

GCE

Chemistry B (Salters)

Unit **F332**: Chemistry of Natural Resources

Advanced Subsidiary GCE

Mark Scheme for June 2015

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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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These are the annotations, (including abbreviations), including those used in scoris, which are used when marking

Annotation	Meaning
	Blank Page – this annotation must be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
	Benefit of doubt
	Contradiction
	Cross
	Error carried forward
	Ignore
	Not answered question
	Benefit of doubt not given
	Not good enough
	Rounding error
	Repeat
	Noted but no credit given
	Error in no. of significant figures
	Tick
	Omission mark

Subject-specific Marking Instructions

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
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
ORA	Or reverse argument

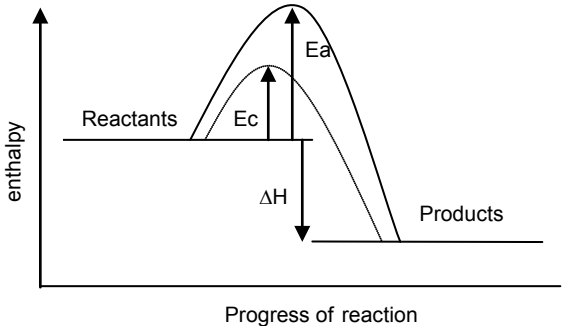
All questions must be annotated with a tick where the mark is given (please refer to Scoris Annotations document from your Team Leader).

Additional objects: You **must** annotate the additional objects for each script you mark. If no credit is to be awarded for the additional object, please use a suitable annotation (either ^ or SEEN).

MARK SCHEME

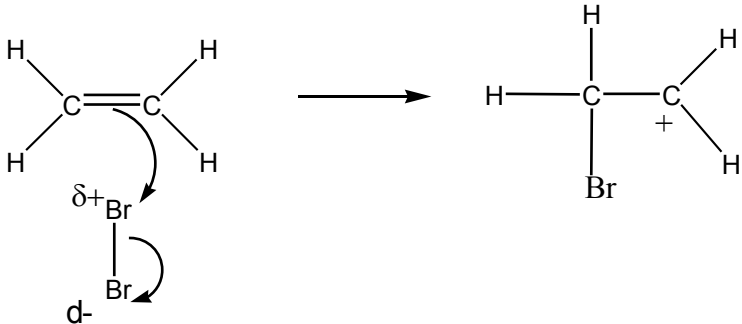
Question	Answer	Mark	Guidance
1 a	<i>Any one from:</i> - Breathing equipment / gas mask / respirator / oxygen mask because CO / CH₃OH / reaction mixture is toxic. - Fire-proof clothing because CO / H₂ / CH₃OH / reaction mixture is flammable. - Gloves / protective clothing because CH₃OH can be absorbed through the skin. - Eye protection because CH₃OH damages eyes / CH₃OH irritates eyes / CH₃OH causes blindness. - Flack jacket AW because Hydrogen is explosive. ✓	1	MP 1, 2 & 3: Both the protection method and reason (which must state 'reaction mixture' or name a specific chemical) are needed for the mark in each case. MP1: DO NOT ALLOW just 'mask' or 'face mask'. ALLOW 'breathing mask' for 'breathing equipment'. ALLOW 'poisonous' for toxic, but NOT harmful, dangerous, etc. MP3: ALLOW lab coat, apron or other equivalent named item of clothing. MP4: ALLOW goggles, safety glasses, etc.

