OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry B (Salters)

Advanced Subsidiary GCE

Unit **F332:** Chemistry of Natural Resources

Mark Scheme for June 2011

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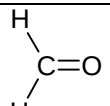
Question	Answer	Mark	Guidance
1 (a) (i)	$Cl_2 + H_2O \rightleftharpoons HClO + HCl$ Formulae correct ✓ Reversible symbol used ✓	2	**Please put a mark (e.g.: red cross) on each of the three additional pages that appear with this answer, if they are blank. Please put in links to relevant question parts for any answers written on these pages.** **ALLOW** multiples. **ALLOW** equation written other way round. **ALLOW** atoms in a formula written in a different order (e.g.: ClHO). **ALLOW** reversible symbol shown as: ⇌ but nothing else. **IGNORE** state symbols. Mark independently.
1 (a) (ii)	The <u>chlorine / Cl</u> has an oxidation state or number of (+)1 (in this compound) ✓	1	**ALLOW** it is the oxidation state of the chlorine. **DO NOT ALLOW** 'it is the oxidation state of the Cl_2'. An oxidation state of -1 **CON**s the mark.
1 (a) (iii)	(Chlorine / HClO / chloric acid) kills or destroys bacteria / microbes / pathogens / (micro-)organisms / germs (that cause the disease) **OR** (Chlorine / HClO / chloric acid) has anti-bacterial properties ✓	1	**IGNORE** references to changes of pH or making the solution acid**<u>ic</u>**. **ALLOW** 'kills viruses'. **DO NOT** award the mark if the answer includes or is for another chemical, including references to making acid. **DO NOT ALLOW** 'kills the cholera'. **IGNORE** references to sterilising and disinfectant.
1 (b) (i)	$Ca(ClO)_2$ ✓	1	**ALLOW** $CaCl_2O_2$ **ALLOW** atoms in a formula written in a different order

Question	Answer	Mark	Guidance
1 (b) (ii)	Chlorine is oxidised and reduced ✓	3	The first mark can be gained from the rest of the answer if correct comments about oxidation and reduction of chlorine are mentioned. Reference to any other substance being oxidised or reduced **CON**s the first mark. **DO NOT ALLOW** mp 1 if the oxidation and reduction are the wrong way round (e.g.: chlorine is oxidised from +4 to +1) or if the answer includes incorrect reference to loss and gain of electrons (e.g.: oxidised by gaining electrons). For mp1, answer must say 'chlorine' or 'Cl' or ClO_2 not Cl_2 or another chlorine compound. Can score oxidation state marks if written on the equation.
	(Reduced) from +4 (in ClO_2) to +1 in HClO ✓		Answer must be clear +4 in ClO_2 / reactant / at beginning in either mp 2 or 3. **IGNORE** references to charge in description of oxidation state.
	(Oxidised) from +4 (in ClO_2) to +5 in $HClO_3$ ✓		**ALLOW** oxidation states shown on equation. **IGNORE** oxidation states of other elements written on equation. Answers giving 1+, 4+ and/or 5+ **OR** 1, 4 and/or 5 **CON**s 1 of mp 2 or 3.

Question	Answer	Mark	Guidance
1 (b) (iii)	***Any two from:*** 1. Calcium chlorate(I) is easy to handle / weigh / transport / store AW ORA ✓ 2. Calcium chlorate(I) is safe(r) or less hazardous to handle / transport / store AW ORA ✓ 3. Chlorine has an unpleasant smell / can cause breathing difficulties AW ORA ✓ 4. Chlorine forms HCl AW ORA ✓ 5. Calcium chlorate(I) is more soluble ✓	2	**ALLOW** 'measure' for 'weigh'. **IGNORE** toxic.
1 (c) (i)	$2I^- \rightarrow I_2 + 2e^-$ $I^- \rightarrow I_2$ ✓ Adding electrons and balancing ✓	2	**ALLOW** multiples in balancing. **ALLOW** e for e^- Equation that includes other species **CON**s the first mark. Second mark is for a completely correct equation. **ALLOW** $2I^- - 2e^- \rightarrow I_2$ **IGNORE** state symbols
1 (c) (ii)	12.30 x 0.0010 /1000 and evaluate (= 1.23×10^{-5}) ✓	1	**ALLOW** answers with 3 s.f. or more.
1 (c) (iii)	½ x 1.23×10^{-5} and evaluate (= 6.15×10^{-6}) ✓	1	**ALLOW** ecf from incorrect answer to (c)(ii) **ALLOW** answers with 3 s.f. or more.

