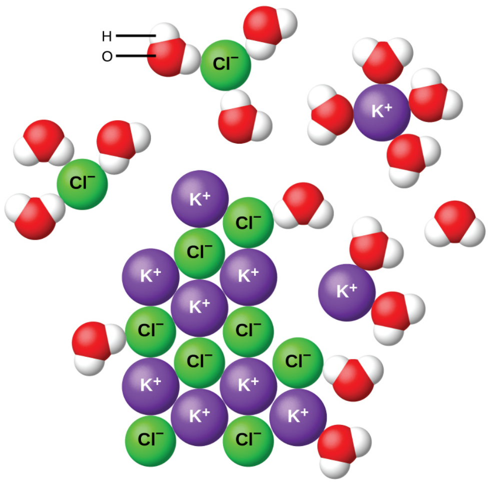
Assessment Schedule – 2020

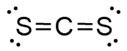
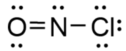
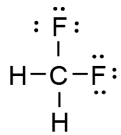
Chemistry: Demonstrate understanding of bonding, structure, properties and energy changes (91164)

Evidence Satement

<table>
<tr><th>Q</th><th>Evidence</th><th>Achievement</th><th>Merit</th><th>Excellence</th></tr>
<tr><td>ONE
(a)</td><td>
<table>
<tr><th>Solid</th><th>Type of solid</th><th>Type of particle</th><th>Attractive forces between the particles</th></tr>
<tr><td>Silicon dioxide SiO_2</td><td>Covalent network</td><td>Atoms</td><td>Covalent bonds</td></tr>
<tr><td>Chlorine Cl_2</td><td>Molecular</td><td>Molecule</td><td>Intermolecular forces</td></tr>
<tr><td>Potassium chloride KCl</td><td>Ionic</td><td>Ions</td><td>Ionic bond</td></tr>
</table>
</td><td>• TWO rows or TWO columns correct.</td><td>• Correct table.</td><td></td></tr>
<tr><td>(b)</td><td>Electrical conductivity depends on the presence of charged particles that are free to move.
Silicon dioxide is a covalent network substance made up of a 3-D lattice of silicon atoms covalently bonded to oxygen atoms (in a tetrahedral arrangement). In both the solid and liquid states, there are no charged particles free to move, and so silica is not able to conduct electricity.
Potassium chloride is an ionic compound that cannot conduct electricity when solid because the ions (charged particles) are fixed in place in a 3-D lattice structure and unable to move. When molten, the ionic bonds between the ions break, so the ions are free to move. With charged particles / ions free to move, KCl can then conduct electricity.</td><td>• Identifies requirement for electrical conductivity and recognises absence or presence of charged particles in one substance.
• Describes the structure of one substance.</td><td>• Explains conductivity by linking particles, and structures AND bonding to the conductivity of ONE of the compounds.</td><td>• Justifies conductivity by relating particles, structures, and bonding to the conductivity of both compounds in all states.</td></tr>
</table>

(c)	Potassium chloride is ionic and when it dissolves in water, it separates into its ions. The negative poles of the water molecules are attracted to the positive K^+ ions, and the positive poles of the water molecules are attracted to the negative Cl^- ions. This causes the ions to be surrounded by water molecules, and the solid dissolves. This solid is soluble because the force of attraction between the ions and water is strong enough to overcome the ionic bonds in the lattice and the force of attraction between water molecules. The non-polar chlorine molecules are not able to attract the polar water molecules with sufficient strength to overcome the solute / solute and solute / solvent attractions and so chlorine is only slightly soluble in water.  https://pressbooks-dev.oer.hawaii.edu/chemistry/chapter/electrolytes/	• Identifies attractions are needed between water and the substance (KCl) for it to be soluble. • Identifies that chlorine is non-polar and is therefore not attracted to water.	• Links relative strengths of attractions of the substance to water for the solubility of ONE of the substances.	• Justifies solubility by linking particles, structure, and bonding for both KCl and Cl_2 using a diagram to illustrate answer.

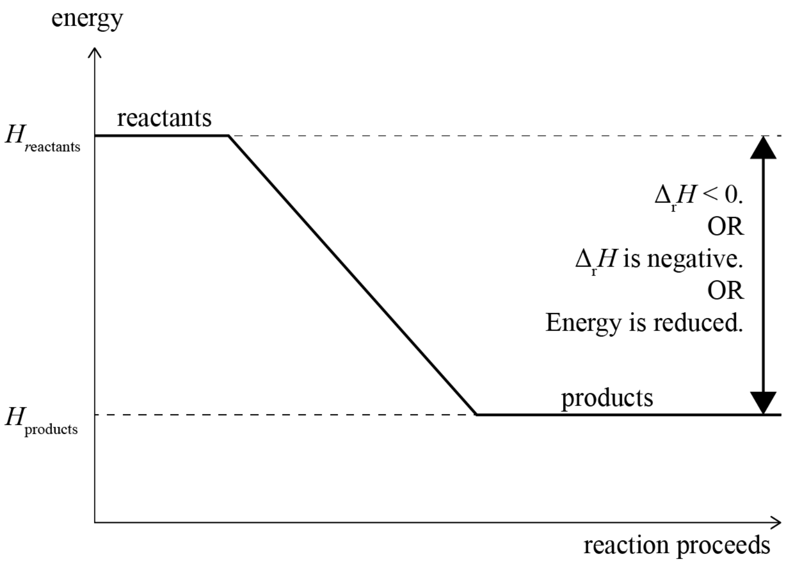
NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	1a	2a	3a	4a	2m	3m	2e (minor error)	2e

