OCR
Oxford Cambridge and RSA

GCE

Chemistry B (Salters)

Unit **F334:** Chemistry of Materials

Advanced GCE

Mark Scheme for June 2015

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

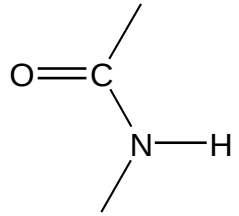
Annotations used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

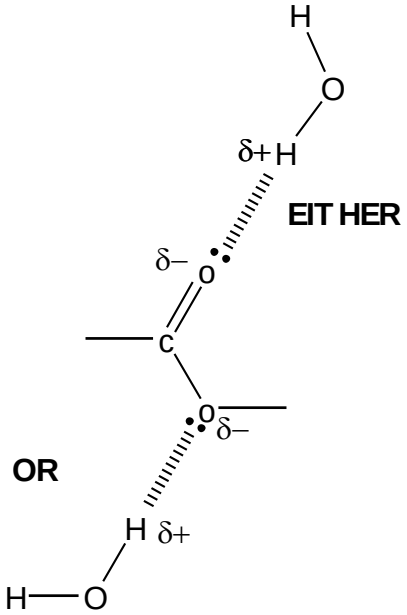
Annotation	Meaning
/	alternative and acceptable answers for the same marking point
✓	separates marking points
not	answers which are not worthy of credit and which will CON a correct answer
ignore	statements which are irrelevant and will NOT 'CON' a correct answer
allow	answers that can be accepted
( )	words which are not essential to gain credit
__	underlined words must be present in answer to score a mark
ecf	error carried forward
AW	alternative wording (replaces the old 'or words to that effect')
ora	or reverse argument

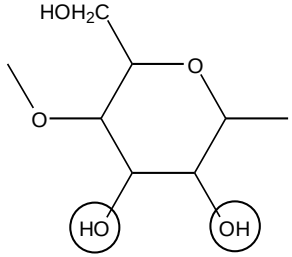
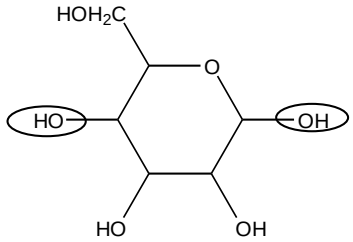
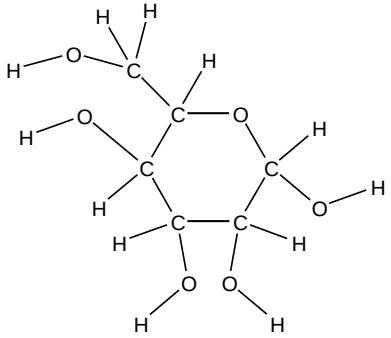
Annotations used in scoris:

Annotation	Meaning
✓	correct response
×	incorrect response
bod	benefit of the doubt
nbod	benefit of the doubt **not** given
ECF	error carried forward
^	information omitted
I	Ignore
R	Reject

Subject-specific Marking Instructions that apply across the whole question paper to be included here.

Question	Answer	Mark	Guidance
1 a i	ammonia / NH_3 ✓	1	NH_4^+ is a **CON** **DO NOT ALLOW** ammonium hydroxide, ammonium salt **IGNORE** conc., state
1 a ii	**N** (atom) has **lone pair** (of electrons) ✓ which can **accept a proton** / hydrogen ion /H^+ ✓	2	
1 b i	addition elimination ✓	1	**ALLOW** circles instead of underlining
1 b ii	 ✓	1	**IGNORE** additions to this linkage, but bonds must be shown on C and N.

