OCR
Oxford Cambridge and RSA

GCE

Chemistry B (Salters)

Unit **F332:** Chemistry of Natural Resources

Advanced Subsidiary GCE

Mark Scheme for June 2016

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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

Annotation	Meaning
BOD	Benefit of doubt given
CON	Contradiction
	Incorrect response
ECF	Error carried forward
TE	Transcription error
NBOD	Benefit of doubt not given
POT	Power of 10 error
^	Omission mark
SF	Error in number of significant figures
	Correct response
	Wrong physics or equation

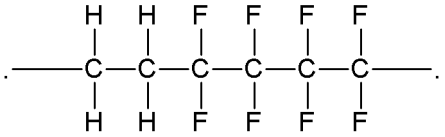
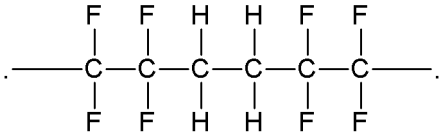
Abbreviations, annotations and conventions

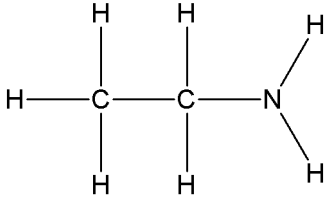
Annotation	Meaning
/	alternative and acceptable answers for the same marking point
(1)	Separates marking points
reject	Answers which are not worthy of credit
not	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

Question			Answer	Mark	Guidance
1	a	i	*Any TWO from:* ✓✓ Consist entirely of carbon atoms Giant (network) / giant (lattice) Covalent	2	 Must have the idea that it consists of only carbon **ALLOW** giant structure. **IGNORE** Macromolecular **DO NOT ALLOW** 'covalent' mark if there are references to ionic or intermolecular bonds or molecules in either substance.
1	a	ii	*Two from:* Every C bonded to 4 C ✓ Diamond doesn't have layers ✓ 3-dimensional/3D **OR** tetrahedral **OR** bond angle 109 (.5)° ✓ Does not have delocalised electrons. ✓	2	 Answer must imply 'each', 'every' or 'all' carbons to score the mark. **IGNORE** Free electron(s)
1	b		44/12 x 51 (= 187) ✓ **OR** 51/720 x 60 x 44 (= 187) ✓ sf mark: 190g ✓	2	 **ALLOW** sf mark for any 2 sig fig answer that follows from any calculation 3.1 scores 1 (sf mark for incomplete calculation)
1	c	i	High pressure (under the ocean keeps the CO_2 in place) ✓ *AW* **OR** it will dissolve in seawater (before it can escape) *AW* ✓	1	 **ALLOW** becomes aqueous

Question			Answer	Mark	Guidance
1	c	ii	*Two from:* Plant more trees/plants/afforestation/reforestation (AW) ✓ Promote photosynthesis by phytoplankton (AW) ✓ Reacting the CO_2 with lime / slaked lime / other suitable named solid / metal oxides ✓ Disposing of it in an old mine / well / pump it into rocks/ other suitable disposal site ✓	2	**NOT** methods of putting less CO_2 into the atmosphere, like burning less fossil fuel. **IGNORE** Lime water **IGNORE** "carbon capture methods" unless specified
1	c	iii	Carbon monoxide causes (photochemical) smog **OR** is poisonous/toxic *AW* ✓ Carbon dioxide causes global warming/ greenhouse effect ✓	2	**ALLOW** warming of atmosphere/ increases global temperature **IGNORE** greenhouse gas
1	d		(Increased acidity) moves equilibrium (position) in equation 1.2 to the left / to the reactants / named reactant ✓ Increased CO_2(aq) moves equilibrium (position) of equation 1.1 to the left / to the reactant / towards CO_2 (g) ✓ CO_2 (g) (concentration) increases ✓	3	For **MP1** and **MP2** **ALLOW** 1 mark if describe what is happening in equations 1.2 and 1.1 (in correct sequence) but do not mention equilibrium. **ALLOW** 2 marks if equilibrium is stated in 1.2 or 1.1 and has described what is happening in both equations. Equation numbers can be implied Maximum of 1 mark for an incorrect sequence (ie 1.1 then 1.2) **IGNORE** Produces more CO_2
1	e	i	Bonds (in CO_2) absorb ir / bonds in CO_2 vibrate (more) / increases vibrational energy of bonds in CO_2 ✓ Only certain frequencies/wavelengths/wavenumbers of ir are absorbed / bonds vibrate at specific frequencies ✓	2	**IGNORE** references to emitting Must mention absorb somewhere in answer for mp2

