

Chemistry B (Salters)

Advanced Subsidiary GCE

Unit **F332**: Chemistry of Natural Resources

Mark Scheme for January 2011

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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.

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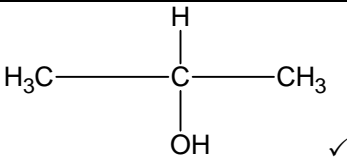
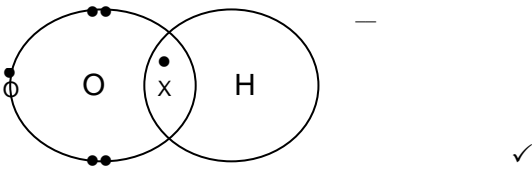
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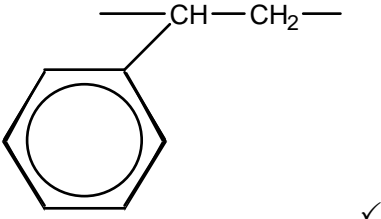
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Question		Answer	Mark	Guidance
1	(a)	Alkene(s) ✓	1	DO NOT ALLOW C=C
1	(b)	(Processing of) crude oil / (dehydration of) propan-1-ol / propan-2-ol / propanol ✓	1	IGNORE cracking NOT 'oil', without 'crude' Hydrolysis of propanol CONs this mark
1	(c)	(Colour change) brown / orange / yellow to colourless ✓	1	Any combination of these colours but no others DO NOT ALLOW "clear" instead of "colourless" IGNORE red
1	(d)	Electrophilic ✓ Addition ✓	2	ALLOW answers indicated in other ways, such as circling Each additional underline CONs a mark
1	(e) (i)	Secondary ✓	1	
1	(e) (ii)	C to which OH / alcohol group / hydroxy(l) group is bonded is itself bonded to 2 other C / one H on C to which OH is bonded / 2 alkyl groups on C ✓	1	Can refer to R groups IGNORE 'OH in middle of chain' NOT 'it' for 'OH'
1	(e) (iii)	Water / steam ✓ Phosphoric acid ✓ High temperature and pressure ✓	3	IGNORE aqueous ALLOW sulphuric acid instead of phosphoric acid or correct formulae Additional reagents CON acid mark IGNORE concentrations IGNORE inert catalyst supports such as alumina ALLOW temps 200-400 °C and pressure above 1 atm ALLOW heat (but not warm) and pressure. Award the high temperature and pressure mark only if the water/steam mark has been gained

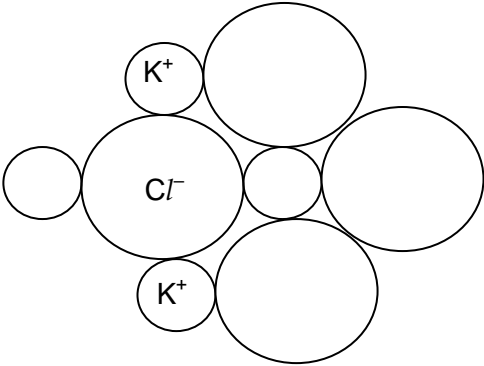
Question		Answer	Mark	Guidance
1	(f)		2	ALLOW any clear structure, e.g.: CH ₃ CHBrCH ₃
1	(g)	Chlorine ✓ <u>UV</u> radiation ✓	2	ALLOW Cl ₂ NOT chlorine water Other reagents CON this mark ALLOW UV light / UV Other conditions CON this mark
1	(h)	(i) <p>Either:</p> <p>OR</p>	2	One mark for each curly arrow DO NOT ALLOW single headed arrows. However, if candidate draws two single headed arrows to the correct positions then award one mark Curly arrow must be drawn carefully starting from the lone pair or bond and ending on an atom or pointing to the line between C and O ALLOW arrows starting at negative charges. Arrow must start within a radius of one lone pair width from either lone pair or minus. (i.e.: lower example is JUST OK) Mark separately

Question			Answer	Mark	Guidance
1	(h)	(ii)		1	ALLOW any clear structure, e.g.: CH ₃ CH(OH)CH ₃ NOT ambiguous attachments of OH (i.e.: bond is in line with left-hand arm of the H or further right) Left-hand CH ₃ can be drawn the other way round
1	(h)	(iii)		1	ALLOW negative charge in any position IGNORE circles ALLOW 'extra' electron shown as a dot ALLOW reversal of dots and crosses Must have correct total of electrons on appropriate atoms ALLOW diagram with no negative charge
1	(h)	(iv)	(It is a negative ion with a) lone <u>pair</u> / electron <u>pair</u> AND available to form a bond / can be donated.	1	
			Total	19	