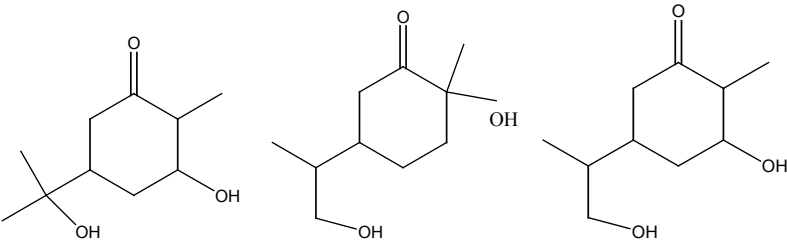
1 b	Rate of forward reaction = rate of back reaction OR reactants and products are formed at the same rate. ✓ Concentrations remain constant / concentrations remain the same / concentrations stay the same. <i>AW</i> ✓	2	DO NOT ALLOW 'concentrations are the same' or 'concentrations are equal'. DO NOT ALLOW 'concentrations of reactants remain constant' or 'concentrations of products remain constant' on their own (i.e.: it must be clear that all concentrations are fixed, not just those on one side of the equilibrium). IGNORE references to closed system and steady state.
1 c	Fewer moles on right-hand side / fewer moles on products side / fewer moles on methanol side (<i>ORA</i>). ✓ Forward reaction is exothermic <i>AW</i> (<i>ORA</i>). ✓	2	ALLOW fewer particles OR fewer molecules in place of fewer moles. DO NOT ALLOW fewer atoms. DO NOT ALLOW answers that just give 'reaction is exothermic' or 'forward reaction has ΔH negative'.
1 d	1. Using a high pressure is too expensive. ✓ 2. Low temperature makes the process slow / low temperature makes reaction rate low. ✓	2	Must be clear which condition is being explained (e.g.: not just 'too expensive and too slow') Mark independently. MP1: ALLOW high pressures are a safety risk OR high pressure is too dangerous. MP2: DO NOT ALLOW 'expensive to use high pressure and temperature'. DO NOT ALLOW 'low temperatures make the process slow', if response also states 'low temperatures are expensive and/or difficult to maintain'. <i>AW</i>

1 e	ΔH with downward arrow AND products labelled with products below reactants ✓ Two curves drawn from the reactants line to the products line, with one having a higher maximum than the other ✓ Arrows drawn upwards from reactants line to maximum of curve and labelled as E_a and E_c, as below ✓ 	3 DO NOT ALLOW a double headed arrow. E_c curve can be drawn with a double 'hump' as long as E_c is indicated as being from the reactant line to the highest point of the curve. For all three arrows: It must be clear from the diagram what the energy difference is that the arrows are marking. So, the arrows must start from (or very close to) reactants line and end as closely as possible to the maximum height of the curves, for E_a and E_c, or a close to being level with the reactants, for ΔH. Mark independently.
1 f	Provides large surface area OR increases surface area OR maximises surface area OR less catalyst needed AW ✓	1 NOT 'high' for large. IGNORE references to cost
1 g	1. Hydrogen bonding ✓ 2. Lone pair on oxygen ✓ 3. (bonds to) δ^+ hydrogen of another molecule ✓	3 MP2: NOT 'lone pair on oxygen molecule'. MP3: NOT 'δ^+ hydrogen molecule' MP3: ALLOW 'partial positive' or 'slightly positive' for δ^+. MP3: ALLOW lone pair on O and $H^{\delta+}$ from a diagram, but must be H of OH group that has the partial positive charge. MP3: Award this mark if response gives 'δ^+ hydrogen bonds to lone pair on another molecule'.

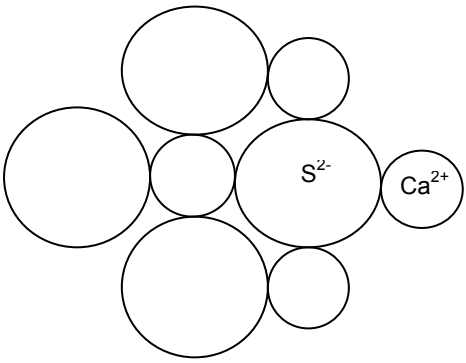
1	h	i	3200 – 3640 (cm ⁻¹) AND O–H ✓	1	ALLOW one number between 3200 and 3640 or any range within these numbers. ALLOW 'OH', but DO NOT ALLOW '–OH' (i.e.: it must be clear that the bond is between the O and the H and not the one that joins the OH group to the molecule). ALLOW C–H at 2850 – 2950 ALLOW C–O at 1050 – 1300
1	h	ii	Used to identify a compound OR distinguish between isomers OR distinguish between compounds with the same functional groups. ✓	1	ALLOW to distinguish between different alcohols, or named alcohols. ALLOW 'molecule', 'substance', 'chemical', for compound, but DO NOT ALLOW 'element'.
				16	

