OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry B (Salters)

Advanced Subsidiary GCE

Unit **F332:** Chemistry of Natural Resources

Mark Scheme for January 2012

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

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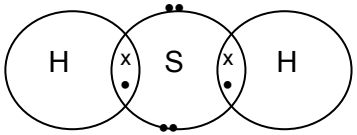
Annotations used in the detailed Mark Scheme (to include abbreviations and subject–specific conventions).

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

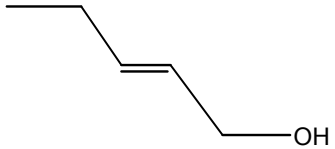
Annotations used in scoris:

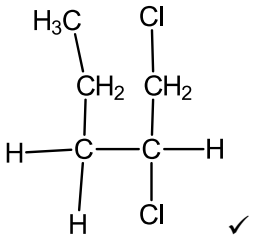
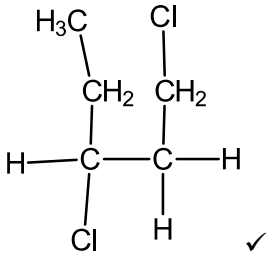
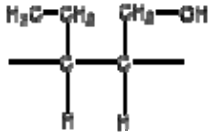
Annotation	Meaning
✓	correct response
×	incorrect response
bod	benefit of the doubt
nbod	benefit of the doubt **not** given
ECF	error carried forward
^	information omitted
I	Ignore
R	Reject

Question			Answer	Marks	Guidance
1	(a)	(i)	 All correct for one mark ✓	1	Any two different symbols can be used to represent the electrons. Candidate does not have to draw circles for electron shells. It **MUST** be clear that a pair of electrons is being shared between the S and each H. **IGNORE** bonds shown as lines.
1	(a)	(ii)	Bent / v–shaped / non-linear ✓ Four pairs of electrons **OR** 2 bonding pairs and 2 lone pairs (around S) ✓ electron (pairs): repel to get as far apart as possible **OR** repel as much as possible **OR** position themselves so they minimise repulsion **OR** repel to produce a tetrahedral arrangement ✓ 109° ✓	4	**DO NOT ALLOW** ecf here for an incorrect diagram in (i) showing no lone pairs. **ALLOW** first marking point for correct diagram **IGNORE** tetrahedral. **ALLOW** ‘areas/groups/regions of electron density’ Must have both repel and distance idea for the mark. **NOT** just ‘lone pairs repel’ / ’atoms repel’ / ‘bonds repel’. **ALLOW** bond angle in the range: 104 – 110° Mark separately. No ecf from earlier marking points.

Question			Answer	Marks	Guidance
1	(b)		The H–S bonds are (slightly) polar **OR** S and H have different electronegativities **OR** H is less electronegative / ∂+ **OR** S is more electronegative / ∂– ✓ (The molecule is) polar because: the charges or dipoles do not balance **OR** centres of negative and positive charges do not coincide **OR** electrons/charges are not evenly distributed **OR** has a positive and a negative side *AW* ✓	2	**NOT** full charges. Can be from a labelled diagram. Must have both polar and a reason. Mark separately.
1	(c)		*In H_2S:* –2 ✓ *In H_2SO_4:* +6 ✓	2	Answer must have sign before number to score both. **ALLOW** one mark for 2– **AND** 6+
1	(d)		Oxygen / O_2 ✓ Oxidation state or number has decreased / changed from 0 to –2 ✓	2	**DO NOT ALLOW** second mark if incorrect oxidation states are given. **ALLOW** gains electrons. Second mark depends on first.
1	(e)	(i)	Burette ✓	1	**ALLOW** minor errors in spelling e.g.: burrete (but not biuret)
1	(e)	(ii)	26.4 x 0.050/1000 = 0.00132 / 1.32 x 10^{-3} ✓	1	**ALLOW** 0.0013
1	(e)	(iii)	Answer to (ii) / 2 (= 0.00066 / 6.6 x 10^{-4}) ✓	1	
1	(e)	(iv)	Answer to (iii) / 20.0 ✓ x 1000 and evaluate (= 0.033 **OR** 3.3 x 10^{-2}) ✓	2	Check that candidates have carried out both ÷ 20 and x 1000 before awarding 2 marks.

