

# **Chemistry B (Salters)**

Advanced Subsidiary GCE

Unit **F332**: Chemistry of Natural Resources

## **Mark Scheme for January 2013**

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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.

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## Annotations

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
<u>    </u>	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:

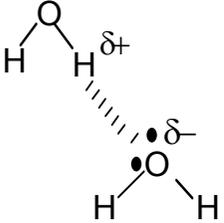
Annotation	Meaning
	correct response
	incorrect response
	benefit of the doubt
	benefit of the doubt <b>not</b> given
	error carried forward
	information omitted
	Ignore
	Reject

Question			Answer	Marks	Guidance
					<b>Please put a tick on every answer at all points in the text where credit has been gained (one tick per mark).</b>
1	(a)	(i)	<p><i>Two from:</i></p> <p>Refining oil ✓            Generating electricity ✓            Processes in a petrochemical plant ✓            Producing steel / iron ✓            Heating limestone / making cement ✓            Fermentation ✓</p>	2	<p><b>ALLOW</b> burning a fossil fuel provided it is the context of another industrial activity (e.g. in a factory)  <b>IGNORE</b> deforestation</p>
1	(a)	(ii)	<p><i>Any <b>two</b> from:</i></p> <p>React the CO<sub>2</sub> with lime / other suitable named solid ✓            Disposal in an old mine / old oil or gas well / other suitable disposal site ✓            Pump it / bury it under the ocean ✓</p>	2	<p><b>ALLOW</b> removal of CO<sub>2</sub> via reactions at source. (e.g. 'react the CO<sub>2</sub> before it is released')  <b>IGNORE</b> 'Pump into rocks' and 'in a container'</p> <p><b>DO NOT ALLOW</b> 'pump it <u>into</u> the ocean' in place of under  <b>DO NOT ALLOW</b> just 'pump it underground'</p>
1	(b)		<p>SiO<sub>2</sub>: giant covalent / network / lattice / whole structure held together by covalent bonds / diagram ✓</p> <p>CO<sub>2</sub>: simple molecular / molecules / O=C=O AW ✓</p> <p><i>Comparison of forces – one from:</i>  <u>weaker</u> intermolecular bonds (or forces) in CO<sub>2</sub></p> <p>less energy needed to separate molecules of CO<sub>2</sub></p> <p>bonds in SiO<sub>2</sub> are stronger than CO<sub>2</sub> intermolecular bonds (or forces) ✓</p>	3	<p><b>IGNORE</b> 'intermolecular bonds' in SiO<sub>2</sub> / giant molecule / giant structure / just 'covalent'.            Marks can be given for a labelled/annotated diagram</p> <p>Any type of intermolecular bonds can be named and can be abbreviated. It must be clear that the intermolecular bonds in CO<sub>2</sub> are being discussed, not the covalent bonds  <b>IGNORE</b> intermolecular bonds in SiO<sub>2</sub></p>

Question			Answer	Marks	Guidance
1	(c)	(i)	Makes their <u>bonds</u> vibrate <b>OR</b> Molecules change in <u>vibrational</u> energy ✓	1	
1	(c)	(ii)	<b>Either:</b>  (vibrational energy) becomes kinetic energy ✓ KE results in increased temperature ✓ <b>OR</b> the molecules re-emit (some of the absorbed IR), ✓ in all directions ✓	2	Idea of transfer of energy is key here.  In the <b>Either option</b> , mark independently <b>ALLOW</b> 'heat' or 'warmer' for increased temperature  <b>NOT</b> reflect for re-emit In the <b>OR</b> option 2nd mark depends on 1st
1	(d)		$(395 / 1,000,000) \times 100 =$ $3.95 \times 10^{-2} / 0.0395$ ✓	1	<b>ALLOW</b> any number of sf.
1	(e)	(i)	Hydrogencarbonate ✓	1	<b>ALLOW</b> hydrogen carbonate <b>IGNORE</b> incorrect oxidation states
1	(e)	(ii)	Rate of forward reaction = rate of back reaction <b>OR</b> reactants and products are formed at the same rate ✓  <u>Concentrations</u> of reactants and products remain constant <b>OR</b> closed system ✓	2	Mark independently  <b>DO NOT ALLOW</b> concentrations of reactants and products are the same/equal
1	(e)	(iii)	System is not closed <b>OR</b> CO <sub>2</sub> moves away from the surface <b>OR</b> specific example of input or output of CO <sub>2</sub> ✓	1	<b>ALLOW</b> ' <u>not</u> a sealed system'
1	(e)	(iv)	CO <sub>3</sub> <sup>2-</sup> (concentration) decreases ✓  <u>Equilibrium</u> (position) moves to left / towards reactants / towards hydrogencarbonate ✓	2	<b>MUST</b> mention <b>equilibrium</b> for the second mark Mark independently
1	(e)	(v)	CO <sub>2</sub> + H <sub>2</sub> O ⇌ 2H <sup>+</sup> + CO <sub>3</sub> <sup>2-</sup> ✓	1	<b>IGNORE</b> state symbols <b>DO NOT ALLOW</b> H <sub>2</sub> CO <sub>3</sub> on right hand side