Question	Answer	Mark	Guidance
2 a	Alkene ✓	1	ALLOW C=C.
2 b	Boiling a liquid / mixture / chemical / solution / reactants <i>AW</i> ✓ 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 descriptions of boiling, such as 'heat a mixture until it vaporises'. ALLOW 'no gases or vapour escape' Can be scored from a diagram showing flask and vertical condenser. DO NOT ALLOW 'prevents evaporating' or (boiling mixture) 'in a vertical condenser'. Sealed equipment CONS the second mark.
2 c i	$\text{C}_{10}\text{H}_{14}\text{O} + 2\text{Br}_2 \rightarrow \text{C}_{10}\text{H}_{14}\text{OBr}_4$ 2 Br ₂ ✓ C ₁₀ H ₁₄ OBr ₄ as only product ✓	2	C, H, O and Br can be in any order in the product formula. ALLOW 1 mark for $\text{C}_{10}\text{H}_{14}\text{O} + \text{Br}_2 \rightarrow \text{C}_{10}\text{H}_{14}\text{OBr}_2$ ALLOW multiples of whole equation (e.g.: $2 \text{C}_{10}\text{H}_{14}\text{O} + 4 \text{Br}_2 \rightarrow 2 \text{C}_{10}\text{H}_{14}\text{OBr}_4$). Mark independently.

2 c ii	 One mark each for two curly arrows ✓✓ Both partial charges with $\delta+$ closest to double bond ✓ Intermediate structure with + charge in correct place ✓	4 DO NOT ALLOW half-headed arrows but ECF if candidate draws two half-headed arrows to the correct positions then award one mark. Curly arrow must be drawn carefully starting from near the bond and ending on an atom or pointing to the line between C and Br. ALLOW cyclic bromonium ion as intermediate. ALLOW any clear structure for intermediate (e.g.: $\text{CH}_2\text{BrC}^+\text{H}_2$ where it must be clear + is on C). IGNORE anything formed from the intermediate or Br^- as a product and any curly arrows on the intermediate side of the equation. ALLOW a maximum of 3 marks if any hydrogen atoms omitted, or extra hydrogen atoms shown. IGNORE partial charges on the ethene molecule. If left-hand side has more than 2 curly arrows, then each extra incorrect curly arrow negates a curly arrow mark. Mark separately
2 d	1. Phosphoric acid ✓ 2. Water at high temperature OR water at 300°C OR steam ✓ OR 1. <u>Concentrated</u> sulfuric acid ✓ 2. Add water ✓	2 IGNORE pressure IGNORE concentration of phosphoric acid and inert catalyst supports such as silica. ALLOW any temperatures of 100°C or above. ALLOW 1 and 2 either way round. H_2O mark dependent on acid mark in both cases (unless any additional reagents have been given, in which case water mark only can be awarded).