Question	Answer	Mark	Guidance
1 c	 **EITHER** **OR** hydrogen bond between O and H ✓ lone pair AND partial charges ✓	**2**	Water must be shown as either H_2O or HO_2 **DO NOT ALLOW** OH or H alone If water is given as **HO_2** AND hydrogen bond(s) and detail correct then award 1 mark **IGNORE** bond angles If **two** examples given, **both** must be correct for 2 marks hydrogen bond must be as shown or dashed/dotted **NOT** a single line lone pair **MUST BE** in line with hydrogen bond
1 d	more hydrogen bonds ✓	**1**	**ALLOW** more groups/sites/places which can form H bonds, more electronegative atoms/N and O atoms which can form H bonds **DO NOT ALLOW** more Os which can form H bonds, bonds more easily
		8	

Question	Answer	Mark	Guidance
2 a i	ether ✓	1	
2 a ii	 either or both circled as above ✓	1	**ALLOW** if adjacent C is also circled
2 a iii	  both circled OH groups present ✓ full structural formula correct ✓	2	**AWARD** 1 mark if one of the circled OH groups is incorrect but rest of structure is correct
2 b i	ethanoic acid ✓	1	

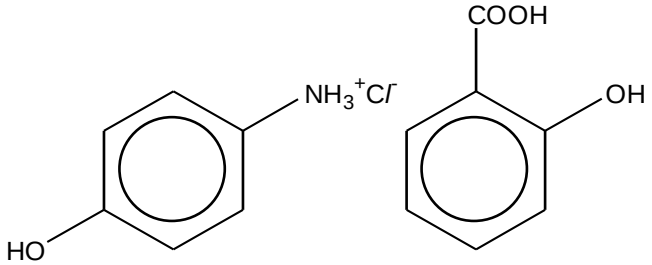
Question	Answer	Mark	Guidance
2 b ii	**cellulose triethanoate:** instantaneous dipole-induced dipole & permanent dipole-permanent dipole **polyester:** instantaneous dipole-induced dipole & permanent dipole-permanent dipole marking: instantaneous dipole-induced dipole in both polymers ✓ permanent dipole- permanent dipole in both polymers ✓	2	**ALLOW** van der Waals for instantaneous dipole-induced dipole **DO NOT ALLOW** abbreviations **DO NOT ALLOW** instantaneous-induced dipole forces unless they have used instantaneous dipole-induced dipole once **ALSO** applies to permanent dipoles hydrogen bonding is a **CON** so does not gain pd-pd mark
2 b iii	longer chains / length of chains ✓ more intermolecular bonds/forces in longer chains **ORA** ✓ **OR** polymer molecules/chains closer ✓ intermolecular bonds stronger ✓ **ORA** **OR** **shorter** monomer chains ✓ more intermolecular bonds between polymer chains / intermolecular bonds more frequent along polymer chains ✓	2	**NOTE** amount of imb/fs per unit length will get 1 mark, needs to relate 'more' to 'stronger' for 2nd mark **NOT** how closely**,** more imbs **may be inferred:** linkages closer together **IGNORE** references to branch/side groups, crystallinity and any other factors
2 c	at temperatures below polymer's Tg ✓ chains / molecules cannot move/slide over one another ✓ chains / molecules break when force applied ✓	3	**IGNORE** references to polymers being brittle **NOT** polymers break/shatter chains/molecules may be implied by use of 'they' referring to polymer chains

Question	Answer	Mark	Guidance
2 d	peak around 3500/3600 / in range 3200-3600 indicates O-H / hydroxyl bond in alcohol ✓ so **cellulose diethanoate** since only 2 of the 3 OH groups in repeating unit of cellulose have reacted / one OH / no OH groups in cellulose triethanoate ora AW ✓	**2**	**IGNORE** references to no O-H peak in range 2500-3200 **MUST** relate OH group to answer **DO NOT AWARD** this mark if a COOH group is also given as present
		14	

<table>
<tr><th>Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>3 a</td><td>
<table>
<tr><th>test</th><th>observations</th></tr>
<tr><td>For C

(add neutral) iron(III) chloride (solution) / $FeCl_3$ ✓</td><td>purple colour formed ✓</td></tr>
<tr><td>For D

(add) Na_2CO_3 (s) or (aq) ✓</td><td>solution / mixture fizzes / bubbles / effervesces / (colourless) gas given off ✓</td></tr>
</table>
</td><td>4</td><td>DO NOT ALLOW iron chloride
ALLOW violet NOT blue or red

ALLOW $NaHCO_3$ / K for Na / Ca CO_3 / $MgCO_3$ / carbonate</td></tr>
<tr><td>3 b i</td><td> 