Question			Answer	Marks	Guidance
1	(f)	(i)	$\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$ Equation ✓ State symbols ✓	2	Completely correct equation (i.e. without spectator ions) scores the first mark  Mark state symbols separately – must have the idea of $(\text{aq}) + (\text{aq}) \rightarrow (\text{s})$
1	(f)	(ii)	$M_r(\text{SO}_4^{2-}) = (32.1 + 4 \times 16) = 96.1$ ✓ $0.000074 \times M_r = 7.1(11) \times 10^{-3} \text{ g dm}^{-3}$ ✓  $7.1 \times 10^{-3}$ for s.f. mark ✓	3	<b>ALLOW</b> $M_r = 96$  Apply ecf for mass of sulfate from an incorrect $M_r$ value. <b>DO NOT</b> award second mark if another incorrect calculation follows $0.000074 \times M_r$  Award sf mark for an answer that is the correct 2sf value of a <u>shown calculation</u>  The correct answer on its own scores all marks
1	(f)	(iii)	Barium carbonate would precipitate out / solid barium carbonate forms / barium carbonate is insoluble ✓	1	
<b>Total</b>				<b>24</b>	

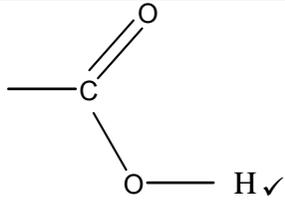
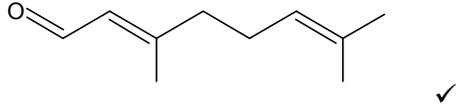
Question			Answer	Marks	Guidance
2	(a)		UV / radiation (in troposphere) does not have enough energy <b>OR</b> UV / radiation / energy (in troposphere) is not high enough frequency <b>OR</b> Bonds are too strong to be broken by the UV / radiation / energy ✓	1	<b>ALLOW</b> 'photon density in the troposphere is insufficient'
2	(b)	(i)	$(290 / 6.02 \times 10^{23}) \times 1000$ <b>AND</b> evaluate  $= 4.817 / 4.82 / 4.8 \times 10^{-19} \text{ J}$ ✓✓  $290 \times 1000$ ✓ <b>OR</b> $290 / 6.02 \times 10^{23}$ ✓	2	A completely correct answer on its own scores both marks  One mark is for converting 290 from kJ to J, i.e. multiply by 1000, the other mark is for dividing by $6.02 \times 10^{23}$ (the Avogadro constant) – in either order
2	(b)	(ii)	Answer to (b)(i) (rounded or not rounded) / $6.63 \times 10^{-34}$ ✓  $= 7.266 / 7.27 / 7.3 \times 10^{14}$ ✓	2	<b>DO NOT ALLOW</b> second mark for evaluating any other expression e.g. Answer to (b)(i) $\times 6.63 \times 10^{-34}$  A completely correct answer on its own scores both marks
2	(c)	(i)	Permanent dipole–(permanent) dipole ✓  Instantaneous dipole – induced dipole ✓	2	<b>DO NOT ALLOW</b> pd-pd  <b>ALLOW</b> van der Waals'  <b>DO NOT ALLOW</b> 'id-id'