Question			Answer	Mark	Guidance
1	e	ii	Energy = 21.7 x 1000 (= 21700) J ✓ Energy in J / 6.02 x 10^{23} (= 3.60 x 10^{-20}) J ✓ Frequency = energy / 6.63 x 10^{-34} and evaluate (= 5.44 x 10^{13} Hz) ✓	3	First mark is for converting 21.7 from kJ to J i.e.: multiply by 1000. Second mark is for dividing by 6.02x10^{23} (the Avogadro constant). **ALLOW** ecf To get second and third marks, there must be a correct evaluation **ALLOW** ecf **IGNORE** sig figs. **ALLOW** 5.43 x 10^{13} Hz unless there is an obvious rounding error 3.27 x 10^{37} scores 2 (not divided by Avogadro constant) A completely correct answer on its own scores 3 marks.
				19	

Question			Answer	Mark	Guidance
2	a		Tetrafluoroethene has stronger/more instantaneous (dipole) – induced dipole forces/bonds (than ethene) *ORA* ✓ As it has more electrons /is a bigger molecule (than ethene) *ORA* ✓ More energy needed to separate molecules (than ethene) *ORA* **OR** more energy needed to break/overcome imb (than in ethene) *ORA* ✓	3	**IGNORE** id-id in mp1 but ALLOW for mp3 **ALLOW** van der Waals, London forces **ALLOW** fluorine has more electrons mp1, mp2 and mp3 must be comparisons **ALLOW** mp3 if incorrect imf's are stated
2	b		Either:  OR  ✓	1	Can have first diagram reversed (i.e.: with the 2 CH_2s at the right). Must show end bonds Can use other representations, such as skeletal. **IGNORE** brackets
2	c		Copolymer ✓	1	**DO NOT ALLOW** co-polymerisation **ALLOW** AB polymer
2	d		ETFE does not form hydrogen bonds with water. ✓	1	**ALLOW**: Intermolecular bonds between ETFE and water are weaker than the water-water interactions **OR** dissolving would need more imbs to be broken than would be made.
2	e	i	Carbocation ✓	1	**ALLOW** carbonium ion **DO NOT ALLOW** carboncation

Question			Answer	Mark	Guidance
2	e	ii	(Partially) positively charged species / electron deficient reagent / electron pair acceptor *AW* ✓ bonds by accepting a pair of electrons/ ✓	2	**ALLOW** atom/molecule/positive ion
2	e	iii	Bromide (ion) / Br^- attacks / bonds with carbocation **OR** Bromide (ion) / Br^- attacks / bonds with intermediate A ✓ Chloride (ion) / Cl^- attacks / bonds with carbocation **OR** Chloride (ion) / Cl^- attacks / bonds with intermediate A ✓ Attack by Bromide (ion) / Br^- gives CH_2BrCH_2Br **OR** Attack by Chloride (ion) / Cl^- gives CH_2ClCH_2Br ✓	3	**ALLOW** 'attract' for 'attack' provided it leads to a reaction/product. **ALLOW** forms a bond with **ALLOW** reacts with **ALLOW** C+ or cation for carbocation **ALLOW** 1 mark for: Carbocation / intermediate A is attacked by nucleophiles **OR** species carrying negative charge Referring to Chlorine /Bromine (ions) loses mp1/mp2 but not mp3 Referring to Br^- or Cl^- as electrophiles/electron pair acceptors negates one mark **ALLOW** marks from suitable diagrams.
2	f	i	Water ✓ Hydroxide (ions) ✓	2	**ALLOW** formulae (H_2O or OH^-) Allow Hydroxyl ion
2	f	ii	 ✓	1	Must show all atoms and all bonds. **IGNORE** bond angles and lone pairs
2	f	iii	Amine(s). ✓	1	**IGNORE** alkyl, primary **DO NOT ALLOW** ammine **ALLOW** amino alkane

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>2</td><td>f</td><td>iv</td><td>(At higher temperatures):
particles have more <u>kinetic</u> energy OR particles move faster OR more collisions per unit of time OR more frequent collisions ✓

more <u>collisions</u> are successful / effective

OR

more <u>collisions</u> have (total) energy of at least the activation energy / more particles <u>collide</u> with an energy ≥ Ea ✓</td><td>2</td><td>ALLOW molecules or ions for particles
ALLOW reverse argument throughout.
IGNORE KE

Must be clear that collisions are between particles/molecules/ions, not reactants or similar wording.

