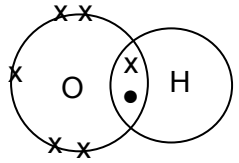
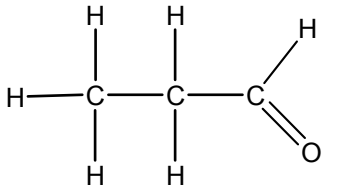
F332 Chemistry of Natural Resources

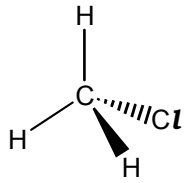
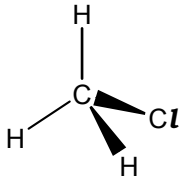
Question			Expected Answers	Marks	Additional Guidance
1	(a)		Incomplete combustion ✓ of hydrocarbons ✓	2	**ALLOW** not enough oxygen or air linked to the idea of combustion / uncomplete combustion Second mark depends on the first. **ALLOW** fossil fuel or named fossil fuel / carbon in the fuel / organic fuel **DO NOT ALLOW** just 'fuel' or carbon as the fuel
	(b)		Toxic / poisonous / reduces the capacity of blood to carry oxygen around the body / AW ✓ **AND** *Any **one** from:* causes (photochemical) smog ✓ oxidised to CO_2 which is a greenhouse gas / reacts with O_2 to form CO_2 which is a greenhouse gas ✓	2	**ALLOW** respiratory problems, but not breathing problems. **IGNORE** harmful / dangerous Answer must have the CO_2 **AND** the greenhouse gas for this alternative. **ALLOW** global warming instead of greenhouse gas.
	(c)	(i)	Homolytic (fission) / homolysis ✓	1	**IGNORE** 'photochemical dissociation'

Question			Expected Answers	Marks	Additional Guidance
		(ii)	464 x 1000 ✓ Energy value/6.02 x 10^{23} **AND** a correct evaluation (= 7.71 x 10^{-19} J) ✓	2	One mark is for converting from kJ to J (ie: multiplying by 1000) The other is for dividing their energy value by 6.02 x 10^{23} (the Avogadro constant) **ALLOW** 2 or more sig. figs. but rounding must be correct. 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.
		(iii)	Answer to **(c)(ii)**/6.63 x 10^{-34} ✓ = 1.16 x 10^{15} ✓ 3 sig. fig. ✓	3	**DO NOT ALLOW** the second mark for evaluating any other expression (eg: answer to **(c)(ii)** x 6.63 x 10^{-34}) **ALLOW** sig. fig. mark for any 3 sig. fig. answer that follows from any calculation (even if their evaluation of their calculation is incorrect). A completely correct answer on its own scores all marks, including the sig. fig. mark.
	(d)	(i)	(A particle) with one (or more) unpaired electron(s). ✓	1	Answer must be in the context of an electron as part of some sort of particle. **IGNORE** 'free' or 'lone' or single electron.
		(ii)	 bond electrons ✓ rest of structure ✓	2	Any symbols can be used to represent the electrons (including the same symbol for all electrons). Candidate does not have to draw circles for electron shells. Non-bonding electrons do not have to be shown in pairs. It **MUST** be clear that a pair of electrons (with any symbols) is being shared between the H and the O for the first mark. **IGNORE** any inner electron shells.