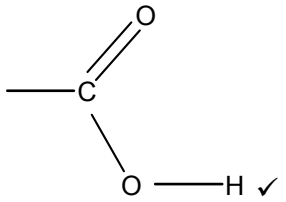
Question			Answer	Marks	Guidance
1	(e)	(v)	Answer to (iv) x 250 /10 (=0.825) ✓ 0.825 to 3 s.f. ✓	2	**ALLOW** s.f. mark for any 3 sig fig answer that follows from any correctly evaluated calculation. A completely correct answer on its own scores both marks, including the s.f. mark.
			Total	**18**	

Question			Answer	Marks	Guidance
2	(a)		Alcohol ✓ Alkene ✓	2	**ALLOW** hydroxyl / hydroxy **ALLOW** C=C **OR** 'carbon–carbon double bond' Additional incorrect answers negate one correct answer.
2	(b)		$C_5H_{10}O$ ✓	1	**ALLOW** elements in any order Do **NOT** allow C_5H_9OH
2	(c)	(i)	(Colour change from) brown/orange/yellow ✓ to colourless ✓	2	**IGNORE** red in the first answer Any combination of these colours but no other should be mentioned (red/brown scores mark) **IGNORE** 'clear' for the second answer Mark separately.
2	(c)	(ii)	answer to (b) + $Br_2 \rightarrow$ answerBr_2 (e.g.: $C_5H_{10}O + Br_2 \rightarrow C_5H_{10}OBr_2$) ✓	1	**ALLOW** elements in any order Answer just Br_2 added anywhere on to structure from (b), no further 'expanding' of formula.
2	(c)	(iii)	Electrophilic ✓ Addition ✓	2	**ALLOW** answers indicated in other ways, such as circling. Each additional underline **CON**s a mark.
2	(d)	(i)	 *E* ✓	1	Candidate can draw structural formula instead of skeletal. **ALLOW** 'C_2H_5' (for '$H_3C–CH_2$') and 'CH_2OH' **BOTH** structure and '*E*' for one mark **ALLOW** ambiguous attachments
2	(d)	(ii)	Rotation not possible around the C=C bond **OR** C=C restricts twisting ✓ two different groups on each carbon of the C=C ✓	2	Mark separately **IGNORE** 'each side / end of C=C'

Question			Answer	Marks	Guidance
2	(e)		 ✓  ✓	2	Candidate can draw skeletal formula instead of structural. **ALLOW** 'C_2H_5' (for '$H_3C–CH_2$') and 'CH_2Cl' **IGNORE** missing hydrogen atoms on structural formulae **ALLOW** ambiguous attachments. Marks are for diagrams of 1,2-dichloropentane and 1,3-dichloropentane.
2	(f)	(i)	 ✓	1	Candidate can draw skeletal formula instead of structural but 'end' bonds must be shown **ALLOW** 'C_2H_5' (for '$H_3C–CH_2$') and 'CH_2OH' **IGNORE** brackets and 'n' **ALLOW** ambiguous attachments

Question			Answer	Marks	Guidance
2	(f)	(ii)	Lone pair on oxygen **OR** oxygen small and electronegative ✓	3	**Please use annotations in the answer in appropriate places.** Can refer to intermolecular forces rather than intermolecular bonds. **NOT** lone pair on oxygen molecule.
			hydrogen with δ+ charge **OR** H polarised in O–H bond ✓		**ALLOW** H polarised in N-H **OR** F-H bond for second mp
			Polymer can also form hydrogen bonds with water ✓		**ALLOW** any of mp 1-3 from a labelled diagram, but QWC can only be scored if there is also a written description.
			*QWC for reason why polymer can form hydrogen bonds with water – as it has OH **OR** alcohol groups* ✓	1	**Please indicate QWC using green tick or red cross on the right on the pencil icon on the answer screen.**

