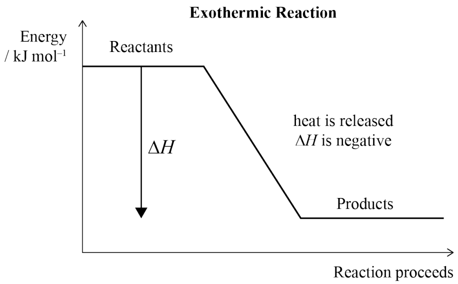
Assessment Schedule – 2016

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

Evidence Statement

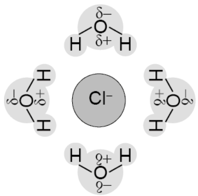
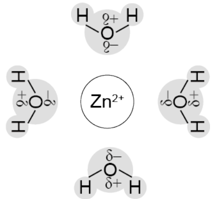
Q	Evidence	Achievement	Merit	Excellence
ONE (a)	Endothermic The temperature decreased OR heat / energy has been absorbed.	• Correct term with relevant reason in (a) OR (b).		
(b)	Exothermic. The enthalpy of the reaction is negative / energy has been released.			
(c)(i)	Energy is required to change pentane from a liquid to a gas. The energy / heat is used to break weak intermolecular forces / bonds / attraction between pentane molecules.	• Identifies energy / heat is required / absorbed / taken in.	• Explains that energy / heat is required / absorbed for breaking (intermolecular) forces / bonds / attractions.	• Explains that energy / heat is required / absorbed for breaking (intermolecular) forces / bonds / attractions. AND Diagram correctly drawn and fully labelled.
(ii)		• Diagram correctly drawn, but not labelled.	• Diagram correctly drawn, but not fully labelled.	
(iii)	n (pentane) = 125 g / 72.0 g mol^{-1} = 1.74 mol n (hexane) = 125 g / 86.0 g mol^{-1} = 1.45 mol If 1 mole of pentane releases 3509 kJ energy, then 1.74 mol of pentane 1.74 × 3509 = 6106 kJ energy released. If 2 moles of hexane release 8316 kJ energy, then 1 mole of hexane releases 4158 kJ energy. So 1.45 mol of hexane 1.45 × 4158 = 6029 kJ energy releases. So pentane releases more energy (77.0 kJ) than hexane, per 125 g of fuel.	• Amount (moles) of pentane or hexane correct.	• Pentane or hexane calculation correct.	• Both pentane and hexane calculations with units are correct, and identifies pentane as releasing more energy (link back to question) per 125 g of fuel.

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

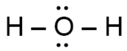
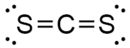
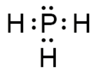
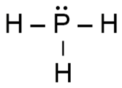
<table>
<tr><th>Q</th><th>Evidence</th><th>Achievement</th><th>Merit</th><th>Excellence</th></tr>
<tr><td>TWO
(a)</td><td>

Substance	Type of substance	Type of particle	Attractive forces between particles
$ZnCl_2(s)$ (zinc chloride)	***ionic***	***ions***	***ionic***
$C(s)$ (graphite)	***covalent network***	***atoms***	***covalent***
$CO_2(s)$ (carbon dioxide / dry ice)	***molecular***	***molecules***	***intermolecular***

</td><td>• One row or one column correct.</td><td></td><td></td></tr>
<tr><td>(b)</td><td>Electrical conductivity depends on the presence of charged particles that are free to move.
Graphite is a covalent network substance made up of carbon atoms covalently bonded to 3 other carbon atoms. This leaves one valence non-bonded / delocalised electron from each carbon atom. These electrons are free to move and so graphite is able to conduct electricity.
$ZnCl_2$ is an ionic compound that cannot conduct electricity when solid because the ions (charged particles) are fixed in place in a 3D lattice structure and unable to move. When molten, the ionic bonds between the ions break, so the ions are free to move in the molten liquid. With charged particles / ions free to move, $ZnCl_2$ can then conduct electricity.</td><td>• Identifies that charged particles which are free to move are required for electrical conductivity.
• Identifies $ZnCl_2(s)$ as not having ions / charges particles that are free to move
OR
identifies $ZnCl_2(l)$ does have ions / charged particles that are free to move
OR
Identifies $C(s)$ does have electrons / charged particles that are free to move.</td><td>• Explains conductivity by linking particles, structures, and bonding to either the conductivity of C (graphite)
OR
$ZnCl_2$ in both solid and liquid (molten) states.</td><td>• Justifies conductivity by relating particles, structures, and bonding to the conductivity of C (graphite)
AND
$ZnCl_2$ in both solid and liquid (molten) states.</td></tr>
</table>

