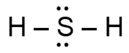
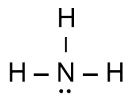
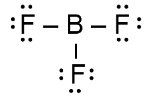
Assessment Schedule – 2018

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

Evidence Statement

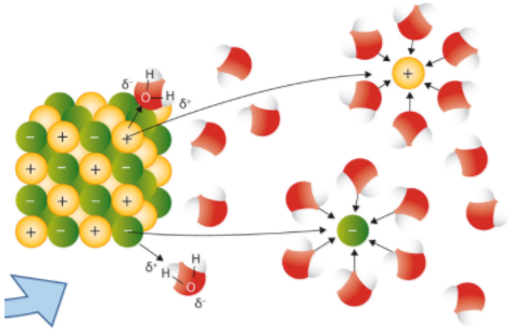
Q	Evidence	Achievement	Merit	Excellence
ONE (a)	Endothermic because the enthalpy change is positive.	• Either (a) or (b)(i) correct including a reason.		
(b)(i) (ii)	Exothermic because energy is released. The evaporation of water is endothermic because energy is absorbed to break the attractive forces between water molecules.	• Identifies endothermic.	• Links absorption of energy (or heat) to breaking the attractive forces (or bonds) and in turn to endothermic.	
(c)(i) (ii)	This is an exothermic reaction; the total energy of the products is less than the total energy of the reactants. Therefore, as the change in enthalpy is the difference in energy between products and reactants, the change is negative and the difference in energy is released as heat to the surroundings. If 2 moles of butane produce 5760 kJ then 1 mole produces 2880 kJ. n(butane) = $\frac{450}{58.0}$ = 7.76 moles q = 7.76 × 2880 = 22 300 kJ released alternative: n(butane) = $\frac{450}{58.0}$ = 7.76 moles so n(reaction) = n(butane)/2 = 3.88 mol So q = 5760 x 3.88 = 2.23×10^{4} kJ released	• Recognises energy of products is less than reactants OR that the reaction is exothermic. • One step of calculation correct.	• Identifies Energy (or enthalpy) is less for products than reactants and in turn links the difference in energy or energy/heat lost to negative enthalpy. • Two steps of calculation are correct.	• Correct answer with unit.
(d)	$\Delta H = \Sigma E(\text{Bonds broken}) - \Sigma E(\text{Bonds made}) = -92.0 \text{ kJ mol}^{-1}$ $E(\text{N}\equiv\text{N}) + 3E(\text{H–H}) - 6E(\text{N–H}) = -92.0 \text{ kJ mol}^{-1}$ $6E(\text{N–H}) = 2253 - (-92.0) = 2345 \text{ kJ mol}^{-1}$ *Therefore* $E(\text{N–H}) = \frac{2345}{6} = 391 \text{ kJ mol}^{-1}$	• Identifies the bonds broken.	• Correct process with error.	• Calculates N-H bond enthalpy with correct unit.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	1a	2a	3a	4a	2m	3m	2e with minor error or omission	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><td>H_2S</td><td>NH_3</td><td>BF_3</td></tr><tr><td></td><td></td><td></td></tr><tr><td>Bent</td><td>Trigonal Pyramid</td><td>Trigonal Planar</td></tr></table></td><td>• TWO Lewis structures correct
• TWO shapes correct.</td><td></td><td></td></tr>
<tr><td>(b)</td><td>NH_3 has four electron clouds / regions of negative charge around its central N atom. As the electron clouds maximise separation to minimise repulsion they take a tetrahedral geometry with a bond angle of 109.5º. Three of the regions are bonded and one is non-bonded, so the overall shape is trigonal pyramid.
In contrast, BF_3 only has three regions of negative charge around its central B atom. As the electron clouds maximise separation to minimise repulsion they take a trigonal planar geometry with the bond angle of 120º. While BF_3 has three bonded regions like NH_3, because there is no non-bonding regions BF_3's shape is trigonal planar.
So although both molecules have three bonded areas to the central atom, ammonia has a fourth region of negative charge, which is not bonded. This affects its angle and shape.</td><td>• Identifies the numbers of electron clouds / areas of negative charge for ONE molecules.
OR
Identifies non-bonding / bonding pairs of electrons for ONE molecules.</td><td>• Links areas of negative charge around the central atom minimizing repulsion to bond angles for ONE molecule.</td><td>• Compares and contrasts bond angle and shapes of BOTH molecules by referring to electron repulsion, areas of negative charge and bonding / nonbonding electron pairs.</td></tr>
<tr><td>(c)</td><td>In HCN, the two bonds are polar due the difference in electronegativity between H and C, and C and N. The resulting bond dipoles are differing in size as H and N have different electronegativities, so despite the symmetric linear arrangement the bond dipoles do not cancel and HCN is overall polar.
The C=O bond is also polar due to O being more electronegative than C giving these bonds dipoles. But because both bonds are identical and are arranged symmetrically in a linear shape, the bond dipoles cancel and the molecule is non-polar overall.</td><td>• Identifies that the atoms within a bond have different electronegativities.
OR
Linear is recognised as symmetric.</td><td>• Links bond polarity to electronegativity differences between atoms for ONE molecule OR uses symmetry to link polarity to bond dipoles cancelling / not cancelling for ONE molecule.</td><td>• Justifies polarity of BOTH molecules by referring to differences in electronegativity, dipoles and symmetry of molecules.</td></tr>
<tr><td>(d)</td><td>n(methanol) $= \frac{4428}{91} = 48.7$ moles
mass (methanol) $= 48.66 \times 32 = 1557$ g
volume (methanol) $= \frac{1.56}{0.790} = 1.97$ L</td><td>• One step of calculation correct.</td><td>• Correct process with error.</td><td>• Calculates volume with correct unit.</td></tr>
</table>