DO NOT ALLOW more chance of / likelihood of collisions.

IGNORE more particles have energy ≥ than E_a</td></tr>
<tr><td>2</td><td>g</td><td>i</td><td><table><tr><th>Absorption ranges / cm^{-1}</th><th>Bond</th></tr><tr><td>3200 - 3640</td><td>O-H</td></tr><tr><td>Plus one of:</td><td></td></tr><tr><td>1050 - 1300</td><td>C-O</td></tr><tr><td>2850 – 2950</td><td>C-H</td></tr></table>✓ ✓</td><td>2</td><td>ALLOW OH range 3200-3600 cm^{-1} or 3600 – 3640 cm^{-1}

Mark is for a correct range within those given and correct bond in each case.

ALLOW OH, CH, CO but bond must only be between atoms

DO NOT ALLOW lower case letters</td></tr>
<tr><td>2</td><td>g</td><td>ii</td><td>Fingerprint (region) ✓

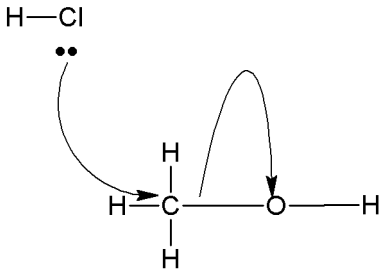
Unique/distinct/characteristic (part of the IR spectrum) to the compound AW
OR can be used to identify the compound (by comparison with a database)
OR
Can differentiate between similar molecules
OR
Unique for every molecule✓</td><td>2</td><td>ALLOW ‘molecule’, ‘substance’, ‘chemical’ for compound
DO NOT ALLOW ‘element’</td></tr>
</table>

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>2</td><td>h</td><td></td><td>
<table>
<tr><th>Oxidation conditions</th><th>Formula of functional group of product</th><th>Homologous series of product</th><th></th></tr>
<tr><td>Heat and immediately distil</td><td>(-)CHO</td><td>Aldehyde</td><td>✓</td></tr>
<tr><td>Heat under reflux</td><td>(-)CO_2H</td><td>Carboxylic acid</td><td>✓</td></tr>
</table>
</td><td>2</td><td>Mark is for correct name of product and correct homologous series in each case.

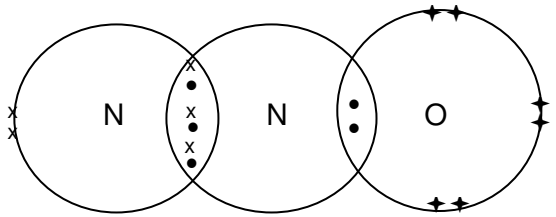
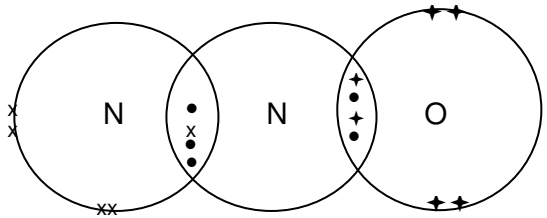
ALLOW CH_3CHO and CH_3CO_2H/ CH_3COOH/ COOH or ‘R’ group
DO NOT ALLOW COH

ALLOW Full structural formulae</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td>24</td><td></td></tr>
</table>