2 e	Any two from:  One mark for each correct structure ✓✓	2	Can be a more structured diagram. ALLOW structures that show bond lines to OH groups with the line to the H rather than the O.
2 f i	Reaction mixture stays orange / no colour change ✓ Tertiary alcohols are not oxidised / C=O is not oxidised OR Tertiary alcohols do not react / C=O does not react✓	2	IGNORE an incorrect colour if 'no colour change' or 'stays (wrong colour)' is also given. IGNORE references to ketones NOT just 'no change' or 'no reaction'. DO NOT ALLOW 2nd mark if referring to secondary or primary alcohol. ALLOW tertiary OH or description of a tertiary alcohol for 'tertiary alcohol'.
2 f ii	Loss of a molecule from a compound / one molecule becomes two / one reactant forms two products ✓ forming an unsaturated compound ✓	2	ALLOW for 1st mark: clear description of a specific elimination reaction (e.g.: water is lost from a molecule OR molecule is dehydrated OR molecule has hydrogen and oxygen atoms removed, which form water). ALLOW forming double bonds / C=C / alkenes

2	f	iii	<u>Remove water:</u> Sodium sulfate OR sodium sulphate OR Na₂SO₄, <i>or other salt with an anhydrous form</i> ✓ <u>Separate carvone and compound A:</u> Distillation ✓	2	ALLOW silica gel (but not just silica); sodium carbonate; calcium chloride; magnesium chloride; copper sulfate (this is only a selection of suitable responses). IGNORE calcium carbonate and sodium hydrogencarbonate and conc sulphuric acid. IGNORE fractional ALLOW chromatography
				19	

Question	Answer	Mark	Guidance
3 a i	$1s^2 2s^2 2p^6 3s^2 3p^6$ ✓	1	ALLOW upper or lower case letters but numbers must be superscripts ALLOW [Ne] $3s^2 3p^6$
3 a ii	$\text{Ca}^{2+} (\text{aq}) + \text{S}^{2-} (\text{aq}) \rightarrow \text{CaS} (\text{s})$ Equation ✓ State symbols ✓	2	Completely correct equation (i.e.: without spectator ions) scores the first mark. ALLOW answer with multiples. Mark state symbols separately – must have the idea of $(\text{aq}) + (\text{aq}) \rightarrow (\text{s})$ Mark independently. (Equations like: $\text{CaCl}_2 (\text{aq}) + \text{S}^{2-} (\text{aq}) \rightarrow \text{CaS} (\text{s}) + 2\text{Cl}^- (\text{aq})$ score 1 mark for correct state symbols on the appropriate species).
3 a iii	 1. Smaller circles labelled Ca^{2+} and larger circles labelled S^{2-} ✓ 2. At least one more large circle correctly drawn, to show ions alternate ✓ 3. At least one small circle surrounded by 4 large circles ✓	3	IGNORE particles shown in other layers. MP1: ALLOW ecf from (a)(ii) MP1: DO NOT ALLOW mark if diagram includes electrons OR if <i>any</i> circles are incorrectly labelled. MP1: ALLOW positive ions labelled 'calcium' and negative ions labelled 'sulphide'. MP2: DO NOT ALLOW if large circles are in contact with each other. Mark independently. IGNORE any overlap between small and large circles.

