

Chemistry B (Salters)

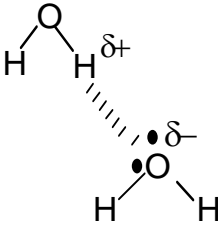
Mark Scheme

Question			Answer	Marks	Guidance
					Please put a tick on every answer at all points in the text where credit has been gained (one tick per mark).
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>ALLOW burning a fossil fuel provided it is the context of another industrial activity (e.g. in a factory) IGNORE deforestation</p>
1	(a)	(ii)	<p><i>Any two from:</i></p> <p>React the CO₂ with lime / other suitable named solid ✓</p> <p>Disposal in an old mine / old oil or gas well / other suitable disposal site ✓</p> <p>Pump it / bury it under the ocean ✓</p>	2	<p>ALLOW removal of CO₂ via reactions at source. (e.g. 'react the CO₂ before it is released') IGNORE 'Pump into rocks' and 'in a container'</p> <p>DO NOT ALLOW 'pump it <u>into</u> the ocean' in place of under DO NOT ALLOW just 'pump it underground'</p>
1	(b)		<p>SiO₂: giant covalent / network / lattice / whole structure held together by covalent bonds / diagram ✓</p> <p>CO₂: simple molecular / molecules / O=C=O AW ✓</p> <p><i>Comparison of forces – one from:</i> <u>weaker</u> intermolecular bonds (or forces) in CO₂</p> <p>less energy needed to separate molecules of CO₂</p> <p>bonds in SiO₂ are stronger than CO₂ intermolecular bonds (or forces) ✓</p>	3	<p>IGNORE 'intermolecular bonds' in SiO₂ / 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 CO₂ are being discussed, not the covalent bonds IGNORE intermolecular bonds in SiO₂</p>

Question			Answer	Marks	Guidance
1	(c)	(i)	Makes their <u>bonds</u> vibrate OR Molecules change in <u>vibrational</u> energy ✓	1	
1	(c)	(ii)	Either: (vibrational energy) becomes kinetic energy ✓ KE results in increased temperature ✓ OR the molecules re-emit (some of the absorbed IR), ✓ in all directions ✓	2	Idea of transfer of energy is key here. In the Either option , mark independently ALLOW 'heat' or 'warmer' for increased temperature NOT reflect for re-emit In the OR option 2nd mark depends on 1st
1	(d)		$(395 / 1,000,000) \times 100 =$ $3.95 \times 10^{-2} / 0.0395$ ✓	1	ALLOW any number of sf.
1	(e)	(i)	Hydrogencarbonate ✓	1	ALLOW hydrogen carbonate IGNORE incorrect oxidation states
1	(e)	(ii)	Rate of forward reaction = rate of back reaction OR reactants and products are formed at the same rate ✓ <u>Concentrations</u> of reactants and products remain constant OR closed system ✓	2	Mark independently DO NOT ALLOW concentrations of reactants and products are the same/equal
1	(e)	(iii)	System is not closed OR CO ₂ moves away from the surface OR specific example of input or output of CO ₂ ✓	1	ALLOW ' <u>not</u> a sealed system'
1	(e)	(iv)	CO ₃ ²⁻ (concentration) decreases ✓ <u>Equilibrium</u> (position) moves to left / towards reactants / towards hydrogencarbonate ✓	2	MUST mention equilibrium for the second mark Mark independently
1	(e)	(v)	CO ₂ + H ₂ O ⇌ 2H ⁺ + CO ₃ ²⁻ ✓	1	IGNORE state symbols DO NOT ALLOW H ₂ CO ₃ 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 (aq) + (aq) → (s)
1	(f)	(ii)	$M_r(\text{SO}_4^{2-}) = (32.1 + 4 \times 16) = 96.1$ ✓ $0.000074 \times M_r = 7.1(11) \times 10^{-3} \text{ g dm}^{-3}$ ✓ <i>7.1 x 10⁻³ for s.f. mark</i> ✓	3	ALLOW $M_r = 96$ Apply ecf for mass of sulfate from an incorrect M_r value. DO NOT 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	
			Total	24	