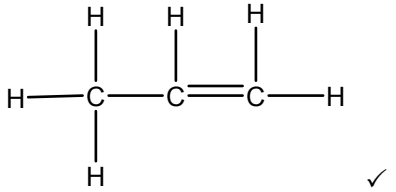
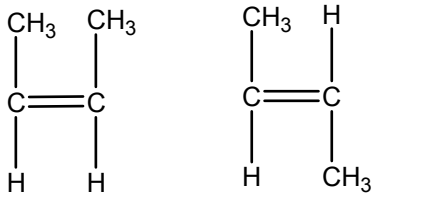
Question			Expected Answers	Marks	Additional Guidance
		(iii)	propagation ✓ one radical is used and replaced by another / AW ✓	2	 **ALLOW** there is a radical on both sides of the equation. Mark independently.
	(e)		*SiO_2*: giant covalent / network solid / lattice / whole structure held together by covalent bonds / diagram ✓ *CO_2*: simple molecular / molecules / O=C=O / AW ✓ *comparison of forces:* <u>weak</u> intermolecular bonds (or forces) in CO_2 / less energy needed to separate molecules / bonds in SiO_2 are stronger than CO_2 intermolecular bonds (or forces) ✓	3	**IGNORE** 'intermolecular bonds' in SiO_2 / giant molecule / giant structure Marks can be given for a labelled / annotated diagram **IGNORE** 'covalent'. Any type of intermolecular bonds can be named and can be abbreviated. It must be clear that the intermolecular bonds in CO_2 are being discussed, not the covalent bonds.
	(f)	(i)	0.008 / 8 x 10^{-3} ✓	1	

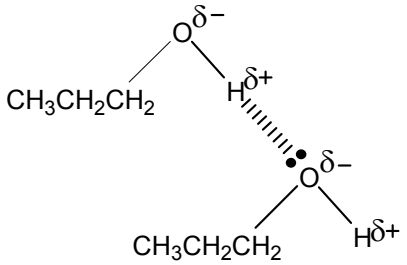
Question			Expected Answers	Marks	Additional Guidance
		(ii)	*Any **four** points from:* 1 Sun emits UV ✓ 2 Earth absorbs some of the energy (from the Sun) / heats up ✓ 3 Earth radiates emits / re-emits IR ✓ 4 (CO_2) absorbs IR radiation ✓ 5 making <u>bonds</u> vibrate (more) ✓ 6 turned into kinetic energy that raises the temperature / transfers kinetic energy to thermal energy or heat or it warms the atmosphere or Earth. ✓ 7 some CO_2 molecules radiate IR (which warms Earth) ✓ **AND** more CO_2 molecules means more radiation is absorbed / more CO_2 means greater temperature increase / enhancing the greenhouse effect / causing global warming / warming the atmosphere / Earth / planet more ✓ **QWC -** *mark for connection of ideas: idea of linking IR absorbtion to vibrations of bonds / increase in temperature (marking point 4 linked to 5 or 6)* ✓	**6**	**IGNORE** other types of radiation from the Sun. **DO NOT ALLOW** Earth reflects IR in point 3. Award marks for points 5 and 6 if the wrong frequency range of radiation is given as being absorbed in 4. (eg candidate states CO_2 absorbs UV).
	(g)	**(i)**	aldehyde(s) ✓	**1**	**ALLOW** alkanal(s)
		(ii)	$CO + C_2H_4 + H_2 \rightarrow CH_3CH_2CHO$ ✓✓	**2**	**ALLOW** C_3H_6O or full structural formula for propanal. Completely correct scores both marks. Correct formula for ethane / correctly identifies H_2 as the additional reagent scores one mark.

Question			Expected Answers	Marks	Additional Guidance
		(iii)	 ✓	1	
			Total	**29**	

Question			Expected Answers	Marks	Additional Guidance
2	(a)		Bromoalkane(s) / halogenoalkane(s) ✓	1	**ALLOW** halokane(s) / haloalkane(s) / halogenoalkane
	(b)	(i)	$CH_3OH + HBr \rightarrow CH_3Br + H_2O$ ✓✓ Right hand side ✓ Left hand side ✓	2	**ALLOW** CH_4O / BrH / $BrCH_3$ **IGNORE** state symbols
		(ii)	Nucleophilic ✓ Substitution ✓	2	Any clear indication scores the mark eg: circled. If more than two choices indicated, each extra response **CON**s a correct answer.
	(c)	(i)	Amine(s) ✓	1	**ALLOW** small spelling error.
		(ii)	CH_3NH_2 / CH_5N ✓	1	
	(d)		δ+ on C and δ- on C*l* ✓	1	**IGNORE** δ+ on Hs. **DO NOT ALLOW** δ- on Hs
	(e)		 **OR**  ✓ bond angle 109º ✓	2	**ALLOW** other 3-D representations of the molecule. **ALLOW** chlorine in any position. Diagram needs to be as shown on the left or one bond in the plane, with two going into the plane of the page and one coming out (or vice versa). **DO NOT ALLOW** two bonds in the same plane at 180º. **ACCEPT** bond angle values in the range 100 – 112º