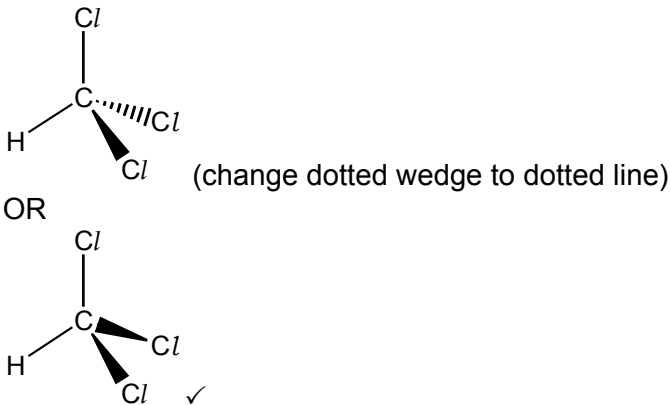
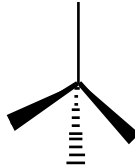
3	b	i	$(15.70 \times 0.0250 / 1000) = 0.0003925$ ✓	1	ALLOW standard form: 3.925×10^{-4} ALLOW 0.000393 or 0.00039
3	b	ii	Answer to (b) (i) ✓	1	ALLOW answer to (b) (i) that has been rounded.
3	b	iii	Answer to (b)(ii)/40 ✓ x 1000 and evaluated (= 0.0098125) ✓ Correct evaluation of candidates calculation to 3sf (=0.00981) ✓	3	Correct answer on its own (i.e.: no working shown) scores all three marks – even if answer to (b)(ii) is incorrect. ALLOW sf mark for an answer that is the correct 3sf value of any shown calculation.
3	c	i	$\text{Li (g)} \rightarrow \text{Li}^+ \text{ (g)} + \text{e}^-$ Equation with correct state symbols ✓	1	ALLOW e without a sign for the electron symbol OR ${}_{-1}^0\text{e}$ ALLOW $\text{Li (g)} - \text{e}^- \rightarrow \text{Li}^+ \text{ (g)}$ IGNORE state symbol on electron DO NOT ALLOW capital 'G' for state symbol. DO NOT ALLOW multiples of the equation.
3	c	ii	Outer Li electron is closer to the nucleus (ORA) OR Outer Li electron has less shielding (ORA) OR Outer Li electron has fewer electron shells (between it and the nucleus) AW (ORA) ✓ <u>Nuclear</u> attraction (to electron) is stronger / pull from the <u>nucleus</u> (to electron) is stronger / pull from the <u>nuclei</u> (to electron) is stronger AW (ORA) ✓	2	Both need to be a comparison. IGNORE 'molecule' ALLOW 'it' for lithium. ALLOW descriptions of 'outer', such as 'outermost', 'furthest from nucleus', 'in highest energy level'. Nucleus / nuclear / nuclei must be correctly spelled at least once for the second mark to be awarded (with tick on correct spelling, not on pencil icon). Mark separately.

3 d	1.7% = 17000 ppm ✓ 17000/400 = 42.5 times more concentrated ✓ OR 400ppm = 0.04% ✓ 1.7/0.04 = 42.5 times more concentrated ✓	2	ALLOW 2 or more sf ALLOW ecf for second mark. Answer alone scores 2 marks without any reference to working (if any)
3 e	1. The temperature is higher OR water is hotter ✓ 2. Particles have more <u>kinetic</u> energy ✓ 3. There are more frequent successful <u>collisions</u> OR there are more frequent effective <u>collisions</u> ✓ OR Greater proportion of <u>collisions</u> has total energy of at least the activation enthalpy OR greater proportion of <u>collisions</u> is successful.	3	ALLOW reverse argument throughout. IGNORE answers in terms of concentrations. 1.ALLOW 'warmer' for 'hotter'. ALLOW 'give out heat'. 2.ALLOW 'ions' or 'molecules' for particles, but IGNORE 'reactants have more kinetic energy' and IGNORE 'bonds have more kinetic energy'. ALLOW particles move faster. 3.ALLOW 'more frequent <u>collisions</u> with energy greater than activation energy' but idea of frequency (not just 'more') must be there. DO NOT ALLOW 'greater chance of collisions'. DO NOT ALLOW just 'more' for greater proportion' Answer must be in terms of the collision, not the particles (e.g.: not 'more particles have energy greater than activation energy when they collide').
		19	

Question	Answer	Mark	Guidance
4 a	1,1,2-trichloro-1,2,2-trifluoroethane Trichlorotrifluoroethane ✓ 1,1,2 and 1,2,2 ✓	2	IGNORE commas, dashes and spaces. ALLOW minor spelling errors, such as 'flouro'. Mark independently. ALLOW 1,2,2-trichloro-1,1,2-trifluoroethane for 2 marks ALLOW 1,1,2-trifluoro-1,2,2-trichloroethane OR 1,2,2-trifluoro-1,1,2-trichloroethane for 1 mark.
4 b i	C-Br ✓	1	ALLOW answer in words. DO NOT ALLOW 'the bromine bond' OR 'the Br bond'.
4 b ii	Visible / ultraviolet / UV ✓	1	