Question			Answer	Marks	Guidance
2	(g)	(i)	(Potassium / sodium) dichromate / chromate / $K_2Cr_2O_7$ / $Na_2Cr_2O_7$ / $Cr_2O_7^{2-}$ ✓ Acidified / (sulfuric) acid / H_2SO_4 / H^+ ✓	2	**IGNORE** dichromate oxidation state if dichromate written in words (**ALLOW** minor spelling error). **IGNORE** formula if correct name is given. **ALLOW** hydrochloric acid / HC*l* / nitric acid / HNO_3 for second mark. **DO NOT ALLOW** the solution acidified with organic acids. **IGNORE** 'concentrated'. **ALLOW** concentrated sulphuric acid with water, but **DO NOT** give credit for **conc.** sulphuric acid as the **only** reagent. Any additional reagent, other than water, negates the dichromate mark, but candidate can still score the acid mark. Mark independently. **IGNORE** reaction conditions.
2	(g)	(ii)	Aldehyde ✓	1	**ALLOW** carbonyl
2	(h)	(i)	To boil a liquid ✓ With a vertical / upright condenser **OR** allowing liquid to drop back into the flask **OR** without liquid boiling away **OR** prevent loss of products (and/or reactants) ✓	2	 **ALLOW** 'no gases escape' Can be scored from a diagram showing flask and vertical condenser. **NOT** prevents evaporating Sealed equipment **CON**s the second mark.

Question			Answer	Marks	Guidance
2	(h)	(ii)	 ✓ Carboxylic acid ✓	2	**ALLOW** 'carboxyl', **NOT** 'carboxylic' without 'acid' **DO NOT ALLOW** –OH for –O–H in structure but must show a single bond from C atom to the rest of the molecule (which can be shown as R).
			Total	**25**	

Question			Answer	Marks	Guidance
3	(a)		*SiO_2*: giant covalent / giant structure / network solid / giant lattice / whole structure held together by covalent bonds, e.g.: every silicon atom is bonded to 4 oxygen atoms **OR** diagram showing at least 2 Si with all surrounding Os ✓ *CO_2*: simple molecular / molecules / O=C=O *AW* ✓ *One from:* a) <u>weak</u> intermolecular bonds in CO_2 b) little/less energy needed to separate molecules (of CO_2) c) bonds in SiO_2 are stronger than CO_2 intermolecular bonds ✓	3	**NOT** giant ionic structure **IGNORE** giant molecule. Reference to 'oxygen molecules' **CON**s this mark Statements that SiO_2 has any type of intermolecular bond **CON**s mp1. **IGNORE** 'covalent'. **IGNORE** 'intermolecular bonds' in SiO_2 in mp3. c) Needs to be a comparison.
3	(b)		***2 from:*** Burning fossil fuels / named fossil fuel / hydrocarbons ✓ Production of cement ✓ Making iron/ making steel ✓ Deforestation *AW* ✓ Fermentation ✓ Oil refining ✓	2	**Must** refer to the process for the mark (e.g.: not just 'fossil fuels') **NOT** just burning fuels in vehicles
3	(c)	(i)	***2 from:*** Burn a fuel from a plant source **OR** an example, e.g.: wood, charcoal, (bio)ethanol, etc (which are carbon neutral) ✓ Use specified alternative energy source, choosing one from: solar energy / wind turbine / nuclear energy / hydroelectric / hydrothermal / wave / geothermal ✓ Improve the efficiency of the process **OR** use a catalyst (so that it needs less energy to run) ✓	2	**NOT** just 'alternative fuel that does not produce greenhouse gases' **ALLOW** 'burn fossil fuels more efficiently' **IGNORE** references to recycling / capturing CO_2

Question			Answer	Marks	Guidance
3	(c)	(ii)	(Capture and storage of the gas would need) lots of equipment / energy / compression **OR** costs would be incurred for: remedying environmental consequences / clearance of land / new or more infrastructure *AW* / specific equipment / larger workforce / space for storage *AW* ✓	1	**IGNORE** reference to CO_2 being gas.
3	(d)	(i)	Infrared (radiation) ✓	1	**ALLOW** 'IR'
3	(d)	(ii)	Makes their <u>bonds</u> vibrate (more) **OR** molecules gain or change in <u>vibrational energy</u> ✓	1	
3	(d)	(iii)	***Either:*** (Vibrational energy) becomes kinetic energy ✓ KE results in increased temp ✓ **OR** the molecules re–emit (some of the absorbed IR) ✓ in all directions ✓	2	Idea of transfer of energy is key here. Mark independently. **ALLOW** 'heat' or 'warmer' for increased temperature. **NOT** 'reflect' for re-emit. Second mark dependant on first in second set of marks