Question			Expected Answers	Marks	Additional Guidance
	(f)		*Any **two** from:* 1. chloromethane is not broken down / unreactive in the troposphere / lower atmosphere ✓ 2. but is broken down / photodissociated (in the stratosphere) / AW by ✓ 3. high energy UV / high frequency UV ✓ 4. (breakdown of chloromethane) producing chlorine atoms / chlorine radicals ✓ **AND** (products of chloromethane) <u>catalyse</u> ozone breakdown / AW ✓ C–Br bond is weaker (than C–C*l*) ORA ✓ so can be broken in the <u>troposphere</u> / molecule reacts in the <u>troposphere</u> / reacts before reaching the stratosphere ✓	**5**	**ALLOW** 'radiation' for 'UV' Points 2 and 4 can be scored from a reaction equation. **QWC**: To gain this mark, candidate must use the word catalyst or a derivative of it, spelled correctly and used in a grammatically correct way (eg: do not award for 'it catalyse the breakdown of ozone'). **ALLOW** 'catalyze'.
	(g)	(i)	(concentration) values were low ✓	**1**	Answers need to show that values were less and not just different from the expected ones.
			Total	**15**	

Question			Expected Answers	Marks	Additional Guidance
3	(a)	(i)	addition ✓	1	**DO NOT ALLOW** additional.
		(ii)	propene ✓  ✓	2	**ALLOW** prop-1-ene **DO NOT ALLOW** prop-2-ene Mark independently. No ecf for the second mark.
	(b)	(i)	bromine (water) ✓	1	**ALLOW** Br_2
		(ii)	(from) brown / orange / yellow ✓ (to) colourless ✓	2	**ALLOW** any combination of these colours, but no others for the first mark (eg no mark for red / brown). **DO NOT ALLOW** clear for the second answer
	(c)		 (Z) ✓ (E) ✓	2	Name and structure required for the mark in each case Correct structures with names swapped round scores 1 mark. Diagrams do not have to show correct bond angles. A correct representation of but-2-ene scores 1.
	(d)		instantaneous (dipole) - induced dipole ✓	1	**ALLOW** temporary dipole–induced temporary dipole / van der Waals forces
	(e)	(i)	low flexibility / resistant to chemical attack / does not react with water / unreactive / not prone to stress fractures / high <u>tensile</u> strength / abrasion resistant / impermeable / insoluble / rigid ✓	1	**IGNORE** strong, hard, durable, tough, malleable, dense, high melting point, can be moulded or remoulded. **ALLOW** waterproof or 'will not wear away'.
		(ii)	bags ✓	1	**IGNORE** food wrap / cling film / packaging.
			Total	**11**	

Question			Expected Answers	Marks	Additional Guidance
4	(a)	(i)	 hydrogen bond between correct atoms ✓ lone pair on relevant O in line with H bond ✓ partial charges shown, δ– on each O and δ+ on each H ✓ O–H–O straight ✓	4	Hydrogen bond can be shown in other forms, but not as a solid line. Second mark, but **NOT** third mark, can be scored if the hydrogen bond is between incorrect atoms.
		(ii)	*Any **three** from:* 1. intermolecular bond in propene is instantaneous dipole-induced dipole ✓ 2. hydrogen bonds / intermolecular bonds (in propan-1-ol) are stronger than those in propene (ORA) ✓ 3. intermolecular bonds must be broken for the liquid to boil ✓ 4. more <u>energy</u> is needed to break them (ORA) ✓ **AND** **QWC -** mark for connection of ideas: idea of linking strength of intermolecular bonds to amount of energy needed to break them ✓	4	**ALLOW** van der Waals' **DO NOT ALLOW** harder / easier **DO NOT ALLOW** 'higher temperature' for 'more energy'.