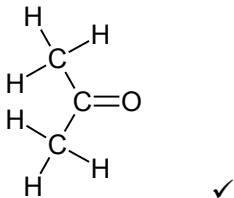
4 b iii	<u>CALCULATION A: Energy to break one bond:</u> $(290 / 6.02 \times 10^{23}) \checkmark$ $\times 1000 (= 4.817 / 4.82 / 4.8 \times 10^{-19} \text{ J}) \checkmark$ <u>CALCULATION B: Minimum frequency to break one bond</u> Candidate value for energy in J / 6.63×10^{-34} and evaluate $(= 7.266 / 7.27 / 7.3 \times 10^{14} \text{ Hz}) \checkmark$ <u>CALCULATION C: Energy of one photon</u> $6.63 \times 10^{-34} \times 5.3 \times 10^{14} (= 3.514 / 3.51 / 3.5 \times 10^{-19} \text{ J}) \checkmark$ <u>CALCULATION D: Energy of one mole of photons</u> Candidates value for energy in J / 1000 $\checkmark$ $\times 6.02 \times 10^{23}$) and evaluate $(= 211.5 / 211 / 210 \text{ kJ mol}^{-1}) \checkmark$ <u>Will bond break?</u> <u>Response has A and B:</u> Candidates answer $> 5.3 \times 10^{14} \text{ Hz}$: bond does not break because frequency of radiation/energy is less than that needed to break bond. (ORA) $\checkmark$ <u>Response has C and D:</u> Candidates answer $< 290 \text{ kJ mol}^{-1}$: bond does not break because radiation has energy/ frequency less than that needed to break bond. (ORA) $\checkmark$ <u>Response has A and C (with C evaluated):</u> Energy to break one bond $>$ energy of one photon, so bond does not break. (ORA) $\checkmark$	4 IGNORE sig figs. A completely correct answer to the calculation on its own scores 3 marks. IGNORE evaluations at the end of intermediate steps in the calculation. In B and D, allow candidate value from previous part of working to any number of sf. DO NOT ALLOW mark for explanation if no calculation has been attempted. ALLOW ecf for explanation mark from incorrect calculation that shows bond will break (e.g.: candidate's calculated value for energy or frequency of radiation is greater than bond energy).
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4 c	1. <u>Both</u> (AW) form chlorine radicals AW OR UV can break C-Cl bonds in <u>both</u> ✓ 2. CFC-113 can form <u>more</u> (chlorine) radicals OR CFC-113 has <u>more</u> Cl / CFC-113 has <u>more</u> C-Cl bonds ✓ 3. Chlorine radicals <u>catalyse</u> the breakdown of ozone ✓	3	ALLOW chlorine atoms or Cl for chlorine radicals. MP1 & MP2: IGNORE halogen radicals and Br radicals and F radicals. MP2: ALLOW 'chlorines' or 'chlorine' for Cl MP3: ALLOW mark if response refers to halogen radicals or F or Br radicals rather than Cl radicals.
4 d	Chlorine: Toxic / poisonous / causes respiratory diseases ✓ Methane: Greenhouse gas / causes global warming / causes greenhouse effect ✓	2	IGNORE harmful / irritant / dangerous / breathing problems / comments about ozone breakdown..
4 e	All correct for one mark ✓	1	Any two different symbols can be used to represent the bonding electrons. Candidate does not have to draw circles for electron shells.