Question	Answer	Mark	Guidance
1 (c) (iv)	Answer to c(iii) / 250 ✓ x 1000 (= 2.46 x 10^{-5}) ✓ 2.5 x 10^{-5} to 2s.f. ✓	3	**ALLOW** s.f. mark for any correctly evaluated and rounded 2 sig. fig. answer that follows from any calculation. MP 1 and 2 can be scored in either order. In order to score the second mark, there must be a correct evaluation of their expression. 2.5 x 10^{-5} on the answer line scores all marks, including the s.f. mark.
1 (d)	5 ✓ p^6 ✓	2	**IGNORE** any inner shells. Mark separately. **ALLOW** upper or lower case letter but number for electrons in sub-shell must be superscript. **IGNORE** a 'dot-and-cross' diagram.
1 (e)	***Any one from:*** Bleach ✓ (Making) PVC ✓ (Making) solvents / a named solvent ✓ Disinfectant / antiseptic ✓ (Making) hydrochloric acid ✓ Extraction of bromine ✓	1	 **IGNORE** cleaning. **DO NOT ALLOW** just 'making plastics'. **ALLOW** sterilising. **ALLOW** (making) (H)CFCs. **ALLOW** (making) medicines. **ALLOW** chemical warfare.
	TOTAL	**20**	

Question	Answer	Mark	Guidance
2 (a) (i)	1½ $O_2 \rightarrow O_3$ ✓	1	**IGNORE** state symbols. All other species must be absent from the equation for the mark to be given. **ALLOW** $O_2 + ½ O_2 \rightarrow O_3$ **ALLOW** multiples.
2 (a) (ii)	Catalyst is NO / nitrogen monoxide / nitrogen (II) oxide **OR** NO_2 / nitrogen dioxide / nitrogen (IV) oxide **OR** O / oxygen atom / oxygen radical ✓ It is regenerated / recycled / reformed ✓	2	**ALLOW** 'nitrogen oxide'. **ALLOW** 'remains unchanged **at the end'**, 'not used up'. **DO NOT ALLOW** 'not involved in reaction'. Second mark depends on first.
2 (a) (iii)	(A particle) with one (or more) unpaired electron(s) ✓	1	**IGNORE** 'free' or 'lone' or single electron. **ALLOW** 'an electron not in a pair'. **DO NOT ALLOW** 'is an unpaired electron' **OR** 'an element or compound or substance with …'. **IGNORE** wrong method of formation e.g.: heterolytically.
2 (b) (i)	 ✓	1	Must show all atoms and all bonds for the mark.

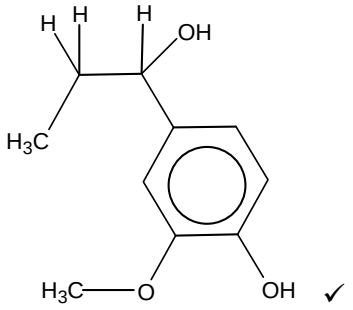
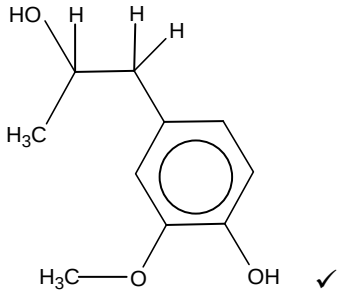
Question	Answer	Mark	Guidance
2 (b) (ii)	(Potassium / sodium) dichromate / correct formula ✓	3	**IGNORE** dichromate oxidation state if dichromate written in words (**ALLOW** minor spelling error). **IGNORE** formula if correct name is given.
	Acidified / (sulfuric) acid / H_2SO_4 / H^+ ✓		**ALLOW** hydrochloric acid / HCl / 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.
	Distil ✓		Only allow distil mark if dichromate given as reagent. Reflux **CON**s distil mark. **IGNORE** heat. Any additional reagent, other than water, negates the dichromate mark, but candidate can still score the acid mark.