Question			Answer	Mark	Guidance
3	a		[Ne] 3s ↑↓ 3p ↑↓ ↑↓ ↑↓ ✓	1	**ALLOW** use of other arrow symbols (such as 1, as long as – in each box – one points up and one down).
3	b		2 NaC*l* + **2** H_2O → **C*l*$_2$ + H_2 + 2NaOH** ✓	1	**IGNORE** state symbols All parts in bold need to be present in the response.
3	c	i	They bond to the negative groups on the resin / membrane **AND** block the movement of Na^+ ions through the resin / membrane. **OR** ions may pass through the resin / membrane **AND** form group II hydroxides / contaminate the NaOH ✓	1	
3	c	ii	$Mg^+ (g) \rightarrow Mg^{2+} (g) + e^-$ ✓✓ Award marks for: Equation ✓ State symbols ✓	2	Mark separately **ALLOW** e without a sign for the electron symbol or $_{-1}^{0}e$ **ALLOW** $Mg^+ (g) - e^- \rightarrow Mg^{2+} (g)$ **IGNORE** state symbol on electron **NOT** capital 'G' for state symbol **ALLOW** 1+ charge but NOT +1 or +2
3	c	iii	Outer shell / outermost electron of Mg **AND** is closer to the nucleus (than Ca) / shielded less (than Ca) (*ORA*) **OR** Mg has fewer electron shells between outermost electron and the nucleus (than Ca) (*ORA*) ✓ Nuclear attraction (to electron) is stronger/greater **OR** attraction/pull from the nucleus/nuclei is stronger/greater **AND** more energy is needed to remove an electron AW (*ORA*) ✓	2	Mark separately Must be a comparison. **DO NOT ALLOW** 'molecule' **ALLOW** descriptions for outer such as 'furthest from the nucleus', 'in highest energy level', 'valence electron', $3s^1$ and $4s^1$ electrons **NOT** 'it' for magnesium but second mark does not need element specified. Nucleus / nuclear / nuclei must be correctly spelt once for both marks to be awarded. **NOT** 'harder to remove' or 'to overcome attraction'

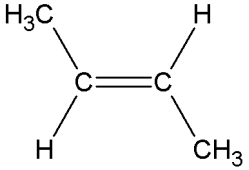
Question			Answer	Mark	Guidance
3	d	i	 Marks are awarded as follows: mp1 Lone pair **and** start of curly arrow from it in correct place ✓ mp2 End of curly arrow from Cl in correct place ✓ mp3 Curly arrow from C-O bond to O ✓	3	**DO NOT ALLOW** single headed (half-curly) arrows. However, if candidate draws two single headed (half-curly) arrows to the correct positions then award 1 mark for mp2 and mp3 If Cl^- instead of HCl then maximum 2 marks **IGNORE** arrow from H-Cl bond to Cl Mp1 arrow must start close to lone pair Mp2 Curly arrow must be drawn carefully starting from the Cl and pointing to the C atom or an imaginary line between C and C*l* Mp3 Curly arrow must be drawn carefully starting from the bond and pointing to the O atom Any additional arrow negates 1 mark Mark separately. **IGNORE** further reaction steps **IGNORE** partial charges on atoms **ALLOW:** marks can be awarded for SN1 mechanism which has attack by Cl^- to the C+ atom. Do not award MP3 if leaving group is OH^- and not H_20
3	d	ii	Nucleophilic ✓ Substitution ✓	2	**ALLOW** answers indicated in other ways, such as circles, ticks Each additional underline negates a mark.
3	e	i	Burette ✓	1	**ALLOW** small spelling error (e.g.: 2 rs or one t). **NOT** biuret.
3	e	ii	$Ba(OH)_2 + 2\ HCl \rightarrow BaCl_2 + 2\ H_2O$	1	**IGNORE** state symbols

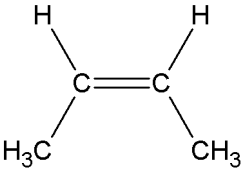
Question			Answer	Mark	Guidance
3	e	iii	Moles $Ba(OH)_2$ =(19.6/1000) x 0.100 (= 1.96 x 10^{-3}) ✓ Moles H^+ = 2 x moles $Ba(OH)_2$ (= 3.92 x 10^{-3}) **OR** $2H^+ + Ba(OH)_2 \rightarrow 2H_2O + Ba^{2+}$ ✓ Moles H^+ = 2 x moles $Ba(OH)_2$ / 50 (= 7.84 x 10^{-5}) Previous ans x 1000 (=7.84 x 10^{-2}) ✓	3	**ALLOW** 2 or more sf Ecf from incorrect mole ratio 0.0196 scores 2 (have divided by 2, not x2) 0.0392 scores 2 (have used 1:1 ratio) **IGNORE** sig figs. A completely correct answer on its own scores 3 marks.
				17	