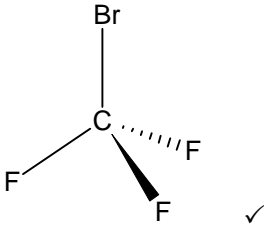
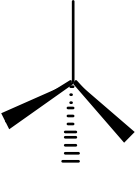
Question		Answer	Mark	Guidance
2	(a)	(Good thermal) insulator / low density ✓	1	ALLOW lightweight, but not light IGNORE one other irrelevant response If more than one other irrelevant response, this CONs the mark
2	(b)		1	The correct shape is not required for the mark More detailed structures can be drawn IGNORE brackets and 'n' DO NOT ALLOW ambiguous attachments to benzene ring, or benzene ring without circle
2	(c)	Softens / flows / melts / is deformed when <u>warmed / heated</u> ✓	1	ALLOW 'can be (re)moulded / <u>reshaped</u> when warm'
2	(d) (i)	Amount of phenylethene / product increases OR higher yield ✓ (increased temperature) moves (position of) equilibrium in the endothermic direction (ORA) ✓	2	Endothermic must be correctly spelled for the second mark to be awarded or 'exothermic' if reverse argument given ALLOW 'reaction moves in / favours the endothermic direction' / forward reaction is endothermic / shifts towards the endothermic reaction ALLOW endothermic for QWC if written on equation 2.1. Mark independently
2	(d) (ii)	Amount of phenylethene / product decreases / lower yield ✓ (increased pressure) moves (position of) <u>equilibrium</u> to the side with fewer molecules / moles / particles ✓	2	NOT just 'equilibrium moves to the left'. NOT atoms. Mark independently

Question			Answer	Mark	Guidance
2	(e)	(i)	Larger / greater / more surface area of catalyst OR Higher surface area to volume ratio ✓ So more collisions per unit of time / more frequent collisions / collisions occur more often OR provides surface onto which reactants are adsorbed / can bond (AW) ✓	2	NOT higher surface area NOT just more collisions Mark independently
2	(e)	(ii)	(Catalyst) provides an alternative reaction path / route ✓ that has a lower activation enthalpy ✓	2	Answer must have the idea of a different path to gain the mark Mark independently
2	(f)		Elimination ✓	1	Any clear indication scores the mark (e.g.: ringed) More than one indicated scores zero

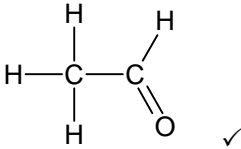
Question			Answer	Mark	Guidance
3	(a)		$M_r(\text{NaCl}) = 58.5$ and $M_r(\text{KCl}) = 74.6 / 74.5$ ✓ $2 / M_r(\text{NaCl}) : 1 / M_r(\text{KCl})$ and evaluate as 1: something (= 1 : 0.39) ✓	2	'moles Na : moles K = 1: 0.39' scores both marks ALLOW any number of s.f. for 2 nd mp ALLOW 2 nd mp if A_r values of K and Na have been used instead of M_r values (= 1: 0.29)
3	(b)	(i)	White ✓	1	IGNORE colour changes on standing
3	(b)	(ii)	Silver chloride ✓	1	
3	(b)	(iii)	$\text{Ag}^+ + \text{Cl}^- \rightarrow \text{AgCl}$ ✓	1	ALLOW with no state symbols NOT if state symbols are wrong
3	(c)	(i)	Green gas OR Green-yellow gas ✓	1	Both colour and 'gas' needed for mark IGNORE shades of colour, like dark or pale
3	(c)	(ii)	$[\text{Ne}] \quad 3s \quad \boxed{\uparrow\downarrow} \quad 3p \quad \boxed{\uparrow\downarrow} \quad \boxed{\uparrow\downarrow} \quad \boxed{\uparrow}$ ✓	1	ALLOW single arrow in any 3p atomic orbital 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	(d)	(i)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 / [\text{Ar}] 4s^1$ ✓	1	ALLOW capital letters. ALLOW $1s^2 2s^2 2p^6 3s^2 3p^6 3d^0 4s^1$ NOT subscripts
3	(d)	(ii)	$\text{K}(\text{g}) \rightarrow \text{K}^+(\text{g}) + \text{e}^-$ Equation ✓ K and K^+ both shown as (g) ✓	2	ALLOW e without a sign for the electron symbol ALLOW $\text{K}(\text{g}) - \text{e}^- \rightarrow \text{K}^+(\text{g})$ IGNORE state symbol on electron NOT capital 'G' for state symbol