<table>
<tr><th>Q</th><th>Evidence</th><th>Achievement</th><th>Merit</th><th>Excellence</th></tr>
<tr><td>TWO
(a)</td><td>
<table>
<tr><th>Molecule</th><th>CS_2</th><th>NOCl</th><th>CH_2F_2</th></tr>
<tr><td>Lewis Structure</td><td></td><td></td><td></td></tr>
<tr><td>Name of Shape</td><td>linear</td><td>bent</td><td>tetrahedral</td></tr>
</table>
</td><td>• TWO Lewis structures correct.
OR
TWO shapes correct.
(Straight OK for linear. V-shaped OK for bent.)</td><td></td><td></td></tr>
<tr><td>(b)</td><td>CH_2O has three electron clouds / regions of negative charge around its central atom. As the electron clouds maximise separation to minimise repulsion, they take a trigonal planar geometry with a 120° bond angle. All regions are bonded and so the overall shape is trigonal planar.
NF_3 has four regions of negative charge around its central atom. As the electron clouds maximise separation to minimise repulsion, they take a tetrahedral geometry with a 109.5° bond angle. Three of the regions are bonded and one region is non-bonding, so the molecular shape is trigonal pyramidal.</td><td>• Identifies the numbers of electron clouds / areas of negative charge for ONE molecule.
OR
Identifies non-bonding AND bonding pairs of electrons for ONE molecule.</td><td>• Links areas of negative charge around the central atom minimising repulsion to bond angles for ONE molecule.</td><td>• Justifies bond angle and shapes of BOTH molecules by referring to electron repulsion, areas of negative charge and bonding AND non-bonding electron pairs.</td></tr>
<tr><td>(c)(i)

(ii)</td><td>Polar: bent
Non-polar: linear

If ZX_2 is polar, this indicates that the polar Z–X bonds (caused by different electronegativity values between Z and X) are not arranged symmetrically around the central atom due to the bent shape. It is a polar molecule because the effect of the dipoles is not cancelled.
If ZX_2 is non-polar, this means that the polar Z–X bonds are arranged symmetrically around the central atom in a linear shape. The effect of any dipoles formed by the different electronegativity of X–Z bond is cancelled.</td><td>• Predicts one possible shape for ZX_2 for one polarity.
• Polarity depends upon the symmetry of the molecule.</td><td>• Links the arrangement of polar bonds to the shape and symmetry for one polarity.</td><td>• Justifies the predicted shapes of the possible molecules of ZX_2 .</td></tr>
<tr><td>(d)</td><td>$n = \frac{740}{296} = 2.5 \text{ moles}$
$m(\text{S}) = n \times M$
$= 2.5 \times 32.1$
$= 80.3 \text{ g}$
(= 81.2 g if no early rounding)</td><td>• ONE step of process correct.</td><td>• Correct answer.</td><td></td></tr>
</table>

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	1a	2a	3a	4a	2m	3m	2e (minor error)	2e

Q	Evidence	Achievement	Merit	Excellence
THREE (a)(i)	Exothermic. Because energy is released / the enthalpy change is negative / products have less energy than reactant.	• Reaction type correct with reason.		
(ii)		• Diagram correct shape with reactants and products labelled.	• Diagram correctly drawn and enthalpy change, reactants and products correctly labelled.	
(b)	The state change from liquid to gas is endothermic because energy is absorbed to break the attractive forces between the molecules.	• Identifies endothermic.	• Links absorption of energy (or heat) / *taken in* to breaking the attractive forces (or bonds) and, in turn, to endothermic. *(Must be clear that forces between ethanol molecules are broken, not covalent bonds.)*	

<table>
<tr>
<td>(c)</td>
<td>
<table>
<tr><th colspan="2">Bonds broken</th></tr>
<tr><td>C = C</td><td>614</td></tr>
<tr><td>Cl – Cl</td><td>242</td></tr>
<tr><td>Total</td><td>856</td></tr>
</table>
<table>
<tr><th colspan="2">Bonds made</th></tr>
<tr><td>C – C</td><td>346</td></tr>
<tr><td>C – Cl</td><td>$2x$</td></tr>
</table>
Energy = bonds broken – bonds made
$-148 = 856 - (346 + 2x)$
$2x = 658$
$x = 329$ kJ mol^{-1}
</td>
<td>• Identifies the bonds broken or bonds made.</td>
<td>• Correct process with ONE error.</td>
<td>• Calculates enthalpy with correct unit.</td>
</tr>
<tr>
<td>(d)</td>
<td>
$n(\text{ethanol}) = \frac{1500}{46} = 32.61$ moles
$\frac{40\,600}{32.61} = 1245$ kJ mol^{-1}
Since it is a fuel and is exothermic, it needs to be -1245 kJ mol^{-1} / -1250 kJ mol^{-1}.
</td>
<td>• Amount (moles) of ethanol correct.</td>
<td>• Process with ONE minor error / correct answer, but positive ΔH or no units.</td>
<td>• Correct answer with correct sign, units and significant figures.</td>
</tr>
</table>

NØ	**N1**	**N2**	**A3**	**A4**	**M5**	**M6**	**E7**	**E8**
No response; no relevant evidence.	1a	2a	3a	4a	2m	3m	2e	2e +1m

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 7	8-13	14 – 18	19 – 24