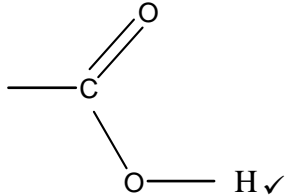
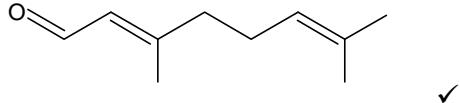
Question			Answer	Marks	Guidance
2	(a)		UV / radiation (in troposphere) does not have enough energy OR UV / radiation / energy (in troposphere) is not high enough frequency OR Bonds are too strong to be broken by the UV / radiation / energy ✓	1	ALLOW 'photon density in the troposphere is insufficient'
2	(b)	(i)	$(290 / 6.02 \times 10^{23}) \times 1000$ AND evaluate $= 4.817 / 4.82 / 4.8 \times 10^{-19} \text{ J}$ ✓✓ 290×1000 ✓ OR $290 / 6.02 \times 10^{23}$ ✓	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 6.02×10^{23} (the Avogadro constant) – in either order
2	(b)	(ii)	Answer to (b)(i) (rounded or not rounded) / 6.63×10^{-34} ✓ $= 7.266 / 7.27 / 7.3 \times 10^{14}$ ✓	2	DO NOT ALLOW 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	DO NOT ALLOW pd-pd ALLOW van der Waals' DO NOT ALLOW 'id-id'

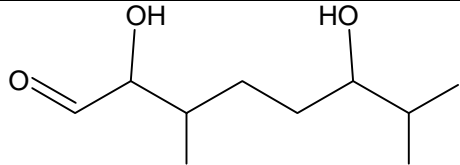
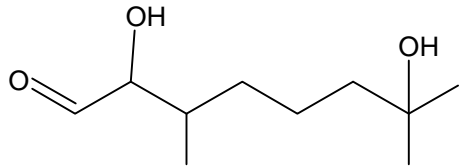
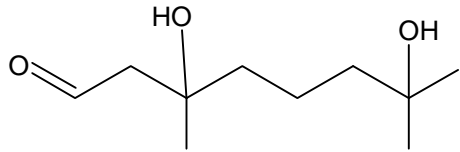
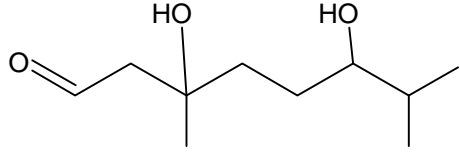

Question			Answer	Marks	Guidance
2	(c)	(ii)	 <p>Hydrogen bond between correct atoms of two correctly drawn water molecules ✓</p> <p>Lone pair on relevant O in line with H bond ✓</p> <p>Partial charges as shown ✓</p> <p>O–H–O straight ✓</p>	4	<p>Hydrogen bond can be shown in other forms, but NOT as a solid line</p> <p>Second mark, but NOT 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>ALLOW N, O, F</p> <p>IGNORE C, P, S, Cl, Se, Br, I</p>
2	(d)	(i)	<p>Intermolecular bonds in chloromethane are weaker ORA</p> <p>OR</p> <p>Less energy needed to break intermolecular bonds in chloromethane ORA ✓</p>	1	<p>Answer must be a comparison</p> <p>ALLOW 'it' for chloromethane'</p> <p>IGNORE less / fewer IMB</p> <p>IGNORE references to specific types of intermolecular bond</p>
2	(d)	(ii)	<p>IMB in bromomethane are stronger ORA</p> <p>OR</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 A_r for Br / higher M_r for CH_3Br ✓</p>	2	<p>ALLOW 'it' for bromomethane'</p> <p>DO NOT ALLOW if bond polarity is included in the reason (i.e. it must be id-id being described)</p> <p>IGNORE 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 MUST be clear that a pair of electrons is being shared between the H and the O IGNORE inner shell electrons DO NOT ALLOW 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	ALLOW multiples ALLOW CH_4O for methanol formula
2	(f)	(ii)	Methanol ✓	1	DO NOT ALLOW ecf from (f)(i) ALLOW 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 CONs a correct answer
2	(g)	(i)	C–Cl, because Cl has a greater <u>electronegativity</u> than Br OR OR C–Cl, because there is a greater difference in <u>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 MUST have C–Cl AND reason for the mark ALLOW ‘less shielding in chlorine’ ORA
2	(g)	(iii)	As the weaker C–Hal bond in bromomethane makes it react faster ORA OR the chloromethane reacts more slowly and has the more polar bond ORA ✓	1	ALLOW ‘reacts more easily’ in place of ‘reacts faster’ ALLOW 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)
			Total	23	