Question			Answer	Mark	Guidance
3	(d)	(iii)	Outer shell / outermost electron(s) of K AND further from the nucleus (than Na) / shielded more (than Na) (ORA) ✓ Attraction / pull from the nucleus is weaker <u>and</u> less energy is needed to remove an electron (ORA) ✓	2	Must be a comparison. IGNORE 'molecule' NOT 'it' for potassium but second mark does not need element specified Mark separately. NOT 'harder to remove'
3	(e)		 <p>Alternating K⁺ and Cl⁻ (at least 3 correct labels) ✓ At least one small circle surrounded by 4 large circles ✓</p>	2	IGNORE particles drawn in other layers Any incorrect labels CONs the K ⁺ Cl ⁻ labels mark
3	(f)	(i)	$(25.00 \times 0.100 / 1000) = 0.00250$ ✓	1	ALLOW 0.0025 or standard form
3	(f)	(ii)	Burette ✓	1	ALLOW small spelling error (e.g.: 2 rs or one t). NOT biuret
3	(f)	(iii)	Answer to (f) (i) ✓	1	
3	(f)	(iv)	Answer to f(iii)/20.10 ✓ x 1000 and evaluated (= 0.1244) ✓ Correct evaluation of candidates calculation to 3 sf (=0.124) ✓	3	ALLOW sf mark for any 3 sig fig answer that follows from any calculation NB: 0.124 does not score all three marks if (f)(iii) is incorrect

Question			Answer	Mark	Guidance
3	(g)	(i)	Method 1 / burning potassium in chlorine, as KCl is the only product / all reacting atoms used / all products are useful (ORA) ✓	1	ALLOW 100% atom economy / only one product / no co-product / no other products / no by-products / no atoms lost / no waste / addition reaction. An incorrect statement about method 2 CONs the mark
3	(g)	(ii)	A lot of energy / high temperature is required OR reaction produces a low yield of KCl ✓	1	ALLOW K and Cl_2 / reagents of method 1 are expensive ALLOW reagents are dangerous and safety precautions / reaction conditions are expensive
3	(h)	(i)	(Mg is in) Group II and has a 2+ / +2 charge ✓	1	ALLOW 'second group'
3	(h)	(ii)	$MgCO_3$ ✓	1	
3	(h)	(iii)	<u>Giant</u> network / <u>giant</u> lattice ✓ With every C bonded to four other Cs / every C is tetrahedrally bonded ✓ Covalent ✓	3	ALLOW <u>giant</u> structure. Answer must imply 'every' or 'all' carbons to score the mark. References to ionic or intermolecular bonds CON 'covalent' mark
			Total	27	

Question		Answer	Mark	Guidance
4	(a)	Bromotrifluoromethane ✓	1	IGNORE 1s, commas, dashes and minor spelling errors (e.g.: 'fluro', 'flouro') ALLOW trifluorobromomethane
4	(b)	 <p>Bond angle 109° ✓</p>	2	Shape must be 3-dimensional ACCEPT 105 – 110° Two bonds that are shown in the same plane MUST be next to each other  ACCEPT
4	(c)	C–Br ✓	1	ALLOW in words
4	(d) (i)	Homolytic (fission) / homolysis ✓	1	IGNORE 'photodissociation' and 'photolysis'
4	(d) (ii)	$8.67 \times 10^{14} \times 6.63 \times 10^{-34}$ ✓ $= 5.75 \times 10^{-19}$ (J) ✓	2	A completely correct answer on its own scores both marks. ALLOW ecf only if the sole error is a mis-copy of one of the number values. ALLOW 2sf or more but rounding must be correct

Question			Answer	Mark	Guidance
4	(d)	(iii)	= answer to (d) (ii) $\times 6.02 \times 10^{23}$ ✓ /1000 (= + 346 KJ mol ⁻¹) ✓	2	One mark for multiplying answer to (d)(ii) by 6.02×10^{23} (Avogadro's constant) Other mark for converting the answer from J to KJ, i.e.: dividing by 1000 Can be scored in either order, but must be correctly evaluated to score both marks A completely correct answer on its own scores both marks (ALLOW 2 or more sf but rounding must be correct)
4	(e)		Prediction / discovery (in the lab) that Cl can damage ozone layer ✓ Spectroscopic measurements showed ozone levels depleted/ lower than expected ✓ Results (initially) disregarded/ignored/overlooked/ thought to be an error/ thought to be anomalous as they were so low / depletion so high ✓	3	IGNORE 'hole in the ozone layer'. Must be lower, not different. Must mention 'spectroscopic' or one particular spectroscopic method (e.g.: ir) Must imply 'very low' and not just 'anomalous' or different. Both parts needed for the mark.
4	(f)	(i)	(Greenhouse gas) <u>absorbs IR from Earth</u> ✓ More greenhouse gas means more IR absorbed ✓	2	Mark separately
4	(f)	(ii)	There is a relationship/ correlation between models of gas and models of <u>temperature</u> OR models of gas and measured <u>temperatures</u> OR gas levels and measured <u>temperatures</u>	1	NOT 'global warming' for 'temperature'
			Total	15	