<table>
<tr><th colspan="3">Question</th><th>Expected Answers</th><th>Marks</th><th>Additional Guidance</th></tr>
<tr><td></td><td>(b)</td><td></td><td>Elimination ✓</td><td>1</td><td>ALLOW any indication of chosen answer (eg: circling).

DO NOT ALLOW the mark if more than one answer has been chosen.</td></tr>
<tr><td></td><td>(c)</td><td></td><td><table><tr><th>reagent</th><th>conditions</th></tr><tr><td>sulfuric / phosphoric acid ✓</td><td>heat / reflux ✓

concentrated ✓</td></tr><tr><td colspan="2">OR</td></tr><tr><td>alumina / silica / pumice / porous pot ✓</td><td>heat ✓

with (propan-1-ol) vapour ✓</td></tr></table></td><td>3</td><td>ALLOW correct formula for reagent.

ALLOW temperatures over 100°C for the heat mark

Sulfuric acid AND alumina: CON reagent mark (but can still score condition marks).
Clear alternatives (ie: sulfuric acid OR alumina) scores the mark.

ALLOW c. for concentrated.
Aqueous / water CONs the concentrated mark.

The conditions marks may only be awarded if candidate has written an appropriate reagent, even if they have made a small mistake, eg: sulfuric without acid, or wrong formula (like A1O)

(Concentrated) sulfuric acid with dichromate and heat scores zero.

IGNORE references to pressure conditions.</td></tr>
<tr><td></td><td>(d)</td><td></td><td>rate of forward reaction = rate of back reaction ✓

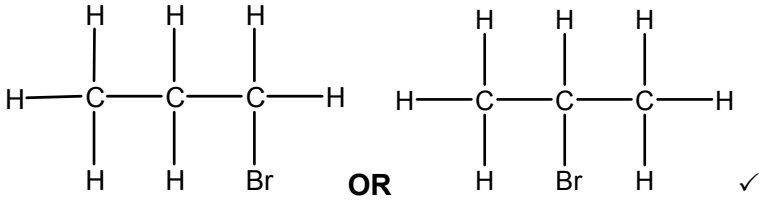
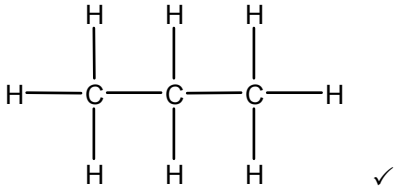
<u>concentrations</u> of reactants and products remain constant / closed system ✓</td><td>2</td><td>IGNORE references to steady state.</td></tr>
<tr><td></td><td>(e)</td><td>(i)</td><td>amount of <u>propene</u> produced decreases ✓

(increased pressure) pushes (position of) <u>equilibrium</u> to the left/to the reactants / side with fewest molecules ✓</td><td>2</td><td>MUST mention equilibrium for the second mark.

Mark independently.</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>amount of <u>propene</u> produced increases ✓

(increased temperature) pushes (position of) <u>equilibrium</u> in the endothermic direction / to the right / to the products ✓</td><td>2</td><td>MUST mention equilibrium for the second mark.