Question			Answer	Mark	Guidance
4	a		Sodium sulfate / Sodium sulphate/ Na_2SO_4 *or other salt with an anhydrous form* ✓	1	**ALLOW** silica gel (but not just silica), sodium carbonate, calcium chloride, magnesium chloride, copper sulfate (this is only a selection of suitable responses) or correct formula for a salt with an anhydrous form. **DO NOT ALLOW** calcium carbonate, sodium hydrogen carbonate and conc sulphuric acid.
4	b	i	(Reaction of N_2 and O_2 during) lightning **OR** forest fires **OR** from bacterial processes **OR** photodissociation of NO_2 *AW*. ✓	1	
4	b	ii	Burning fuel in vehicle engines / putting fertilisers onto soil / use of aerosol spray /burning fossil fuels to generate electricity *AW* ✓	1	Answer must be an <u>activity</u> (e.g.: driving a vehicle) **DO NOT ALLOW** 'burning a fuel' without a context.
4	b	iii	Dinitrogen oxide ✓	1	**ALLOW** nitrogen (I) oxide or dinitrogen monoxide **DO NOT ALLOW** Dinitrogen (I) oxide
4	c		 **OR**  Bonding electrons correct ✓ Lone pairs correct✓	2	Any two or three different symbols can be used to represent the electrons of different atoms. Candidate does not need to draw circles for electron shells. It **MUST** be clear that pairs of electrons are being shared between the two Ns and the N and the O. **IGNORE** inner shell electrons. Diagrams showing NO_2 scores 0

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>4</td><td>d</td><td></td><td>78% = 780000 ppm ✓
780000/0.38 = 2.1 x 10^6 times more ✓
OR
0.38ppm = 3.8 x 10^{-5} % ✓
78/3.8x10^{-5} = 2.1 x 10^6 times more ✓</td><td>2</td><td>ALLOW 2 or more sf

ALLOW ecf from an incorrect conversion

Correct answer scores 2</td></tr>
<tr><td>4</td><td>e</td><td></td><td> 
E-but-2-ene

 
Z-but-2-ene

Marks are for:
Diagrams correctly drawn ✓
But-2-ene for both ✓
E/Z correct way round✓</td><td>3</td><td>Mark independently

No more than 2 bonds above or below the C=C

ALLOW skeletal structures

ALLOW ambiguous attachments

IGNORE Cis /Trans
IGNORE Brackets around E/Z and hyphens</td></tr>
<tr><td>4</td><td>f</td><td></td><td><table><tr><th>Component of air</th><th>Name</th><th>Formula</th></tr><tr><td>A</td><td>Oxygen</td><td>O_2</td></tr><tr><td>B</td><td>Argon</td><td>Ar</td></tr></table>✓</td><td>1</td><td>All correct for the mark.</td></tr>
<tr><td>4</td><td>g</td><td>i</td><td>Evidence from more than one source, or from two or more different surveys. (AW) ✓</td><td>1</td><td></td></tr>
</table>

Question			Answer	Mark	Guidance
4	g	ii	Homogeneous ✓	1	**DO NOT ALLOW** Homolytic
4	h		1. Both have hydrogen bonding ✓ 2. Lone pair on oxygen ✓ 3. (bonds to) hydrogen with δ^+ charge on another molecule✓ 4. Ice is less dense because: molecules get further apart (ORA) **OR** 'more open structure' ✓ 5. (Intermolecular bonds) keep ice in a lattice / regular arrangement / crystalline structure / tetrahedral structure / ordered (AW) ✓ <u>*QWC:*</u> (For same numbers of water molecules) ice takes up more room/space than liquid water, leading to lower density (of ice). (AW) ✓	5 1	**MP2: NOT** lone pair on oxygen molecule **MP3: DO NOT ALLOW** δ^+ hydrogen molecule **DO NOT ALLOW** negative oxygen **ALLOW** partially positive (AW) **MP2, MP3: ALLOW** lone pair on O and $H^{\delta+}$ from a diagram but must be H of OH group that has the partial positive charge, including anything between the molecules. **MP4:** Must be a comparison **ALLOW** any idea of greater separation of molecules Here, including anything between the molecules **MP5:** mention of 'air','oxygen' between molecules negates this mark, but **IGNORE** 'empty space' or 'open space'. **IGNORE** molecules less/more dense **IGNORE** strength of H bonds in water/ice
				20	