Question			Answer	Mark	Guidance
5	(a)		<p><i>Explanation:</i></p> <p>1. A sequence / series / cycle of reactions OR several reactions ✓</p> <p>2. where a product of one reaction continues reacting / becomes a reactant in the next reaction OR a radical is used and a new one is regenerated which is then used in the next step ✓</p> <p><i>Example:</i></p> <p>At least two consecutive radical propagation steps, from the article, either as equations (not necessarily balanced) or words e.g.: 'OH• reacts with hydrocarbons to form RO₂•, which then reacts further to give HO₂• ✓</p>	3	<p>SCRIPT SHOWS A MARK OF 2 AND 1, BUT YOU WILL NEED TO ENTER A SINGLE SCORE OUT OF 3.</p> <p>NOT continuous mp1 and mp2 must be stated clearly in the explanation, not gained by implication from the example</p> <p>ALLOW 'radical produced in each step to continue the cycle' for 2 marks (mp 1 and 2)</p> <p>ALLOW examples that are correct, but not from the article</p>
5	(b)	(i)	(A particle) with an unpaired electron ✓	1	<p>IGNORE 'free' or 'lone' or single electron NOT 'is an unpaired electron'</p>
5	(b)	(ii)	$O + H_2O \rightarrow 2 \cdot OH$ / $O + H_2O \rightarrow \cdot OH + \cdot OH$ ✓	1	<p>Radicals do NOT need to have the • to show the unpaired electron IGNORE position of dot on radical</p>
5	(c)	(i)		1	

Question			Answer	Mark	Guidance
5	(c)	(ii)	<p>(The IR spectrum of the gas mixture would show) a peak / trough / absorption value in the range 1720 – 1740 (cm^{-1}) for the C=O ✓</p> <p>fingerprint (region) for ethanal / same as known spectrum of ethanal ✓</p>	2	IGNORE wavenumber for fingerprint region.
5	(d)		<p>The *OH removes the H atom / the *OH reacts to form water ✓</p> <p>This leaves an (alkyl) radical / molecule, which breaks down (in the atmosphere) ✓</p>	2	Can show first marking point using equation
5	(e)		<p>NO_2 concentration increases to 11 am, then decreases / peaks at 11 am ✓</p> <p>Increase caused by reaction of NO with oxygen / NO forms NO_2 ✓</p> <p>Decrease caused by <u>UV</u> (radiation) breaking bonds in NO_2 / Decrease caused by <u>UV</u> (radiation) breaking down NO_2 ✓</p>	3	<p>IGNORE references to 'rush-hour'</p> <p>ALLOW times for maximum NO_2 between 10.30 and 11.30</p> <p>Both increase and reaction required for the mark</p> <p>All three parts needed for the mark</p> <p>ALLOW 'photolysis / photodissociation' for 'breaking bonds'</p> <p>NOT $h\nu$ for UV</p>

Question		Answer	Mark	Guidance
5	(f)	<p><i>Four from points 1 to 5:</i></p> <p><i>Formation of ozone:</i></p> <ol style="list-style-type: none"> 1. NO_2^* breaks down, forming O ✓ 2. O_2 breaks down forming O ✓ 3. O reacts with O_2 to produce an ozone molecule ✓ <p><i>Removal of ozone:</i></p> <ol style="list-style-type: none"> 4. Ozone molecules are broken down <u>by UV</u> (into O and O_2) ✓ 5. Ozone molecules react with radicals (such as O), producing oxygen ✓ <p><i>plus those below:</i></p> <p>Smog chambers / EUPHORE / simulation chambers / computer models / atmospheric studies (AW) / laboratory experiments (predict changes in ozone levels) ✓</p> <p>Respiratory problems / breathing difficulties / asthma attacks / weakens immune system / photochemical smog / greenhouse gas / toxic ✓</p> <p>QWC for linking marking point 1 or 2 with 3 OR linking 4 and 5, providing it is through the O radical ✓</p>	6 1	<p>Please indicate QWC using green tick or red cross on the right of the pencil icon on the answer screen</p> <p>mp 1 ALLOW ‘photolysis’ for ‘breaks down’. Marking points 1 - 5 can be gained from correct equations In mp 1-5, both parts needed for the mark</p> <p>mp 4 ALLOW ‘photolysis’ for ‘broken down by UV’ NOT hv for UV mp 5 ALLOW any radical</p> <p>NOT just modelling</p> <p>NOT just harmful to health</p>
		Total	20	

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