1 mark for each correct structure ✓✓</td><td>2</td><td>Any clear structure acceptable
ALLOW NH_3Cl. NH_3^+

DO NOT ALLOW an OH group to be bonded to the ring via -HO</td></tr>
</table>

Question	Answer	Mark	Guidance
3 b ii		6	**please annotate marks given with ticks** **ALL** marking points may be gained from labelled diagram(s)
	draw **pencil-line** near bottom of **plate/sheet** ✓		'near bottom' may be implied by what follows **DO NOT ALLOW** paper for plate/sheet **BUT** ecf for further use
	place 1 **drop** (or similar word) **of mixture AND** a **drop of each** of the 2 compounds (on the line) AW ✓		**ALLOW** draw base-line with pencil
	place plate in solvent, **line above solvent** level **AND** add **lid/cover** ✓		
	when solvent nears **top of plate** AW, **remove/dry** plate ✓		
	locate spots with/ expose to **UV light/iodine** ✓		any other named locating agent is a **CON** **DO NOT ALLOW** 'locating agent' alone
	compare heights/position of spots from mixture with the two compounds AW **OR** **calculate/measure/determine** $\boldsymbol{R_f}$ values of spots and **compare** with those of the two compounds AW ✓		**DO NOT ALLOW** vague statements about comparing spots, **MUST** refer to positions **DO NOT ALLOW** vague statements about $\boldsymbol{R_f}$ values *e.g.* $\boldsymbol{R_f}$ values will identify compounds **MUST** indicate that spot heights or $\boldsymbol{R_f}$ values have been measured **AND** compared

Question	Answer	Mark	Guidance
3 c i	for concentration to half: **1**. 4.96 x 10^{-3} to 2.48 x 10^{-3} = 220-30 = **190 hours** ✓ **2**. 3.83 x 10^{-3} to 1.92 x 10^{-3} = 290-100 = **190 hours** ✓ half-life constant (means 1st order) ✓ **OR** every 70 hours**,** **1**. from 30-100 hours = about **23%** of conc. Is used up ✓ **2**. from 220-290 hours = about **23%** of conc. Is used up ✓ same proportion of starting conc. used up (means 1st order) ✓ **OR** every 70 hours (a set time interval) for 1st order the concentration drop will be a constant ratio ✓ **1**. from 30-100 hours = about **1.295** ✓ **2**. from 220-290 hours = about **1.292** ✓	**3**	units required for half-lives at least once **otherwise** 1 mark only for both times correct **DO NOT ALLOW** half-life **MARK** if no relevant data given **IGNORE** units **IGNORE** units **NOTE** any data referring to actual rates cannot be relevant/meaningful
3 c ii	average rate of reaction = **(5.55 - 1.92) x 10^{-3} / 290** ✓ = 1.25 x 10^{-5}	**1**	Give mark for getting the working correct, may make an error with calculator **IGNORE** units for rate of reaction
3 c iii	k = 4.96 x 10^{-9} / 4.96 x 10^{-3} = 1.0x 10^{-6} ✓ s^{-1} ✓	**2**	**ALLOW** 1.00 x 10^{-6} **or** 1 x 10^{-6} **or** 10^{-6}
3 d i	change/alter/different functional/side groups (in structure / formula) ✓	**1**	**ALLOW** add / remove group(s) **IGNORE** references to altering shape, specific named groups
3 d ii	make a large number of related compounds (together quickly) AW ✓	**1**	**DO NOT ALLOW ‘**test’ instead of ‘make’ **MUST** refer to a large number in some way *e.g.* many **NOT** just ‘compounds’
		20	