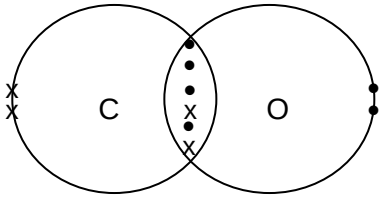
Question	Answer	Mark	Guidance
2 (b) (iii)	1. The reaction will be faster at higher temp **OR** rate increases with temperature ORA ✓ 2. Greater proportion of collisions **OR** more frequent collisions **OR** more collisions per unit time: **AND** (a) have (total energy of at least) the activation enthalpy **OR** (b) are effective **OR** (c) are successful ✓	**2**	**Please use annotations on answer in appropriate place.** **DO NOT ALLOW** 'better chance of', 'are more likely' or 'particles have energy greater than activation energy' (must be collisions). MP2 must have one of the first 3 statements <u>and</u> one of (a), (b) or (c).
	3. QWC Particles / molecules / O_3 and C_2H_4 have more energy ORA ✓	**1**	**DO NOT ALLOW** atoms **OR** reagents **OR** reactants. **ALLOW** 'higher energy' for 'more energy'. **IGNORE** vibrational or rotational energy and references to speed.
2 (b) (iv)	Respiratory problems / breathing difficulties / asthma attacks / weakens immune system / attacks lung tissue / greenhouse gas / degrades rubber ✓	**1**	**IGNORE** toxic and global warming. **ALLOW** '(adds to) greenhouse effect'.

Question	Answer	Mark	Guidance
2 (c)			**Please use annotations on answer in appropriate place.**
	1. It filters / removes / screens / absorbs / prevents / blocks / shields / stops (AW) any type of <u>uv</u> ✓	6	**IGNORE** 'protects us from UV'. **DO NOT ALLOW** 'reflects UV'.
	<u>Plus two from mp 2 – 6 :</u> 2. (radiation) of high energy / frequency / UVC / UVB / 10^{16} Hz / 200-320 nm ✓ 3. (radiation) causes skin cancer / damages skin / damages DNA / cell mutations ✓ 4. (radiation) damages eyes ✓ 5. (radiation) damages immune system ✓ 6. (radiation) affects crops ✓		**ALLOW** mp2 – 6 if the wrong type of radiation has been given in mp1. **DO NOT ALLOW** high intensity radiation. **DO NOT ALLOW** just 'cancer'.
	<u>and:</u> 7. Oxygen **OR** water molecules are split **OR** dissociate to form (oxygen) atoms / radicals		Mark can be awarded for the correct equation: $O_2 \rightarrow 2O$ **OR** $H_2O \rightarrow 2H + O$ Answer for oxygen must say 'oxygen molecules', O_2 or dioxygen. **ALLOW** splitting up of nitrogen oxides or any named oxide of nitrogen or correct formula.
	OR the bond in the O_2 **OR** H_2O molecule is broken ✓		
	8. <u>uv</u> radiation causes formation of oxygen radicals ✓		MP 8 can be awarded for uv written on reaction arrow, but not h*v*.
	9. The O atoms / radicals react with O_2 forming ozone ✓		Mark can be awarded for the correct equation: $O + O_2 \rightarrow O_3$
	QWC: Mark awarded for correct sequence of processes in the last part of the answer (mp 7 & 9) ✓	1	**Please indicate QWC using green tick or red cross on the right of the pencil icon on the answer screen.**
	TOTAL	**19**	

Question	Answer	Mark	Guidance
3 (a)	***Any two from:*** Ether / alkoxy ✓ Alkene ✓ Phenol / hydroxy(l) ✓	2	 Not methoxy Not C=C **OR** C to C double bond. Alcohol **CON**s phenol / hydroxy(l) mark. Additional incorrect answers **CON**s a correct answer.
3 (b)	(Colour change) from brown / orange / yellow ✓ to colourless ✓	2	**IGNORE** red in the first answer. **ALLOW** a combination of these colours, but no others. **DO NOT ALLOW** 'clear' for the second answer. **ALLOW** 'is decolourised' for second mark. Mark separately, but must be in correct order.
3 (c) (i)	Hydrogen bonding (between water molecules) ✓ Lone pair on oxygen / oxygen atom small & electronegative ✓ (bonds to) hydrogen with δ+ (charge) / O–H bond polarised / hydrogen attached to electron-withdrawing group ✓	3	**NOT** between chemicals other than just water. **DO NOT ALLOW** 'oxygen molecule'. **NOT** H is electropositive **OR** just positive **OR** 'bonds to hydrogen molecule'. **ALLOW** 'H has partial positive (charge)' **ALLOW** lone pair on O and $H^{\delta+}$ from a diagram.