4 f	 (change dotted wedge to dotted line) OR Bond angle 109° ✓	2 ALLOW other 3-D representations of the molecule. ALLOW hydrogen in any position. Diagram needs to be as shown on the left or one bond in the plane, with two coming out of the plane of the page and one going in (or vice versa) - like this, but with atoms labelled:  If two bonds are shown in the same plane, they must be next to each other (i.e.: not two lines in the same plane at 180° to each other). ACCEPT bond angle values in the range 107 – 111 ° DO NOT ALLOW diagram mark if molecule is incorrect.
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4 g	(a) Earth absorbs uv and radiates ir ✓ (b) CHCl_3 molecules absorb ir ✓ (c) bonds vibrate ✓ (d) vibrational energy becomes KE / increase in vibrational energy increases KE OR KE becomes thermal energy OR molecules radiate ir ✓ <i>QWC for connection of ideas:</i> <i>Linking absorbing ir with MP(c)</i> or <i>linking absorbing ir with MP(d)</i> ✓	4 1	(a) ALLOW 'emits' or 'gives out' for radiates, but DO NOT ALLOW reflects. (b) ALLOW 'molecules' for CHCl_3 (but not 'it', unless clearly in the context of CHCl_3). (c) ALLOW this for answers suggesting other radiations are absorbed by the CHCl_3. Also, ALLOW 'increases vibrational energy of bonds or molecules'. (d) ALLOW 'emits' or 'gives out' for radiates. ALLOW 'heat' for thermal energy'. Please indicate QWC mark using red cross or green tick on the right of the pencil icon on the answer screen.
4 h i	<i>Two from:</i> Models of the atmosphere and the models' temperatures ✓ Computer models of the atmosphere's composition and temperature ✓ Temperature and concentration data from the atmosphere ✓	2	

4	h	ii	As <u>concentration</u> of greenhouse gases increases, atmospheric <u>temperatures</u> increase. <i>AW</i>	1	DO NOT ALLOW just 'atmosphere gets warmer' for temperature increases and DO NOT ALLOW 'level' for concentration. IGNORE increase in concentration of greenhouse gases causes increase in temperature. ALLOW answers in terms of <u>positive</u> correlation
4	i		<i>Advantage:</i> They are broken down in the troposphere/they do not reach the stratosphere ✓ <i>Disadvantage – one of:</i> (they are also) greenhouse gases / global warming gases OR more expensive OR form HF ✓	2	If the response does not state which is the advantage and which the disadvantage, assume the advantage comes first and the second is the disadvantage. IGNORE less effective
				26	

Question	Answer	Mark	Guidance
5 a i		1	Diagram must show all atoms and all bonds.
5 a ii	Ketone ✓	1	ALLOW carbonyl. ALLOW minor spelling errors, such as 'keytone'.
5 b	Electrophilic addition ✓	1	
5 c i	Carbocation ✓	1	ALLOW 'carbonium ion'.
5 c ii	100% ✓	1	Answer must be a percentage and not just a number.
5 d	High temperature <u>and</u> high pressure ✓ Platinum ✓	2	ALLOW temperatures 100-200 ^o and pressures >1≤10atm ALLOW high temperature and pressure ALLOW answers in either order. IGNORE conditions for platinum catalyst.

5 e	Any 3 from: - One uses only 2-methylpropene and the other uses 2-methylpropene and 2-methylpropane ✓ - Catalysts are different OR one uses HF, the other uses H₂SO₄ OR one uses HF, the other uses Ni - One uses one catalyst, the other uses two ✓ - The processes have different number of steps. ✓ - One uses a heterogeneous catalyst and the other a homogeneous catalyst ✓ - One uses high temperatures and pressures, the other doesn't need them. ✓	3	Answers must be comparisons. MP1: ALLOW one has one organic reactant, the other has two OR one uses 2-methylpropene, the other uses 2-methylpropane. MP2: DO NOT ALLOW 'one uses H₂SO₄, the other uses Ni'. MP5: ALLOW one has reactants in same phase as catalyst; the other has reactants in different phase from catalyst. IGNORE comments about intermediates.
5 f	Poly(phenylethene) ✓	1	ALLOW 'poly(styrene)' or 'poly phenylethene'
5 g i	A bond breaks so that each new particle has one of the bonding electrons OR bond breaks forming two new particles each with an unpaired electron <i>AW</i> OR Homolytic fission ✓	1	ALLOW homolysis