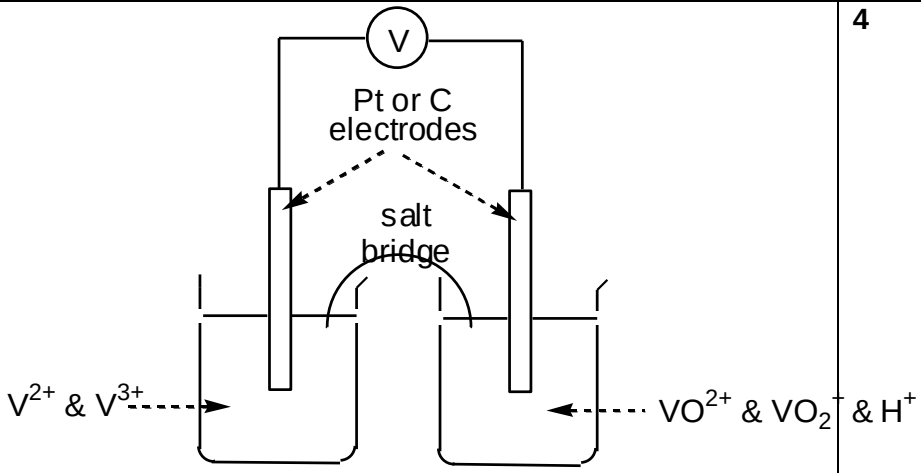
<table>
<tr><th>Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>4 a i</td><td>sulfur dioxide / sulfur trioxide
OR
chlorine ✓</td><td>1</td><td>IGNORE formulae

ALLOW hydrogen chloride NOT hydrochloric acid or sulfur (di)chloride</td></tr>
<tr><td>a ii</td><td><table><tr><th>compound</th><th>oxidation state of vanadium</th></tr><tr><td>VS_4</td><td>+4</td></tr><tr><td>$NaVO_3$</td><td>+5</td></tr><tr><td>$Na_2V_6O_{16}$</td><td>+5</td></tr><tr><td>V_2O_5</td><td>+5</td></tr></table>VS_4 correct ✓
rest correct ✓</td><td>2</td><td>ONLY penalise ONCE for lack of sign
sign must be before number, ecf after first error</td></tr>
<tr><td>a iii</td><td>step 1 ✓

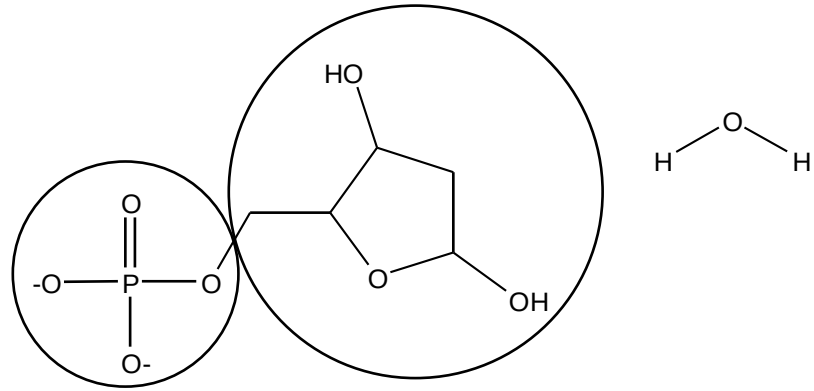
oxidation state of V changes/increases ✓</td><td>2</td><td>more than step 1 is a CON but mark explanation separately

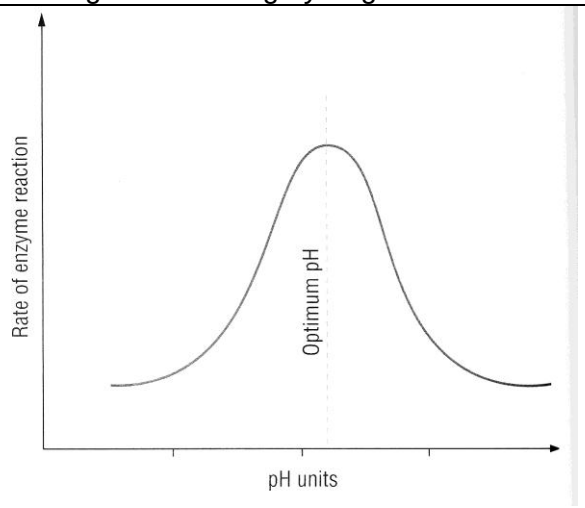
ALLOW electron loss by V
ALLOW ecf for the 2nd mark, from wrong oxidation state for VS_4 in table in aii,
e.g. +8 (for VS_4) to +5, so oxidation state decreases
If two steps in first part, both reasons must refer correctly to the data in aii</td></tr>
</table>