Question	Answer	Mark	Guidance
3 (c) (ii)	Intermolecular bonds / hydrogen bonds between eugenol and water are weaker than the water-water interactions ORA ✓ **OR** Eugenol can only form 1 / fewer hydrogen bond (per molecule) ORA ✓	1	**ALLOW** intermolecular bonds between eugenol and water are weaker than the eugenol - eugenol imb ORA
3 (d) (i)	(Isoeugenol) has a C=C bond ✓ with **different** groups on each carbon of the C=C ✓	2	**ALLOW** just double bond. Different groups can be identified by labels on the structure of isoeugenol. Second marking point includes first (i.e.: scores 2 marks).
3 (d) (ii)	Platinum catalyst ✓ r.t.p. ✓ **OR** Nickel catalyst ✓ High temperature <u>and</u> pressure ✓	2	**Must** score catalyst mark to get condition mark. Condition must match catalyst. Any additional chemicals **CON** one mark. **ALLOW** just 'room temperature'. Quoted values in the ranges temp. 100-200^{0}C and pressure above 1 up to 10atm.

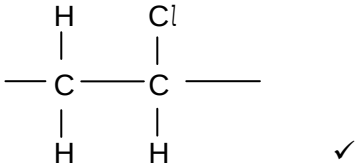
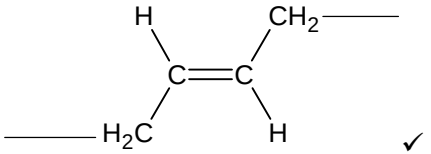
Question	Answer	Mark	Guidance
3 (d) (iii)	 ✓  ✓	2	**ALLOW** condensed structural formulae or skeletal formulae. **ALLOW** bonds to wrong atoms of groups (e.g.: bond line to H of OH). If the same mistake in the rest of the molecule is made in both isomers and the positions of the OH and H groups are correct, allow max 1 (e.g.: have only drawn the relevant part of the molecule).
3 (e) (i)	Aldehyde ✓	1	**ALLOW** carbonyl
3 (e) (ii)	1720 – 1740 (cm^{-1}) ✓	1	Data range taken from Data Sheet provided to students.
3 (e) (iii)	***Any two from:*** Region below 1500 (cm^{-1}) / to the right of 1500 (cm^{-1}) ✓ Unique (part of the spectrum) for molecule AW ✓ Can be used to identify the molecule (by comparison with a database) ✓	2	 **ALLOW** right-hand end of spectrum / low frequency end of spectrum / low wavenumber end of spectrum. **ALLOW** 1450 (cm^{-1}) ± 50 (cm^{-1}) For mp 2 and 3: **ALLOW** 'element'; 'compound'; 'substance'; 'chemical' for 'molecule'. **IGNORE** references to the shape of the spectrum. For mp 3: **IGNORE** 'functional group' or 'bonds' in place of molecule.
	TOTAL	**18**	