(c)	Polar water molecules attract the ions in zinc chloride's 3-D lattice strongly enough to separate and dissolve them. The negative charges on the oxygen ends of the water molecules are attracted to the positive Zn^{2+} ions, and the positive hydrogen ends of the water molecules are attracted to the negative Cl^{-} ions, forming hydrated ions that can spread out through the solution.   The polar water molecules are unable to interact with the non-polar carbon dioxide molecules strongly enough to break the intermolecular forces between the carbon dioxide molecules.	• Identifies attractions are needed between water and the substance for it to be soluble.	• 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 $ZnCl_2$ and CO_2.

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

Q	Evidence	Achievement	Merit	Excellence
THREE (a)(i)	 OR  bent / v-shaped  linear  OR  trigonal pyramid	• Two Lewis structures (electron dot diagrams) correct. AND Two shapes correct.		
(ii)	Bond angle is determined by the number of electron clouds / areas of negative charge around the central atom, which are arranged to minimise repulsion / are arranged as far apart from each other as possible (maximum separation). **Both** H_2O and PH_3 have 4 electron clouds / areas of negative charge around the central atom, so the bond angle is that of a tetrahedral arrangement of 109.5°**,** whereas there are only 2 electron clouds / areas of negative charge around the central atom in CS_2, which means minimum repulsion is at 180°**,** resulting in CS_2's shape being linear. The shapes of H_2O and PH_3 differ despite having the same tetrahedral arrangement because water has two non-bonding pairs of electrons around the central atom, while phosphine only has one non-bonding pair. The resulting shapes are bent or v-shaped for H_2O, while PH_3 is trigonal pyramid.	• Identifies the numbers of electron clouds / regions of negative charge around the central atoms for TWO molecules. OR Identifies non-bonding pairs and bonding pairs of electrons on the central atoms for TWO molecules.	• Links areas of negative charge around the central atom to minimise repulsion (maximum separation) and bond angles for TWO molecules.	• Compares and contrasts the bond angle and shapes of all three molecules by referring to electron repulsion, areas of negative charge / electron clouds and bonding / non-bonding electrons.
(b)	Each N-H bond in NH_3 is polar / forms a dipole because the N and H atoms have different electronegativities. The shape of the molecule (due to the presence of one non-bonding electron pair) is trigonal pyramidal which is asymmetrical, so the dipoles / bond polarities do not cancel. The resulting NH_3 molecule is polar. Each B-H bond in BH_3 is polar / forms a dipole because the B and H atoms have different electronegativities. The shape of the molecule is trigonal planar which is symmetrical, so the dipoles / bond polarities cancel. The resulting BH_3 molecule is non-polar.	• Identifies that the atoms within the bonds have different electronegativities.	• Links bond polarity to electronegativity differences between atoms for one molecule OR Uses symmetry to link molecule polarity to bond dipoles cancelling / not cancelling for 1 molecule.	• Justifies polarity of ammonia and borane referring to differences in electronegativity, dipoles, and symmetry (shape) of molecules.

(c)	Bond breaking C=C 614 C–C × 2 692 C–H × 8 3312 H–H 436 5054 kJ mol^{-1} Bond making C–C × 3 1038 C–H × 10 4140 5178 kJ mol^{-1} $\Delta_r H°$ = Bond breaking – bond making $\Delta_r H°$ = 5054 kJ mol^{-1} – 5178 kJ mol^{-1} $\Delta_r H°$ = –124 kJ mol^{-1} OR Bond breaking C=C 614 H–H 436 1050 kJ mol^{-1} Bond making C–C 346 C–H × 2 414 × 2 1174 kJ mol^{-1} $\Delta_r H°$ = Bond breaking – bond making $\Delta_r H°$ = 1050 – 1174 $\Delta_r H°$ = –124 kJ mol^{-1}	• Identifies the two relevant bonds broken (C = C and H – H).	• Correct process with minor errors. Identifies which bonds are broken and which bonds are formed.	• Correct answer, including correct sign and unit.

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

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 6	7 – 13	14 – 19	20 - 24