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	ALLOW single arrows in any 3p atomic orbitals pointing up or down ALLOW 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 ✓		ALLOW particulate formation ALLOW ‘industrial smog’ DO NOT ALLOW just ‘smog’								
3	(b)	(i)	<table border="1" style="margin-bottom: 10px;"><tr><td>SO₂</td><td>+4</td><td>SO₄²⁻</td><td>+6</td></tr><tr><td>I₂</td><td>0</td><td>I⁻</td><td>-1</td></tr></table> <p>One mark for both I oxidation states ✓ One mark for each correct oxidation state for S ✓✓</p>	SO ₂	+4	SO ₄ ²⁻	+6	I ₂	0	I ⁻	-1	3	ALLOW 2 marks if all number values are correct, but sign is to the right of the number (ie: 0, 1-, 4+, 6+) ALLOW 1 mark for S if answer gives 4 <u>and</u> 6, but no +
SO ₂	+4	SO ₄ ²⁻	+6										
I ₂	0	I ⁻	-1										
3	(b)	(ii)	<i>Reducing agent:</i> SO ₂ ✓ <i>Explanation:</i> The oxidation number of the S (in SO ₂) increases OR the SO ₂ reduces the oxidation number of the I (in I ₂) OR (SO ₂ is) oxidised to SO ₄ ²⁻ ✓	2	ALLOW sulphur dioxide ALLOW ‘S / SO ₂ is oxidised’ OR ‘SO ₂ loses / donates electrons’ IGNORE sulphur / S has lost electrons ALLOW ‘I ₂ is reduced’ OR ‘iodine gains electrons’ ALLOW ‘number’ for ‘state’ 2 nd mark can be scored if S is incorrectly given as the reducing agent, otherwise 2nd mark depends on first								
3	(b)	(iii)	Grey / black solid ✓	1	Both colour and ‘solid’ needed for mark Any combination of these colours but no others IGNORE shades of colour, like dark or pale								

Question			Answer	Marks	Guidance
3	(c)	(i)	Burette ✓	1	ALLOW small spelling error (e.g.: 2 rs or one t) NOT 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 / 1.58×10^{-4}) ✓	1	
3	(c)	(iv)	Answer to (iii) / 50 $\times 1000 (= 0.00316 / 3.16 \times 10^{-3})$ ✓	1	ALLOW any number of sf
3	(c)	(v)	Any ONE from: If answer (c)(iv) below $1.56 \times 10^{-4} \text{ mol dm}^{-3}$ then wine not preserved ✓ If answer (c)(iv) between 1.56×10^{-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	DO NOT ALLOW just 'use an acid-base indicator' or named indicator or just 'there is a colour change' IGNORE a specific incorrect colour change for a named indicator
			Total	14	

Question			Answer	Marks	Guidance
4	(a)	(i)	Ketone ✓	1	DO NOT ALLOW cycloalkane
4	(a)	(ii)	Alkene ✓	1	ALLOW 'carbon-carbon double bond'
4	(b)	(i)	 <p>Carboxylic acid ✓</p>	2	ALLOW 'carboxyl' but not 'carboxylic' IGNORE anything attached to the left of the C ALLOW 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 ALLOW 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 OR C=C restricts twisting ✓ It contains a C=C with <u>two</u> different groups on each carbon ✓	2	Mark separately IGNORE 'each side / end of C=C' ALLOW 'it contains a C=C with four different groups'
4	(d)		Thujone ✓	1	
4	(e)	(i)	High temperature AND pressure ✓	1	ALLOW temps 200 – 400°C ALLOW pressures of 50 – 70 atm IGNORE any chemicals DO NOT ALLOW mark if 'reflux' given

