	88.9	97.2	100	578

601 candidates aggregated this series.

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

Statistics are correct at the time of publication.

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