Mark independently.</td></tr>
</table>

Question			Expected Answers	Marks	Additional Guidance
	(f)		*Any **three** from:* 1. increased pressure increases number of particles per unit of volume ✓ 2. more collisions occur ✓ 3. (more collisions) per unit of time ✓ 4. rate increases/gets faster ✓	3	**ALLOW** 'particles are closer together' for the first point **DO NOT ALLOW** 'reactants are closer together'. More frequent collisions / collisions occur more often covers two points ✓✓ **IGNORE** more likely to collide / greater chance of collisions in point 2.
	(g)	(i)	 **OR** ✓	1	**ALLOW** any clear representations of a structural formula, eg: $CH_3CHBrCH_3$
		(ii)	 ✓	1	**ALLOW** $CH_3CH_2CH_3$
	(h)		platinum ✓	1	**ALLOW** Pt.
			Total	10	

Question			Expected Answers	Marks	Additional Guidance
5	(a)		Chemical that: causes another chemical to be oxidised / is itself reduced / decreases in oxidation state / is an electron acceptor / removes electrons from another chemical ✓ O_2 / (potassium) manganate(**VII**) ✓ **AND** either (Oxidises) iron from oxidation state +2 / Fe(II) ✓ to +3 / Fe(III) ✓ **OR** (Manganese reduced) from Mn(**V**II) / +7 / manganate(**V**II) ✓ to Mn(IV) / +4 / manganese(I**V**) oxide ✓	**4**	**ALLOW** 'chemical that oxidises another chemical' / oxidising agent. **IGNORE** references to change in pH. **ALLOW** permanganate / MnO_4^- / $KMnO_4$ Fe^{2+} to Fe^{3+} scores 1.
	(b)		Al^{3+} (aq) + $3HCO_3^-$ (aq) → $Al(OH)_3$ (s) + $3CO_2$ (g / aq) ✓✓✓ Correct species ✓ Balanced ✓ State symbols ✓	**3**	Second and third marks depend on the first. **ALLOW** Al^{3+} (aq) + HCO_3^- (aq) → $Al(OH)_3$ (s) for one mark, if no other mark is scored (**IGNORE** any other chemicals)
	(c)		Calcium hydroxide / calcium oxide ✓ Sodium carbonate ✓ Hydrogencarbonate ✓	**3**	**IGNORE** a correct oxidation state for Ca and Na **ALLOW** 'hydrogen carbonate' but **NOT** 'bicarbonate'
	(d)		Calcium ions more highly charged or more positive (than sodium ions) / mention of Ca^{2+} and Na^+ ✓ so are more strongly attracted to the negative charge on the resin / $(R)COO^-$ / anion groups ✓	**2**	**IGNORE** references to reactivity. **DO NOT ALLOW** just 'attracted to the resin'.

Question			Expected Answers	Marks	Additional Guidance
	(e)		moles Ca^{2+} = (800/1000) x 0.002 (=0.0016) ✓ moles Na^{+} = 2 x moles Ca^{2+} (= 0.0032) ✓ mass Na^{+} = moles Na^{+} x 23 = (0.0032 x 23 = 0.0736 / 0.074) (g) ✓	3	Mass Na^{+} = 0.0368 / 0.037 scores 2.
	(f)		*Any **five** points from:* 1. kills bacteria / kills pathogens / disinfectant ✓ 2. cheap compared to other water treatment chemicals. ✓ 3. Cl_2 or chlorine is a gas, making it difficult to contain / it spreads easily. ✓ 4. toxic / poisonous ✓ 5. causes respiratory problems / breathing problems ✓ 6. forms by-products / THMs that are suspected carcinogens ✓ 7. dissolves in rivers / local water supplies ✓ 8. forming bleach and acid ✓ 9. (bleach and acid) kill life forms in the water ✓	5	**DO NOT ALLOW** just 'cheap'. Answer must have 'gas' and either 'difficult to contain' or 'spreads easily' to gain the mark. **ALLOW** Cl_2 / chlorine is a gas so needs a strong container. **IGNORE** 'difficult to store / difficult to transport' **DO NOT ALLOW** harmful / irritant / dangerous instead of toxic. Answer must have 'by-products / THMs' and 'suspected carcinogens' to gain the mark.
			Total	**20**	