Question			Answer	Marks	Guidance
3	(e)	(i)	Equation 3.1: Equilibrium moves so that more CO_2 aqueous will be formed **OR** equilibrium moves to the right ✓ Equation 3.2: (Increased CO_2 aqueous) moves equilibrium to the right ✓ HCO_3^- (concentration) increases ✓	3	If candidate implies that **both** equation 3.1 and equation 3.2 move to the right, but do not mention equilibrium, they score 1 of the first two marks. If they state this, and use the term equilibrium correctly at least once, they can score both mp1 and 2. One of mp 1 and 2 can be scored if the candidate states that 'the equilibrium moves to the right', but it is not clear which reaction they are referring to.
3	(e)	(ii)	System is not closed **OR** CO_2 moves away from the surface **OR** specific example of input or output of CO_2 ✓	1	**ALLOW** 'not a sealed system' or 'it is an open system'.
3	(f)	(i)	$O_2 \rightarrow 2O$ **OR** $O_2 \rightarrow O + O$ ✓ $O + O_2 \rightarrow O_3$ ✓	2	**IGNORE** dots **ALLOW** multiples
3	(f)	(ii)	High frequency radiation **OR** high energy radiation **OR** uv only present in the stratosphere / not in troposphere *AW* ✓ (energy is needed for) bonds in O_2 to be broken **OR** O radicals are formed **OR** (photo)dissociation / photolysis / breakdown of O_2 **OR** homolytic fission / homolysis of O_2 ✓	2	**ALLOW** a specific frequency is needed Mark separately
3	(g)	(i)	$O_3 + O \rightarrow 2O_2$ **OR** $O_3 + O \rightarrow O_2 + O_2$ ✓	1	**IGNORE** state symbols
3	(g)	(ii)	(Catalyst) is in the same phase/state(gases) as the reactants ✓ NO is not used up in the reaction / NO is reformed / NO is regenerated / NO is recycled / NO is (chemically) unchanged ✓	2	**ALLOW** 'it' for NO. **ALLOW** 'does not appear in the overall equation' AW.
			Total	**23**	

Question			Answer	Marks	Guidance
4	(a)	(i)	Propagation ✓	1	
4	(a)	(ii)	It filters / screens / absorbs / removes / prevents / shields / blocks (AW) uv ✓ (uv) of high energy **OR** high frequency / short wavelength ✓ which could otherwise cause skin cancer / damage to DNA / damage to eyes / damage to immune system / cell mutation / affects crops / premature ageing of the skin ✓	3	**IGNORE** protects us from uv **IGNORE** high intensity radiation **ALLOW** UVC/ UVB/ 10^{16} Hz/ 200–320nm **IGNORE** skin damage.
4	(b)		*For CCl_2F_2:* low boiling point ✓ *For CCl_2FCClF_2:* low reactivity **OR** low boiling point ✓	2	
4	(c)	(i)	F radicals not formed (in stratosphere) **OR** HFCs not broken down (in stratosphere) ✓ because of the stronger C–F bond **OR** C–F needs more energy to break **OR** uv not high enough frequency to break C-F **OR** uv not high enough energy to break C–F ✓	2	**ALLOW** HFCs were already broken down in the troposphere. **IGNORE** references to being unreactive. **IGNORE** 'C-F bond is unreactive'.
4	(c)	(ii)	*Advantage:* Same essential properties to the CFC they are to replace **OR** they are broken down in the troposphere ✓ *Disadvantage – **one** of:* (they are also) greenhouse / global warming gases **OR** expensive (to make) **OR** form HF (as a breakdown product) ✓	2s	 **IGNORE** less effective

Question			Answer	Marks	Guidance
4	(d)	(i)	The F in the molecule has a <u>lone pair</u> of electrons ✓ that it can donate (to the δ+ charged carbon atom) **AND** forms a (covalent) <u>bond</u> ✓	2	**ALLOW** 'HF' or 'it' for 'F in the molecule' Second mpt must be in the context of an electron pair donated. Mark independently
4	(d)	(ii)	Catalyst provides an alternative pathway ✓ with a lower activation enthalpy ✓	2	
			Total	**14**	

