Assessment Schedule – 2012

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

Assessment Criteria

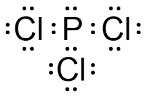
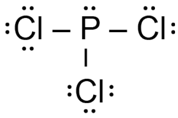
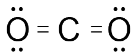
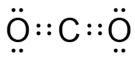
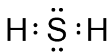
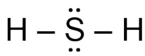
Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding involves describing, identifying, naming, drawing, calculating, or giving an account of bonding, structure and properties of different substances and the energy involved in physical and chemical changes. This requires the use of chemistry vocabulary, symbols and conventions.	*Demonstrate in-depth understanding* involves making and explaining links between the bonding, structure and properties of different substances and the energy involved in physical and chemical changes. This requires explanations that use chemistry vocabulary, symbols and conventions.	*Demonstrate comprehensive understanding* involves elaborating, justifying, relating, evaluating, comparing and contrasting, or analysing links between bonding, structure and properties of different substances and the energy involved in physical and chemical changes. This requires the consistent use of chemistry vocabulary, symbols and conventions.

Evidence Statement

One	Expected Coverage	Achievement	Merit	Excellence
(a)	Lewis diagrams shown (Appendix One).	• In (a) TWO Lewis structures correct.		
(b)	The central atom in SO_2 has three regions of electron density/electron clouds around it. The regions of electrons are arranged as far apart as possible from each other (in order to minimise repulsion) making a trigonal planar shape. This gives a bond angle of 120°. Only two of these regions of electrons are bonding and one is non-bonding so the shape of the molecule is **V-shaped (bent).** The central atom of H_2CO, has three regions of electron density around it. The regions of electrons making a trigonal planar shape, giving a bond angle of 120°. All three of these regions of electrons are bonding so the arrangement of the bonds/molecular shape is **trigonal planar**.	• In (b) ONE shape correct. • States that 120° means there are three regions of electron density around the central atom. • States shape of molecule is determined by regions of electron density around the central atom.	• In (b) the arrangement of electrons around the central atom is used to explain the shape of both molecules. • In (b) the arrangement of electrons around the central atom is used to explain the bond angle of both molecules.	• In (b) the arrangement of the electron density around the central atom is used to explain the shapes and angles of the molecules. Includes a comparison of the different shape but same bond angle.
(c)	The CBr_4 molecule is non-polar. The CH_3Br molecule is polar. Both CBr_4 and CH_3Br have four regions of electrons around the central carbon atom. These are all bonding electron regions (clouds) so the shape of both molecules is tetrahedral. The C-Br bond is polar due to the difference in electronegativity between C and Br. In CH_3Br, the C-Br bonds are more polar than the C-H bond as the electronegativity of the Br is greater than the electronegativity of the C and H. Although the bonds are arranged symmetrically around the carbon atom, the lower polarity of the C-H bond means that the bond dipoles do not cancel so the molecule is polar. In CBr_4, all bonds are polar and are the same (C-Br). The bonds are arranged symmetrically around the central C atom and because the bond dipoles cancel, the molecule is non-polar.	• In (c) C-Br bond is polar. • Predicts one polarity correct with one piece of supporting evidence • Polarity depends upon the symmetry of the molecule.	• In (c) the difference in electronegativities between C and Br are used to explain that C-Br bonds are polar. OR In (c) links the bond dipoles cancelling to the overall molecule polarity.	• In (c) the polarity of molecules are explained and justified in terms of the regions of bond polarity and symmetry / asymmetry.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or no relevant evidence.	1a	2a	3a	4a	2m	3m	2e with minor error / omission / additional information.	2e

Appendix One: Question One (a)