Question			Answer	Mark	Guidance
5	a		Photochemical smog ✓	1	
5	b	i	*Any TWO from:* Vehicle emissions ✓ Forests ✓ Plants ✓	2	
5	b	ii	$O_3 + CH_3CH=CH_2 \rightarrow CH_3CHO + {}^{\bullet}O–O–{}^{\bullet}CH_2$ **OR** $O_3 + CH_3CH=CH_2 \rightarrow H_2CO + {}^{\bullet}O–O–{}^{\bullet}CHCH_3$ Right-hand side correct ✓ Left-hand side correct ✓	2	'Dots' for radicals are required here. **ALLOW** CH_3CHCH_2 **ALLOW** O=O–O or with charges, **ALLOW** skeletal formulae. **ALLOW** full structural formulae of organic molecules **IGNORE** intermediate steps.
5	c	i	*One from:* $CH_3^{\bullet} + CH_3^{\bullet} \rightarrow C_2H_6$ $Cl^{\bullet} + CH_3^{\bullet} \rightarrow CH_3Cl$ $Cl^{\bullet} + Cl^{\bullet} \rightarrow Cl_2$ ✓	1	**ALLOW** equations without the radical 'dots'.
5	c	ii	Reaction only involves bond formation / making (and no bond breaking). ✓	1	Must make it clear that it is **only** bond making that occurs
5	c	iii	$CCl_3^{\bullet} + Cl_2 \rightarrow Cl^{\bullet} + CCl_4$ ✓	1	**ALLOW** equations without radical 'dots'.
5	d		*Two from:* ✓✓ Regulates ozone levels / ozone depletion Photochemical smog <u>formation</u> Ozonolysis (of alkenes) / reaction of ozone with alkenes Reaction with SO_2 Reaction with NO_2	2	**IGNORE** forming (Criegee) biradicals **ALLOW** equations **ALLOW** formation of sulphuric acid / SO_3 **ALLOW** formation of nitric acid / NO_2 **ALLOW** formation of organic nitrates

Question			Answer	Mark	Guidance
5	e	i	Species with two unpaired electrons on different atoms. ✓	1	**ALLOW** a biradical carbonyl oxide / a carbonyl oxide with 2 unpaired electrons **ALLOW** molecules instead of species but not atoms
5	e	ii	C-C*l* bond needs higher frequency radiation (to break than C-I bond). ✓ Higher frequency equates to higher energy **AND** C-C*l* bond is stronger/has higher bond enthalpy than C-I bond **OR** Higher frequency equates to higher energy **AND** C-C*l* bond needs more energy (to break than C-I bond). ✓	2	**ORA** throughout Must be comparisons throughout **IGNORE** references to electronegativity **ALLOW** E=hv as an explanation of high frequency equating to higher energy
5	f		*Example:* either •CH_2OO• **OR** •$CH(CH_3)OO$• ✓ *How they form:* Volatile unsaturated compounds react with ozone. ✓ *Why only recently detected - TWO from:* ✓✓ They react extremely quickly. Only form in certain parts of the atmosphere where conditions are right. (*AW*) Alkene ozonolysis reactions are too slow in lab systems to generate enough Criegee biradicals to detect. *How they have been detected:* (Detected by) PIMS/Photoionisation Mass Spec(troscopy). ✓ High intensity light beams. ✓	6	**ALLOW** alkenes react with ozone/ alkene ozonolysis. **ALLOW** They react very rapidly/they are highly reactive therefore very short lived

Question			Answer	Mark	Guidance
			QWC: Linking very quick reactions of Criegee biradicals with the fact they have two unpaired electrons. ✓	1	**Please indicate QWC mark using red cross or green tick on the right of the pencil icon on the answer screen.**
				20	

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