Question			Answer	Marks	Guidance
2	(c)	(ii)	 <p>Hydrogen bond between correct atoms of two correctly drawn water molecules ✓</p> <p>Lone pair on relevant O in line with H bond ✓</p> <p>Partial charges as shown ✓</p> <p>O–H–O straight ✓</p>	4	<p>Hydrogen bond can be shown in other forms, but <b>NOT</b> as a solid line</p> <p>Second mark, but <b>NOT</b> third mark, can be scored if the hydrogen bond is between incorrect atoms</p> <p>If answer is completely correct except that H-bond is not shown, award 2 marks</p>
2	(c)	(iii)	Nitrogen, oxygen, fluorine ✓	1	<p><b>ALLOW</b> N, O, F</p> <p><b>IGNORE</b> C, P, S, Cl, Se, Br, I</p>
2	(d)	(i)	<p>Intermolecular bonds in chloromethane are weaker ORA</p> <p><b>OR</b></p> <p>Less energy needed to break intermolecular bonds in chloromethane ORA ✓</p>	1	<p>Answer must be a comparison</p> <p><b>ALLOW</b> 'it' for chloromethane'</p> <p><b>IGNORE</b> less / fewer IMB</p> <p><b>IGNORE</b> references to specific types of intermolecular bond</p>
2	(d)	(ii)	<p>IMB in bromomethane are stronger ORA</p> <p><b>OR</b></p> <p>More energy needed to break intermolecular bonds in bromomethane ✓</p> <p>because (bromomethane or Br) has more electrons / bromomethane molecules bigger / bromine atoms bigger / higher <math>A_r</math> for Br / higher <math>M_r</math> for <math>\text{CH}_3\text{Br}</math> ✓</p>	2	<p><b>ALLOW</b> 'it' for bromomethane'</p> <p><b>DO NOT ALLOW</b> if bond polarity is included in the reason (i.e. it must be id-id being described)</p> <p><b>IGNORE</b> more IMB</p> <p>Mark independently</p>

Question			Answer	Marks	Guidance
2	(e)		<pre>       x x     x  O  x  H       x x           ✓           </pre>	1	Any <u>two</u> different symbols can be used to represent the electrons Candidate can draw circles for electron shells It <b>MUST</b> be clear that a pair of electrons is being shared between the H and the O <b>IGNORE</b> inner shell electrons <b>DO NOT ALLOW</b> diagram showing a charge
2	(f)	(i)	$\text{CH}_3\text{Cl} + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{OH} + \text{HCl}$ ✓	1	<b>ALLOW</b> multiples <b>ALLOW</b> $\text{CH}_4\text{O}$ for methanol formula
2	(f)	(ii)	Methanol ✓	1	<b>DO NOT ALLOW</b> ecf from (f)(i) <b>ALLOW</b> methan-1-ol
2	(f)	(iii)	Nucleophilic ✓ Substitution ✓	2	Any clear indication scores the marks (e.g. ringed)  More than two indicated: each additional incorrect answer indicated <b>CONS</b> a correct answer
2	(g)	(i)	C–Cl, because Cl has a greater <u>electronegativity</u> than Br ORA OR C–Cl, because there is a greater <u>difference in electronegativity</u> between C and Cl (than between C and Br) ✓	1	Answer must be a comparison  The word ‘electronegativity’ or ‘electronegative’ must be correctly spelled for the mark to be awarded
2	(g)	(ii)	C–Cl, because Cl atoms are smaller (than Br atoms) / bonding electrons are closer to the Cl nucleus / C–Cl bonds are shorter (than C–Br bonds) ✓	1	Answer must be a size comparison <b>MUST</b> have C–Cl <b>AND</b> reason for the mark <b>ALLOW</b> ‘less shielding in chlorine’ ORA
2	(g)	(iii)	As the weaker C–Hal bond in bromomethane makes it react faster ORA <b>OR</b> the chloromethane reacts more slowly and has the more polar bond ORA ✓	1	<b>ALLOW</b> ‘reacts more easily’ in place of ‘reacts faster’ <b>ALLOW</b> mark for ‘the stronger the (C–Hal) bond, the more energy is needed to break it’ if they have identified C–Cl as the stronger bond in 2(g)(ii)
<b>Total</b>				<b>23</b>	