5 g ii	$\text{R-O}^\bullet + \text{H}_2\text{C}=\text{CHCH}_3 \rightarrow \text{RO-CH}_2\text{-CHCH}_3^\bullet$ OR $\text{RO-CH}_2\text{-CHCH}_3^\bullet + \text{H}_2\text{C}=\text{CHCH}_3 \rightarrow \text{RO-CH}_2\text{-CHCH}_3\text{-CH}_2\text{-CHCH}_3^\bullet$ OR $\text{R-O}^\bullet + \text{CHCH}_3=\text{CH}_2 \rightarrow \text{RO-CHCH}_3\text{-CH}_2^\bullet$ OR $\text{RO-CHCH}_3\text{-CH}_2^\bullet + \text{CHCH}_3=\text{CH}_2 \rightarrow \text{RO-CHCH}_3\text{-CH}_2\text{-CHCH}_3\text{-CH}_2^\bullet$	1 Allow other structural representations of the species. Allow any equation of the form: $\text{RO-(CH}_2\text{-CHCH}_3)_n^\bullet + \text{H}_2\text{C}=\text{CHCH}_3 \rightarrow \text{RO-(CH}_2\text{-CHCH}_3)_{n+1}^\bullet$ OR $\text{RO-(CHCH}_3\text{-CH}_2)_n^\bullet + \text{CHCH}_3=\text{CH}_2 \rightarrow \text{RO-(CHCH}_3\text{-CH}_2)_{n+1}^\bullet$ where n is an integer (if written out in more detail, check sequence of CH₂ then CHCH₃ correct) ALLOW responses without the 'dot' for the unpaired electron or incorrectly positioned 'dots'.
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5 h	1. <u>One property for each, taken from:</u> Atactic: soft / rubbery / flexible Isotactic: strong / hard / rigid / excellent resistance to stress / excellent resistance to cracking. ✓ 2. Both have instantaneous (dipole) – induced dipole bonds. ✓ <u>Explanation:</u> 3. Isotactic chains are stereoregular (ORA) OR atactic has methyl groups randomly oriented OR isotactic has all methyl groups in same orientation ✓ 4. Atactic chains cannot pack as closely (ORA) / atactic chains have less surface contact (ORA) ✓ 5. which leads to atactic having weaker (intermolecular) bonds (ORA) ✓ 6. so less energy is needed to break (intermolecular) bonds in atactic (ORA) OR less force is needed to break (intermolecular) bonds in atactic (ORA) OR chains of atactic slide over each other more easily (ORA) OR less force is needed to make atactic chains slide over each other (ORA) ✓ <i>QWC for showing clearly that the process from mp5 follows from the process in mp4 OR that the process from mp6 follows from mp5 ✓</i>	6 Please use annotations on answer in appropriate place One mark for <u>both</u> properties. ALLOW atactic is softer (ORA), OR atactic is more flexible (ORA) OR atactic is less dense (ORA) OR atactic has a lower Tm or Tg (ORA) (must be a comparison). MP2: ALLOW van der Waals. MP3: ALLOW 'branches' for 'methyl groups'. MP3: IGNORE 'stereochemical' and 'regular' for stereoregular. MP4: DO NOT ALLOW just 'don't fit together easily / less easily' (ora) MP5: ALLOW less/fewer intermolecular bonds / attractive forces can form between atactic chains (ora) / attractive forces are weaker between atactic chains (ora) MP6: Answer must be a comparison. Please indicate QWC mark using red cross or green tick onto the right of the pencil icon on the answer screen.
		1 20

APPENDIX 1

Use this space for a generic mark scheme grid that applies across the question paper

APPENDIX 2

Use this space if you have extensive subject specific information that is inappropriate to include in section 10 page 3.

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