Question			Answer	Marks	Guidance
4	(e)	(ii)	    	4	<p>ALLOW 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>ALLOW 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 OR 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 OR linking mp 3 with mp 4 ✓</i></p>	5	<p>Please use a range of annotations in the answer in appropriate places.</p> <p>MP1: IGNORE red or combinations including red for bromine water colour. DO NOT ALLOW 'clear' for 'colourless'</p> <p>MP2 ALLOW mark if bromine reacts because it is a test for unsaturation</p> <p>MP3: ALLOW 'more bromine water is needed' or similar wording IGNORE comments relating to the speed of the reaction</p> <p>MP4: ALLOW 'It has more double bonds' (ORA)</p> <p>Please indicate QWC using green tick or red cross on the right of the pencil icon on the answer screen.</p>
			Total	19	

Question			Answer	Marks	Guidance
5	(a)		Propagation: one radical is used and replaced by another (AW) ✓ Reaction 6 OR 7 OR 8 ✓	2	ALLOW there is a radical on both sides of the equation Mark independently
5	(b)	(i)	(Fig. 1 shows) O ₃ with double bond and single bond / O ₃ with one bond of 4 electrons and one of 2 electrons ✓ Both bonds in O ₃ are same length and so cannot be of different types OR all bonds are equivalent OR bonds would be different lengths ✓	2	ALLOW 2 marks for: 'The double bond would be shorter than the single bond' OR 'The bonds are not the same length if double and single'
5	(b)	(ii)	Three regions of electrons around <u>central</u> O OR three regions of electron density around <u>central</u> O OR 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 OR with high enough frequency to photodissociate molecule / high enough energy to photodissociate molecule / low enough wavelength to photodissociate molecule ✓	2	ALLOW 'more radiation' OR 'UV is more intense' ALLOW reverse argument at lower altitude
5	(c)	(ii)	Particles are closer together OR concentration increases AW ✓ so particles collide more frequently / more successful collisions per second ✓	2	DO NOT ALLOW reactants for particles ALLOW 'atoms' or 'molecules' for 'particles' DO NOT ALLOW '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 OR 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	DO NOT ALLOW high intensity radiation ALLOW UVC / UVB / 10^{16} Hz / 200-320 nm ALLOW sunburn

Question			Answer	Marks	Guidance
5	(e)		<p><u>Reactions producing chlorine radicals:</u></p> <p>1. $\text{ClO}^\bullet + \text{ClO}^\bullet \rightarrow \text{ClOOC}l$ OR described in words ✓</p> <p>2. $\text{ClOOC}l + h\nu \rightarrow 2\text{Cl}^\bullet + \text{O}_2$ OR described in words ✓</p> <p><u>Lack of termination – two from:</u></p> <p>3. Reaction 8 is slow OR $\text{Cl}^\bullet + \text{CH}_4 \rightarrow \bullet\text{CH}_3 + \text{HCl}$ is slow</p> <p>4. Reaction 9 has no NO_2 OR $\text{ClO}^\bullet + \bullet\text{NO}_2 \rightarrow \text{ClONO}_2$ has no NO_2 (AW)</p> <p>5. (No NO_2 for reaction 9) because: EITHER it has all been converted to nitric acid/HNO_3 OR not regenerated since there is no upward flow in the vortex</p> <p>✓✓</p> <p><u>Removal of ozone by chlorine radicals:</u></p> <p>6. $\text{Cl}^\bullet + \text{O}_3 \rightarrow \text{ClO}^\bullet + \text{O}_2$ OR described in words ✓</p> <p>7. $\text{ClO}^\bullet + \text{O}^\bullet \rightarrow \text{Cl}^\bullet + \text{O}_2$ OR reaction 7 in words OR chlorine radicals regenerated (in a catalytic cycle) OR chlorine radicals catalyse ozone depletion ✓</p> <p><u>QWC</u></p> <p>8. QWC for linking 2 with 6 OR 4 with 5 ✓</p>	6	<p>Please use a range of annotations in the answer in appropriate places.</p> <p>ALLOW radicals shown without the ‘dot’ in all cases MP1 and 2: ALLOW ‘reaction 13 then reaction 14 produces chlorine radicals’ (AW) for 2 marks</p> <p>MP3: ALLOW ‘prevented’ for ‘slow’</p> <p>MP3 & 4: ALLOW description of reaction in words</p>
			Total	20	Please indicate QWC using green tick or red cross on the right of the pencil icon on the answer screen.