Question			Answer	Marks	Guidance								
3	(a)	(i)	[Ne] 3s <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td>↑↓</td></tr></table> 3p <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td>↑↓</td><td>↑</td><td>↑</td></tr></table> ✓	↑↓	↑↓	↑	↑	1	<b>ALLOW</b> single arrows in any 3p atomic orbitals pointing up or down <b>ALLOW</b> use of other arrow symbols (such as 1, as long as – in each box that contains a pair– one points up and one down)				
↑↓													
↑↓	↑	↑											
3	(a)	(ii)	Acid rain ✓		<b>ALLOW</b> particulate formation <b>ALLOW</b> 'industrial smog' <b>DO NOT ALLOW</b> just 'smog'								
3	(b)	(i)	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>SO<sub>2</sub></td> <td>+4</td> <td>SO<sub>4</sub><sup>2-</sup></td> <td>+6</td> </tr> <tr> <td>I<sub>2</sub></td> <td>0</td> <td>I<sup>-</sup></td> <td>-1</td> </tr> </table> <p>One mark for <b>both</b> I oxidation states ✓ One mark for <b>each</b> correct oxidation state for S ✓✓</p>	SO <sub>2</sub>	+4	SO <sub>4</sub> <sup>2-</sup>	+6	I <sub>2</sub>	0	I <sup>-</sup>	-1	3	<b>ALLOW</b> 2 marks if all number values are correct, but sign is to the right of the number (ie: 0, 1-, 4+, 6+)  <b>ALLOW</b> 1 mark for S if answer gives 4 <u>and</u> 6, but no +
SO <sub>2</sub>	+4	SO <sub>4</sub> <sup>2-</sup>	+6										
I <sub>2</sub>	0	I <sup>-</sup>	-1										
3	(b)	(ii)	<p><i>Reducing agent:</i> SO<sub>2</sub> ✓</p> <p><i>Explanation:</i> The oxidation number of the S (in SO<sub>2</sub>) increases <b>OR</b> the SO<sub>2</sub> reduces the oxidation number of the I (in I<sub>2</sub>) <b>OR</b> (SO<sub>2</sub> is) oxidised to SO<sub>4</sub><sup>2-</sup> ✓</p>	2	<b>ALLOW</b> sulphur dioxide  <b>ALLOW</b> 'S / SO <sub>2</sub> is oxidised' <b>OR</b> 'SO <sub>2</sub> loses / donates electrons' <b>IGNORE</b> sulphur / S has lost electrons <b>ALLOW</b> 'I <sub>2</sub> is reduced' <b>OR</b> 'iodine gains electrons' <b>ALLOW</b> 'number' for 'state' 2 <sup>nd</sup> mark can be scored if S is incorrectly given as the reducing agent, otherwise <b>2<sup>nd</sup> mark depends on first</b>								
3	(b)	(iii)	Grey / black solid ✓	1	Both colour and 'solid' needed for mark Any combination of these colours but no others <b>IGNORE</b> shades of colour, like dark or pale								

Question			Answer	Marks	Guidance
3	(c)	(i)	Burette ✓	1	<b>ALLOW</b> small spelling error (e.g.: 2 rs or one t) <b>NOT</b> biuret
3	(c)	(ii)	$15.8 \times 0.0100 / 1000 = 0.000158 / 1.58 \times 10^{-4}$ ✓	1	
3	(c)	(iii)	Answer to (ii) (= $0.000158 / 1.58 \times 10^{-4}$ ) ✓	1	
3	(c)	(iv)	Answer to (iii) / 50 $\times 1000 (= 0.00316 / 3.16 \times 10^{-3})$ ✓	1	<b>ALLOW</b> any number of sf
3	(c)	(v)	<i>Any ONE from:</i>  If answer (c)(iv) below $1.56 \times 10^{-4} \text{ mol dm}^{-3}$ then wine not preserved ✓  If answer (c)(iv) between $1.56 \times 10^{-4}$ and $3.28 \times 10^{-3} \text{ mol dm}^{-3}$ then wine is preserved / below (legal) limit ✓  If answer (c)(iv) above $3.28 \times 10^{-3} \text{ mol dm}^{-3}$ then taste of wine is affected / above (legal) limit ✓	1	Comment will depend upon the answer from (c) (iv)
3	(d)		An (acid-base) indicator changes colour (at the end-point) ✓	1	<b>DO NOT ALLOW</b> just 'use an acid-base indicator' or named indicator or just 'there is a colour change' <b>IGNORE</b> a specific incorrect colour change for a named indicator
<b>Total</b>				<b>14</b>	

Question			Answer	Marks	Guidance
4	(a)	(i)	Ketone ✓	1	<b>DO NOT ALLOW</b> cycloalkane
4	(a)	(ii)	Alkene ✓	1	<b>ALLOW</b> 'carbon-carbon double bond'
4	(b)	(i)	 Carboxylic acid ✓	2	<b>ALLOW</b> 'carboxyl' but not 'carboxylic' <b>IGNORE</b> anything attached to the left of the C <b>ALLOW</b> structure with nothing attached to C Diagram must show O-H bond
4	(b)	(ii)	Only neral should be ticked ✓	1	Any clear indication scores the mark More than one ticked: scores zero <b>ALLOW</b> x ✓x
4	(c)	(i)		1	Candidate can draw structural formula instead of skeletal
4	(c)	(ii)	Rotation not possible around the C=C bond <b>OR</b> C=C restricts twisting ✓ It contains a C=C with <u>two</u> different groups on each carbon ✓	2	Mark separately <b>IGNORE</b> 'each side / end of C=C' <b>ALLOW</b> 'it contains a C=C with four different groups'
4	(d)		Thujone ✓	1	
4	(e)	(i)	High temperature <b>AND</b> pressure ✓	1	<b>ALLOW</b> temps 200 – 400°C <b>ALLOW</b> pressures of 50 – 70 atm <b>IGNORE</b> any chemicals <b>DO NOT ALLOW</b> mark if 'reflux' given