Question	Answer	Mark	Guidance
4 (a)	 Bonding electrons ✓ Non-bonding electrons (provided diagram has 6 bonding electrons) ✓	2	**ALLOW** without circles. Any symbols can be used to represent the electrons (but it must be two different symbols denoting electrons from C and O, so dative bond is clear). **ALLOW** bonding electrons in any order, as long as there are 4 of the oxygen symbol and 2 of the carbon symbol. Non-bonding electrons do not have to be shown in pairs. **IGNORE** any inner electron shells.
4 (b) (i)	$CO(g) + H_2O(g) \rightarrow CO_2(g) + H_2(g)$ Equation with correct **state symbols** ✓	1	**ALLOW** equation with <u>one</u> missing +.
4 (b) (ii)	***Any one from:*** React the CO_2 with lime ✓ Disposal in an old oil well / old gas well ✓ At the bottom of the ocean ✓ Making fizzy drinks ✓ Pump it into rocks ✓	1	**ALLOW** 'under the sea' but not 'into the sea'
4 (b) (iii)	Atom economy = (2/46) * 100 = 4% / 4.3% / 4.35% / 4.348% ✓	1	ECF from incorrect equation in 4(b)(i)
4 (b) (iv)	Not very useful (AW) as it has a low <u>atom economy</u> ✓	1	Comment on reaction and low atom economy necessary for mark. **ALLOW** ecf from 4(b)(iii) (i.e.: If answer is 50% or less, not very useful as atom economy is low; if more than 50%, reaction is useful because atom economy is high).

Question	Answer	Mark	Guidance
4 (c) (i)	Rate of forward reaction = rate of back reaction ✓ Concentrations of reactants and products remain constant (AW) **OR** closed system ✓	2	**ALLOW** 'reactants and products produced at same rate' and 'products change to reactants and back again at same rate'. **DO NOT ALLOW** concentrations of reactants and products **are** the same / equal.
4 (c) (ii)	*Higher temperature:* Amount of methanol produced / yield decreases ✓ (increased temperature) pushes (position of) equilibrium in the endothermic direction **OR** equilibrium moves to the left as this it is endothermic **OR** equilibrium moves towards the reactants as it is endothermic ✓ *Higher pressure:* Amount of methanol produced / yield increases ✓ (increased pressure) pushes (position of) equilibrium to the side with fewer (gaseous) molecules / moles / particles ✓	4	**IGNORE** references to 'favour'. **ALLOW** reverse argument. Must mention endothermic (or exothermic, if reverse argument is used). Mark independently. **ALLOW** reverse argument. Mark independently.
4 (c) (iii)	Methanol produced more quickly / rate of reaction increased ✓ Reaction proceeds by a route with lower activation enthalpy / energy ✓	2	MP 2 requires both 'route' and 'lower E_a' for the mark. **QWC:** Term 'activation enthalpy / energy' must be correctly spelled for the mark to be awarded. **IGNORE** references to intermediates.

Question	Answer	Mark	Guidance
4 (d) (i)	Hydrogen chloride / hydrochloric acid / HCl ✓ Heat / high temperature ✓	2	**IGNORE** references to a named catalyst and to pressure. **ALLOW** PCl_5, PCl_3, $POCl_3$ OR $SOCl_2$ in place of HCl **ALLOW** reflux for heat. Second mark depends on first.
4 (d) (ii)	346 / 6.02 x 10^{23} ✓ x 1000 = 5.7 / 5.75 x 10^{-19} J ✓	2	One mark is for dividing by 6.02 x 10^{23} (Avogadro's constant). The other mark is for converting the answer from kJ to J, i.e.: multiplying by 1000. Can be scored in either order. In order to score the second mark, there must be a correct evaluation of their expression. A completely correct answer on its own scores both marks. **ALLOW** 2 or more s.f. correctly rounded (5.747508306 x 10^{-19}). 5.74 x 10^{-19} scores 1 (incorrect rounding).

Question	Answer	Mark	Guidance
4 (d) (iii)	Answer to (d) (ii) / 6.63 x 10^{-34} ✓ = 8.67 x 10^{14} Hz ✓	2	One mark is for dividing the answer to (d)(ii) by the value of 6.63 x 10^{-34} (Planck's constant). The second mark is for evaluating that expression and no other. **ALLOW** 2 or more s.f. correctly rounded A completely correct answer on its own scores both marks. If answer to (d)(ii) is rounded to 2 s.f., answer will be 8.60/ 8.6 x 10^{14}.
4 (d) (iv)	1. (Halogenoalkanes) break down in the presence of uv (or high-frequency radiation) **AND** give chlorine / bromine / halogen radicals ✓ 2. The radicals catalyse the breakdown / removal of ozone ✓ 3. Low ozone concentrations were found above the Antarctic ✓	3	In mp1, **ALLOW** photodissociation / photolysis for 'break down in the presence of uv'. In mp 2, **ALLOW** a description of a catalytic process, in words or equations. In mp3**, ALLOW** 'ozone hole' for 'low ozone concentrations'. Answer must mention both low concentration of ozone and Antarctic / Antarctica / South Pole / Arctic / North Pole / Poles.
	TOTAL	**23**	

