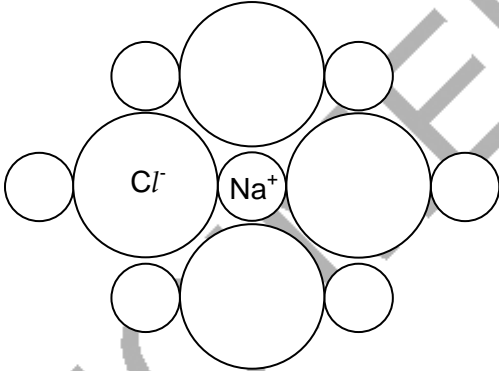

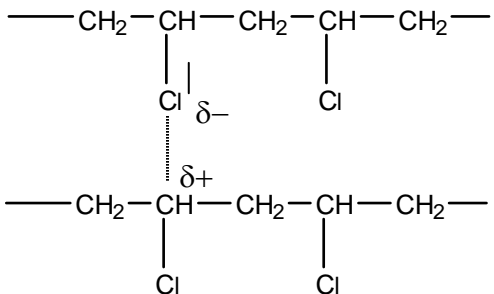


The maximum mark for this paper is 100.

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Question Number	Answer	Max Mark
1(a)	Instantaneous dipole – induced dipole forces (✍ must be correctly spelled) between molecules (1); these are weak, so need little energy to overcome them and produce chlorine gas (1)	[2]
(b)	Volatile/gas (1); toxic to humans/causes respiratory diseases/choking gas (1)	[2]
(c)(i)	increase in (chloride ion) <u>concentration</u> (1); will cause <u>equilibrium</u> (position) to move to the left AW (1); (molecular) chlorine/ Cl_2 (concentration) increases (1)	[3]
(ii)	For example:  correct sized ions for Cl^- and Na^+ (1); 4 oppositely charged ions or atoms around each type of ion/atom (1)	[2]
(iii)	1st IE is low (1), 2nd IE is <u>very</u> (AW) high (1).	[2]
(d)(i)	$\text{Cl}_2 = 0$ (1) $\text{HOCl} = +1$ (1)	[2]
(ii)	Oxidation/redox (1)	[1]
(iii)	Oxidation state of Cl has increased/ Cl has lost electrons (1)	[1]
(iv)	$\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-$	[1]
(e)	$2\text{HClO} \rightarrow 2\text{HCl} + \text{O}_2$ Correct formulae for products (1) Balancing (1)	[2]

Question Number	Answer	Max Mark
<p>2(a)</p> <p>(b)</p> <p>(c)(i)</p> <p>(ii)</p> <p>(iii)</p>	<p>Lean burn engines/ oxygen sensors/ reduced drag/ more complete combustion/ more oxygenates (1)</p> <p>Four from: UV/ visible (1); (warms) Earth (1); which radiates IR (1); makes bonds vibrate (1) more (1)  warm Earth must be related to IR and IR related to vibration (1)</p> <p>System not closed/ as CO₂ (g) moves away from surface/ CO₂ is ionised (1)</p> <p>1. Pump it under pressure onto the ocean floor (1); 2. Pump it underground into spent oil or gas wells (1)</p> <p>The CO₂ combines with any minerals in the surrounding rocks to convert them to carbonates/ pH of Oceans might be affected (1)</p>	<p>[1]</p> <p>[5]</p> <p>[1]</p> <p>[2]</p> <p>[1]</p>
<p>3(a)</p> <p>(b)(i)</p> <p>(ii)</p> <p>(c)(i)</p> <p>(ii)</p>	<p>(drain)pipes/window <u>frames</u>/doors/roofing (1)</p> <p>electrophilic (1) addition (1)</p> <p>elimination (1)</p> <p>permanent dipole—permanent dipole (1)</p> <div style="text-align: center;">  </div> <p>δ+, δ- correct (1); indication of attraction (1)</p>	<p>[1]</p> <p>[2]</p> <p>[1]</p> <p>[1]</p> <p>[2]</p>

Question Number	Answer	Max Mark
(d)(i)	Hydrogen (1); Ni, hot or Pt (room temperature and pressure) (1)	[2]
(ii)	Primary (1); as OH is attached to CH ₂ / C with OH attached to one other C (1)	[2]
(iii)	Aldehyde (1)	[1]
(iv)	(potassium/sodium) dichromate/ correct formula (1); (sulfuric) acid (1); distil (1) <i>NOT heat</i>	[3]
(e)	<i>M_r</i> chloroethene = 62.5 ethanol = 46 (1); Moles chloroethene = 10/62.5 (=0.16) moles ethanol = 1.5/46 (=0.0326/0.033) (1); = moles ethanol (0.16) (1); % = 0.0326 x 100/0.16 = 20% (1) 2 s.f. (1) Mark separately provided some working shown. ecf from figures above (allow 21% if 0.033 moles ethanol used)	[5]
(f)(i)	Peak at ~3200 cm ⁻¹ (<i>or indicated on spectrum</i>) shows (alcoholic) OH bond (1)	[1]
(ii)	Run IR spectrum for known sample of ethanol (1); compare spectra – they have identical fingerprint/peak pattern (1)	[2]
(g)(i)	Water (1); Catalyst with high temp & pressure/ catalyst of sulfuric or phosphoric acid (<i>second mark dependant on first</i>)	[2]
(ii)	(Partially) positively charged/electron deficient reagent/attracted to areas of high electron density (1); Bonds by accepting a pair of electrons (can be shown via mechanism) (1);	[2]
(iii)	Low yield (1)	[1]