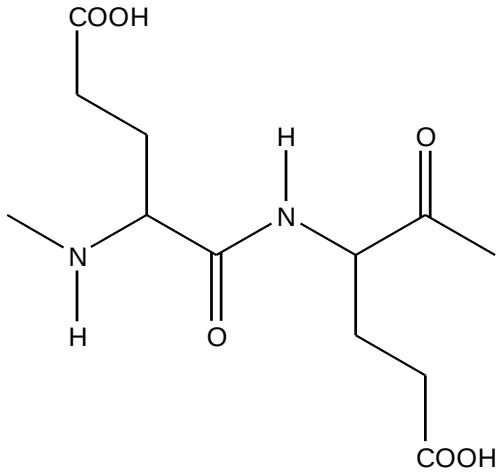
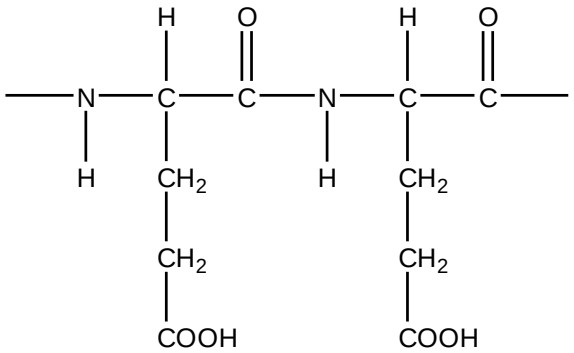
Question	Answer	Mark	Guidance
a iv	**absorb** (specific) **frequencies** (or wavelengths) in (specific) parts of the **visible** spectrum ✓ ✎ **absorb** must be spelled correctly to gain this mark **transmit** complementary colour / frequencies (or wavelengths) not absorbed / yellow light ✓	**2**	**MUST** use frequency/frequencies/wavelength(s) for 1st mark **IGNORE** any reference to energy levels and electrons **ALLOW** 'light' for visible **or** any of its variants *e.g.* absorbed, absorbing, absorption etc. **ALLOW** only complementary colour / frequencies (or wavelengths) can be seen **DO NOT ALLOW** reflect / emit / absor**b**tion
a v	V_2O_5 + 5Ca → 2V + 5CaO ✓	**1**	**IGNORE** state symbols
b	cooling / lowering / controlling temperature (of contents of furnace) ✓	**1**	**ALLOW** *statements which infer cooling e.g.* absorbs heat, prevents furnace getting too hot / thermal shock **IGNORE** references to cost, landfill

Question	Answer	Mark	Guidance
c i	 *diagram shows minimum requirements for 4 marks* both electrodes correct✓ correct vanadium species in each cell ✓ H^+ ions in VO^{2+} and VO_2^+ solution ✓ salt bridge labelled & dipping into solutions **AND** voltmeter attached correctly **AND** circuit complete ✓	**4**	**ALLOW** half-cells reversed **IGNORE** anions, charges on electrodes, water, temperature and concentrations
c ii	E_{cell} = **1.26** V	**1**	**IGNORE** any sign
c iii	temperature is not standard / 25°C ✓ concentrations of ions in a half-cell are not equal ✓	**2**	**DO NOT ALLOW** conditions not standard, must be specific to temperature and/or concentration **ALLOW** concentration not 1 mol dm^{-3} **DO NOT ALLOW** 1 mol(e) for concentration
c iv	$VO_2^+ + 2H^+ + V^{2+} \rightarrow VO^{2+} + H_2O + V^{3+}$ vanadium species correct ✓ equation correct ✓	**2**	**GIVE 1 mark** if equation has species and balancing correct but is reversed