Molecule	Lewis structure
PCl_3	 or 
CO_2	 or 
H_2S	 or 

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<table>
<tr><th>Two</th><th>Expected Coverage</th><th>Achievement</th><th>Merit</th><th>Excellence</th></tr>
<tr><td>(a)</td><td><table><tr><th>Type of particle</th><th>Attractive forces between particles</th></tr><tr><td>molecule</td><td>intermolecular</td></tr><tr><td>atom / cations and electrons</td><td>metallic</td></tr><tr><td>atom</td><td>covalent</td></tr></table></td><td rowspan="3">• ONE row or TWO from one column correct.
• Silicon dioxide has strong covalent bonds.
• High melting point because a lot of energy is required to break the covalent bonds.
• Zinc chloride is made up of zinc ions OR it is held together by ionic bonds.
• For something to conduct there must be free moving charged particles.
• Zinc conducts, because it has free moving electrons.
• Zinc chloride does not conduct as a solid, as the ions are fixed in position.
• Zinc chloride conducts when aqueous or molten, as the ions are free to move.
• Zinc is not soluble, it is a metallic substance.
• Zinc chloride does dissolve in water, as it is an ionic substance.</td><td>• Two rows or ONE column correct
OR
• Explains why silicon dioxide has a high melting point</td><td></td></tr>
<tr><td>(b)</td><td>Silicon dioxide is a covalent network solid. It is made up of silicon and oxygen atoms, with only strong covalent bonds between them. Because the covalent bonds are strong / there are a large number of covalent bonds, it requires a lot of energy to break these bonds and therefore the melting point is high.</td><td rowspan="2">AND
• Explains why zinc conducts and why zinc chloride does not as a solid
OR
• Explains why zinc is insoluble but zinc chloride is soluble.</td><td>• In (b) the high melting point of silicon dioxide is explained and justified by the type of bonding.</td></tr>
<tr><td>(c)</td><td>Zinc atoms are held together in a 3–D lattice by metallic bonding in which valence electrons are attracted to the nuclei of neighbouring atoms.
Zinc chloride is made up of positive zinc ions and negative chloride ions held together by electrostatic attractions in a 3–D lattice.
Conductivity
Zinc chloride does not conduct electricity as a solid as these ions are not free to move around. (When dissolved in water, the ions are free to move and carry the charge so zinc chloride solution conducts electricity.)
In zinc metal the delocalised electrons / valence electrons are free to move through the lattice; therefore they are able to conduct electricity.
Solubility
Zinc does not dissolve in water because water molecules are not attracted to the zinc atoms in the metallic lattice.
Water molecules are polar. When zinc chloride is dissolved in water the attractions between the polar water molecules and between the ions in the salt are replaced by attractions between the water molecules and the ions. The negative charge 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.</td><td>• Contrasts with reference to bonding and structure why zinc conducts and why zinc chloride will not conduct as a solid.

• Contrasts with reference to bonding and structure why zinc is insoluble but zinc chloride is soluble.</td></tr>
</table>

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or no relevant evidence.	1a	2a	4a	6a	m from part (a) or (b) AND m from part (c)	3m	e from part (b) and e from part (c)	3e

<table>
<tr><th>Three</th><th>Expected Coverage</th><th>Achievement</th><th>Merit</th><th>Excellence</th></tr>
<tr><td>(a)</td><td>Bonds broken: C–H and O=O
Bonds formed: C=O and O–H</td><td rowspan="4">• Has TWO correct bonds out of four.
• In (b) one step correct.

• The reaction is endothermic because the value is positive.
• OR
Because the water is absorbing energy from the flame.

• In (d) ONE step of the calculation is correct.</td><td rowspan="4">• Has ALL four correct bonds.

• In (b) calculation correct.

• In (d) two steps of calculation correct.</td><td rowspan="4">• Explains that the bonds being broken are weak intermolecular forces and that energy is required to break these bonds, so therefore the reaction is endothermic.

• Calculation correct in (b)

• Calculation correct in (d).</td></tr>
<tr><td>(b)</td><td>128 g / 16.0 g mol^{-1} = 8.00 mol
8.00 mol × 889 kJ mol^{-1} = 7112 kJ</td></tr>
<tr><td>(c)</td><td>The reaction is endothermic, as ΔH is positive and because the water is absorbing energy from the flame.
During this reaction the weak intermolecular forces between water molecules are broken
Energy is needed to break these attractive forces so the reaction is endothermic.</td></tr>
<tr><td>(d)</td><td>72.0 g / 18.0 g mol^{-1} = 4.00 mol of water being boiled.
Energy required to do this
4.00 mol × 40.7 kJ mol^{-1} = 162.8 kJ
This is the amount of energy that the combustion of methane in the Bunsen is required to produce.
162.8 kJ / 889 kJ mol^{-1} = 0.183 mol of methane to be combusted.
Mass of methane = 0.183 mol ×
16.0 g mol^{-1} = 2.93 g.</td></tr>
</table>

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or no relevant evidence.	Some appropriate writing but does not fulfil any statement from the Achievement criteria column.	1a	2a	3a	2m	3m	e from part (c) AND e from part (b) or (d)	3e

Judgement Statement

	Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
Score range	0 – 8	9 – 14	15 – 19	20 – 24