Question			Answer	Marks	Guidance
4	(e)	(ii)		4	<p><b>ALLOW</b> one mark for each pair of correct structures that show only one of the C=C having reacted. In this case put ✓ and ECF</p> <p><b>ALLOW</b> a mark if there are two structures with 2 OH groups in correct places, but the same error in the remainder of the molecule</p>
			✓		
			✓		
			✓		
			✓		
			✓		

Question		Answer	Marks	Guidance
4	(f)	<p>1. Both compounds (AW) decolourise bromine <b>OR</b> turns from yellow/orange/brown to colourless ✓</p> <p>2. because they are alkenes / have C=C / are unsaturated ✓</p> <p>3. More drops required for neral than citronellal (ORA) ✓</p> <p>4. because neral has twice as many double bonds as citronellal (ORA) / neral is more unsaturated ✓</p> <p><i>QWC for: Linking mp 1 with mp 2 <b>OR</b> linking mp 3 with mp 4 ✓</i></p>	5	<p><b>Please use a range of annotations in the answer in appropriate places.</b></p> <p>MP1: <b>IGNORE</b> red or combinations including red for bromine water colour. <b>DO NOT ALLOW</b> 'clear' for 'colourless'</p> <p>MP2 <b>ALLOW</b> mark if bromine reacts because it is a test for unsaturation</p> <p>MP3: <b>ALLOW</b> 'more bromine water is needed' or similar wording <b>IGNORE</b> comments relating to the speed of the reaction</p> <p>MP4: <b>ALLOW</b> 'It has more double bonds' (ORA)</p> <p><b>Please indicate QWC using green tick or red cross on the right of the pencil icon on the answer screen.</b></p>
<b>Total</b>			<b>19</b>	

Question			Answer	Marks	Guidance
5	(a)		Propagation: one radical is used and replaced by another (AW) ✓  Reaction 6 <b>OR</b> 7 <b>OR</b> 8 ✓	2	<b>ALLOW</b> there is a radical on both sides of the equation  Mark independently
5	(b)	(i)	(Fig. 1 shows) O <sub>3</sub> with double bond and single bond / O <sub>3</sub> with one bond of 4 electrons and one of 2 electrons ✓  Both bonds in O <sub>3</sub> are same length and so cannot be of different types <b>OR</b> all bonds are equivalent <b>OR</b> bonds would be different lengths ✓	2	<b>ALLOW</b> 2 marks for: 'The double bond would be shorter than the single bond' <b>OR</b> 'The bonds are not the same length if double and single'
5	(b)	(ii)	Three regions of electrons around <u>central</u> O <b>OR</b> three regions of electron density around <u>central</u> O <b>OR</b> two sets of bonding electrons and one lone pair around <u>central</u> O AW ✓  Regions of electrons repel to get as far apart as possible ✓	2	Answer needs to make clear that it is the central O being considered (e.g. 'there is a double bond, a single bond and a lone pair around the oxygen')  Mark independently
5	(c)	(i)	(At higher altitudes) there is more UV ✓  with high enough frequency to break bond / high enough energy to break bond / low enough wavelength to break bond <b>OR</b> with high enough frequency to photodissociate molecule / high enough energy to photodissociate molecule / low enough wavelength to photodissociate molecule ✓	2	<b>ALLOW</b> 'more radiation' <b>OR</b> 'UV is more intense'  <b>ALLOW</b> reverse argument at lower altitude
5	(c)	(ii)	Particles are closer together <b>OR</b> concentration increases AW ✓  so particles collide more frequently / more successful collisions per second ✓	2	<b>DO NOT ALLOW</b> reactants for particles  <b>ALLOW</b> 'atoms' or 'molecules' for 'particles' <b>DO NOT ALLOW</b> 'there is a greater chance of collisions'

Question			Answer	Marks	Guidance
5	(c)	(iii)	Reaction 1 is faster at higher altitudes, reaction 2 is faster near the ground <b>OR</b> there is enough <u>UV</u> and enough pressure ✓	1	
5	(d)		High energy UV ✓  (which could otherwise cause) <u>skin</u> cancer / damage to DNA / damage to <u>skin</u> / damage to eyes / damage to immune system / cell mutation / affects crops ✓	2	<b>DO NOT ALLOW</b> high intensity radiation <b>ALLOW</b> UVC / UVB / $10^{16}$ Hz / 200-320 nm  <b>ALLOW</b> sunburn



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