Question	Answer	Mark	Guidance
c v	VO_2^+ **AND** $E^{\ominus}(I_2/I^-)$ must be more negative/less positive than the V ion being reduced **ORA** ✓ $2VO_2^+ + 4H^+ + 2I^- \rightarrow 2VO^{2+} + 2H_2O + I_2$ ✓	2	**ORA** V half-cell is the only one with a more positive $E^{\ominus}$ than the I_2/I^- half-cell **ALLOW** balanced equation with ½ I_2 **IGNORE** state symbols
d i	moles of $Cr_2O_7^{2-}$ used = **0.02160 x 23.50 / 1000** = 0.0005076 (5.076×10^{-4}) ✓ moles of Fe^{2+} reacted = **6** x 0.0005076 ✓ = 0.0030456 (3.0456×10^{-3}) mass of Fe in alloy = 0.0030456 x **55.8** ✓= 0.16994448 g % Fe = 0.16994448 **x100 / 0.1750** ✓ = **97.1** % ✓	5	**DO NOT award marks for random numbers without any explanation to what they refer to** marks are for working out shown in bold **OR** actual answers at each stage **must be 3 sig. figs**. 97% gains 4 marks, 97.1% 5 marks, irrespective of working
d ii	**oxygen / air** (and water) will oxidise/change Fe^{2+} (to Fe^{3+})✓ $NaHCO_3$ reacts with acid to form CO_2 ✓ air/gas is dispelled which cannot return AW ✓	3	
e i	**green solution** ✓ forms a **green precipitate** ✓	2	**IGNORE** any qualifying of green such as pale, dark, dirty, rust etc. **ALLOW** ppt **ALLOW** solid for precipitate
e ii	$Fe^{2+}(aq) + 2OH^-(aq) \rightarrow Fe(OH)_2(s)$ formulae correct & balanced ✓ state symbols correct for precipitation reaction ✓	2	
		32	

Question	Answer	Mark	Guidance
5 a	**1.** to find out about their relatives / ancestors AW **OR** to diagnose illness / cure disease AW ✓ **2.** they are police / criminal suspects AW ✓ **3.** they have not been prosecuted **OR** they are innocent **OR** they have been found not guilty **OR** infringes privacy **OR** prevents access by other people AW ✓	3	**NOTE** they may have answered in a different order to the questions in the stem **DO NOT ALLOW** to be cleared of a crime AW I**GNORE** references to human rights/liberty
b i	nucleotide ✓	1	**IGNORE** any details of the constituents of nucleotides
b ii	 phosphate structure (circled) correct ✓ deoxyribose structure (circled) correct ✓ water structure ✓	3	**ALLOW** an OH group for an O^- on phosphate The phosphate **MUST** be joined at the primary OH **ALLOW** H_2O or any bond angle for water

Question	Answer	Mark	Guidance
c	base pairs held together by <u>hydrogen bonding/bonds</u> ✓ adenine-thymine 2 hydrogen bonds **AND** guanine-cytosine 3 hydrogen bonds ✓ **hydrogen bonds** between base pairs **break** ✓ (two single) **helices / strands** are formed ✓ **each base** (on these helices/strands) forms **hydrogen bonds** to a **new (correct/complementary) base** AW ✓ ✎ to gain this last point replication must be linked to breaking **AND** forming hydrogen bonds	**5**	May be implied by staying the number of hydrogen bonds in each case different numbers of H bonds is **NGE** May refer to just **one strand** **IGNORE** references to phosphodiester bonds *i.e*. both forming and breaking H bonds have to be mentioned in the answer
d	 curve correct shape ✓ label for **optimum pH** in line with **fastest rate of reaction** ✓	**2**	**ALLOW** any curve with a peak, not necessary to be symmetrical Optimum pH should indicate the **peak** of graph **AND** be labelled as such

Question	Answer	Mark	Guidance
e i	structure correct - 2 examples shown below   ✓	1	**ALLOW** any correct structure **ALLOW** without 'spare bonds' **ALLOW** dipeptide structure which must have its secondary amide/peptide between two chiral C atoms
e ii	((side) **–COOH/carboxyl groups** will (lose protons and)) form **–COO^-/carboxylate ions** ✓	1	also forming NH_2^+/ NH_3^+ is a **CON** **ALLOW** carboxyl/COOH becomes deprotonated AW
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