Question			Answer	Marks	Guidance
5	(a)		A particle with an unpaired electron ✓ Homolytic (bond breaking) / homolysis ✓ Example, one from: Oxygen <u>molecule</u> / O_2 / chlorine <u>atom</u> / C*l* / ozone / O_3 ✓	3	**IGNORE** 'free' or 'lone' or 'single' electron **ALLOW** atom / molecule / ion / species for 'particle' OR 'a radical has an unpaired electron' DO **NOT** ALLOW 'IS an unpaired electron'. **IGNORE** radicals that are not in the article. Additional answers that are not radicals **CON** a correct answer. **ALLOW** a correct equation showing the formation of a radical from the article.
5	(b)		$2ClO_3^- + 4H^+ + 2Cl^- \rightarrow 2ClO_2 + Cl_2 + 2H_2O$ ✓✓	2	No other species should be present in the equation. **ALLOW** $2ClO_3^- + 4HCl \rightarrow 2ClO_2 + Cl_2 + 2Cl^- + 2H_2O$ for both marks. One mark can be scored for ClO_3^- as a reactant.

Question			Answer	Marks	Guidance
5	(c)		Chlorine dioxide has polar bonds **OR** chlorine dioxide is a polar molecule **OR** chlorine dioxide has a permanent dipole ***ORA*** for chlorine ✓ Chlorine dioxide forms permanent (dipole)–permanent dipole (bonds) ✓ Chlorine forms instantaneous (dipole) – induced dipole (bonds) (*QWC underlined term must be correctly spelled the first time it appears*) ✓ which are much weaker than permanent dipole–permanent dipole bonds **OR** less energy needed to overcome instantaneous dipole – induced dipole bonds than permanent dipole – permanent dipole bonds *ORA* ✓	4	**ALLOW** chlorine and oxygen have different electronegativities **OR** O slightly negative / C*l* slightly positive **ALLOW** 'forces' for 'bonds' **ALLOW** van der Waals (ignore capitals) forces, but it must be spelled correctly. Award this for any indication that imb are stronger in ClO_2 than Cl_2, even if not named or incorrectly named (e.g.: hydrogen bonds in ClO_2).
5	(d)	(i)	Propene / propyne (or formulae) ✓ Because they have a high density of electrons (for the ClO_2 to attack) **OR** they are electron rich ✓	2	**ALLOW** prop-1,2-diene / CH_2CCH_2 Mark independently.
5	(d)	(ii)	It gains electron(s) **OR** C*l* changes from +4 to –1 / C*l* changes from +4 to +3 **OR** C*l* oxidation state decreases ✓	1	**IGNORE** ClO_2 oxidation number decreases.
5	(e)		Available chlorine in ClO_2 is given by: 35.5 / (35.5 + 2 x 16) (= 0.526) **OR** 35.5 / (67.5) (= 0.526) ✓ Answer x 5 (= 2.63) x 100 to make it a percentage and evaluated (= 262.96 / 263%) ✓	2	**ALLOW** 2 or more sfs, **correctly rounded**.

Question			Answer	Marks	Guidance
5	(f)		**FIVE from:** 1. Less ClO_2 needed (for disinfection) ✓ 2. Chlorine reacts by addition **OR** substitution reactions *ORA* ✓ 3. Chlorine forms (potentially) toxic chlorinated products **OR** (potentially) toxic products with chlorine atoms *ORA* ✓ 4. Chlorine dioxide is more soluble *ORA* ✓ 5. Chlorine oxidises organics to aldehydes/ketones *ORA* ✓ 6. ClO_2 forms fewer (disinfection) by-products / fewer harmful products ✓ 7. ClO_2 removes/disinfects bio-films *ORA* ✓ 8. ClO_2 is more effective against pathogens/anthrax ✓ *QWC for inclusion of **ONE** chemical theory in explanations of the comparisons e.g.:* • *explaining mp1 in terms of greater available chlorine **OR** electrons transferred **OR** greater oxidation capacity;* • *linking mp2 with mp3;* • *explain mp 4 with <u>hydrogen</u> bonding to water* • *giving examples of organic compounds (e.g.: alcohols) converted to aldehydes/ketones* • *example of bromide to bromate to go with mpt 6* ✓	5 1	**ALLOW** 'active at low concentrations' **ALLOW** 'more powerful disinfectant' 5. Both oxidising organics and products are needed. 8. **ALLOW** viruses, bacteria, protozoa, micro-organisms. **Please use annotations in the answer in appropriate places.** **Please indicate QWC using a tick at the appropriate point in the candidate's answer.**
			Total	**20**	

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