Question Number	Answer	Max Mark
4(a)(i)	Any carbon compound with chlorine and fluorine only (1)	[1]
(ii)	High heat of vaporisation/volatile/non-toxic/unreactive (1)	[1]
(b)	In the stratosphere/ upper atmosphere (1); they break down under the influence of <u>high-energy/ high frequency UV/radiation</u> (1); to form chlorine atoms/ <i>radicals/ Cl</i> (1); that <i>catalyse</i> the breakdown of ozone (1) QWC: <i>link between first and second marking points or first and third</i> [1]	[4]
(c)	So much data was being collected that any outside expected ranges was discarded (1); values for ozone concentration were significantly below expected values (1)	[2]
(d)(i)	$O_3 \rightarrow O_2 + O$	[1]
(ii)	Hydrocarbons provide an alternative to equation 4.2 (1); so less ozone is broken down/ more ozone is made because of increased O (1)	[2]
(iii)	Photochemical smog/ an effect like breathing difficulties (1)	[1]
(e)(i)	$\delta+$ on carbon, $\delta-$ on fluorines (1)	
(ii)	Mention of electronegativity (1); Fluorine more electronegative than carbon (1)	[2]
(iii)	Yes, the charges do not balance (1); Shape is tetrahedral (1)	[2]
(f)(i)	UV/radiation (1); does not have enough energy/ does not have high enough frequency (1) REJECT for second mark answers that imply intensity of radiation "C–F is strong/ stronger than C–Cl" scores (1)	[3]
(ii)	$467/6.02 \times 10^{23} (1) \times 1000 = 7.75(7)/ 7.76 \times 10^{-19} \text{ J} (1)$	[2]
(iii)	$7.757 \times 10^{-19} \text{ ecf/ } 6.63 \times 10^{-34} (1) = 1.17 \times 10^{15} (1) \text{ Hz} (1)$	[3]

Question Number	Answer	Max Mark
5(a)(i)	<div style="display: flex; align-items: center; justify-content: center;"> <div style="text-align: center; margin-right: 20px;"> $\begin{array}{c} \text{CH}_3 \quad \text{H} \\ \quad \\ \text{C} = \text{C} \\ \quad \\ \text{CH}_3 \quad \text{H} \end{array}$ </div> <div style="text-align: center;"> <p>C=C correct (1); Completely correct (2)</p> </div> </div> <div style="display: flex; align-items: center; justify-content: center;"> <div style="text-align: center; margin-right: 20px;"> $\begin{array}{c} \text{CH}_3 \quad \text{H} \\ \quad \\ -\text{C} - \text{C}- \\ \quad \\ \text{CH}_3 \quad \text{H} \end{array}$ </div> <div style="text-align: center;"> <p>(1)</p> </div> </div>	[3]
(ii)	<div style="display: flex; align-items: center; justify-content: center;"> <div style="text-align: center; margin-right: 20px;"> $\begin{array}{cccc} \text{H} & \text{H} & \text{H} & \text{H} \\ & & & \\ -\text{C} & -\text{C} & -\text{C} & -\text{C}- \\ & & & \\ \text{H} & \text{CH}=\text{CH}_2 & \text{C}_6\text{H}_5 & \text{H} \end{array}$ </div> </div> <p>or $-\text{CH}_2-\text{CH}=\text{CH}-\text{CH}_2-\text{CHAr}-\text{CH}_2-$ $-\text{CH}_2-\text{CH}=\text{CH}-\text{CH}_2-\text{CHAr}-\text{CH}_2-$</p> <p>Correct structure for part of repeat from butadiene (1); Correct structure for part of repeat from styrene (1)</p>	[2]
(iii)	<p>Add bromine water (1); Colour stays brown with rubber in part (i) (1); Bromine water is decolourised/ colour changes from brown to colourless with rubber in (ii) (1)</p>	[3]
(b)	<div style="display: flex; align-items: center; justify-content: center;"> <div style="text-align: center; margin-right: 20px;"> $\begin{array}{c} \text{CH}_3 \quad \text{CH}_2- \\ \quad \\ \text{C} = \text{C} \\ \quad \\ -\text{CH}_2 \quad \text{H} \end{array}$ </div> </div>	[1]
(c)	The C=C double bond can't be rotated (1)	[1]
(d)	Softens/ flows/ melts when heated/ warmed (1)	[1]

Question Number	Answer	Max Mark
(e)	(enough) energy(1); to break bonds (1); breaking down structure (1)	[3]
(f)	strong S–S bonds (1); stop chains sliding over each other (1) <i>✎ relation between strong bonds and stopping sliding (1)</i> path of lower E_a (1); molecules contain sulfur (1); form intermediates (1)	[6]
Paper Total		[100]

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