Question	Answer	Mark	Guidance
5 (a)	Softens / flows / melts / is deformed when <u>warmed / heated</u> ✓ Example: nylon / polycarbonate ✓	2	**ALLOW** 'can be (re)moulded / <u>re</u>shaped on heating' These are the only examples to score.
5 (b)	Refining oil / generating electricity / power stations / processes in a petrochemical plant / producing steel / producing iron / heating limestone / fermentation / incineration of waste ✓	1	**ALLOW** 'burning a fossil fuel' provided it is the context of another industrial activity e.g.: in a factory. **ALLOW** 'making cement'.
5 (c)	***Any two from:*** Reduces the (vehicle's) weight / makes (vehicle) lighter ✓ Greater design flexibility / can be more easily moulded or shaped ✓ Polymers do not rot like wood / corrode like metals ✓	2	 Answers must be a comparison. **IGNORE** references to roll-over.
5 (d)	Co-polymer ✓	1	**DO NOT ALLOW** co-polymerisation
5 (e) (i)	 ✓	1	Any unambiguous representation. **IGNORE** brackets and n. Answer must show only one repeat unit.
5 (e) (ii)	 ✓	1	Any unambiguous representation (e.g.: skeletal formula). Shape not important. **IGNORE** brackets and n. Answer must show only one repeat unit.

Question	Answer	Mark	Guidance
5 (f) (i)	Propagation ✓	1	**ALLOW** words that sound correct, e.g.: 'propogation / propergation'.
5 (f) (ii)	Initiation ✓	1	
5 (g) (i)	(The adhesive) cannot make bonds **OR** only makes weak bonds **AND** with the polymer **OR** poly(ethene) **OR** surface ✓	1	**ALLOW** covalent bond, imb or named imb. Answer must have comment on bonding and polymer or surface for the mark.
5 (g) (ii)	Instantaneous (dipole) – induced dipole ✓	1	**IGNORE** 'id-id'. **ALLOW** Van der Waals. **ALLOW** small spelling errors
5 (h)	The reaction produces only one product (AW) ✓ **OR** They have joined without producing a small molecule / losing atoms (AW) ✓	1	**ALLOW** 'polymer has the same empirical formula as the monomer' or 'polymer = $(monomer)_n$'
5 (i) (i)	Could be used in production of electricity / power a polymer production plant / provide heating for homes / power other processes / heat other processes ✓	1	

Question	Answer	Mark	Guidance
5 (i) (ii)	***Any two from:***	4	**Please use annotations on answer in appropriate place.** In each pair, second mark depends on first. **IGNORE** references to hydrocarbons.
	Carbon dioxide / CO_2 ✓ is a greenhouse gas / is linked to global warming ✓		
	OR		
	Carbon monoxide / CO ✓ is toxic (or description, e.g.: 'reduces oxygen uptake') / causes smog to form ✓		
	OR		
	Any nitrogen oxide ✓ are toxic / cause acid rain / greenhouse effect / smog formation / cause breathing difficulties ✓		**ALLOW** NO_X **OR '**nitrogen oxides'. **IGNORE** catalyse the depletion of ozone.
	OR		
	HCN / dioxin ✓ toxic ✓		

Question	Answer	Mark	Guidance
5 (j)	Poly(propene): Tough, so accelerator / pedal does not break **OR** become damaged when used **OR** Exceptional fatigue resistance, so accelerator / pedal withstands continual use (AW) ✓ Poly(chloroethene): Good impact strength, so imitation leather / seat cover / fabric does not tear easily **OR** Flexible, so the imitation leather / seat cover / fabric can be pulled or stretched to the (correct) shape **OR** Durable, so imitation leather / seat cover / fabric does not wear out (AW) ✓	**2**	Property quoted must match to a use in a vehicle. Must have the answers on the correct lines. Must mention property, use and appropriate reason (as left) to score each mark.
	TOTAL	**20**	

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