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

Q	Evidence	Achievement	Merit	Excellence
THREE (a)	A – Ionic B – Molecular C – Covalent Network D – Metallic	• Types of solid all correct.		
(b)	Electrical conductivity requires a substance to have mobile charged particles. Solid A is an ionic solid made up of a 3-D lattice of positive and negative ions (cations and anions) that are attracted to each other. In the solid state, these ions are rigidly held in a lattice by strong ionic bonds, so cannot move around. When molten, the ions are able to move freely so it can conduct electricity. In aqueous solution, the ions are also free to move so the solution can also conduct electricity.	• Recognises need for mobile charged particles for conductivity. • Recognises positive and negative ions (or cations and anions).	• Conductivity correctly linked to movement of Compound A's cations and anions.	• Conductivity explained with reference to particles, type of solid and the freedom (or restriction) of movement of cations and anions for ionic compounds in all 3 states.
(c)	Solid B is composed of discrete covalent molecules which are held together by weak intermolecular forces. These weak intermolecular forces are easily broken, so the molecules can be separated with little energy, therefore the melting point is low. Solid D is a metal made of a 3-D lattice of metal atoms surrounded by a sea of delocalised valence electrons, which are strongly attracted to all the nuclei in the lattice. This forms a strong metallic bond which requires a large amount of energy to break, therefore the melting point is high at 660ºC.	• Describes the weak intermolecular forces for molecules. • Describes strong metallic bonding.	• Melting point linked to strength of forces between particles for BOTH solids. OR Melting point linked to the energy requirements to break forces and in turn the strength of the appropriate force for ONE solid.	• Melting point explained with reference to particles, type of solid, attractive forces and the energy required to break these forces for BOTH solids.

(d)(i) (ii)	 Solid A is ionic and when it dissolves in water, it separates into its ions. The ions are charged and are attracted to the charged ends of the polar water molecule. The slightly negative charges on the oxygen ends of the water molecules are attracted to the positive ion, and the slightly positive hydrogen ends of the water molecules are attracted to the negative ions. This causes the ions to be surrounded by water molecules and it dissolves. This solid is soluble because the force of attraction between the ions and water is strong enough to overcome the forces holding the ions together along with the forces holding the water molecules together (in the solvent).	• Diagram shows ions and water molecules.	• Diagram shows attractions between labelled ends of water molecules and the ions in the diagram.	• Solubility of solid A illustrated with annotated diagram of before and after dissolving, with a statement that understands strength of attractions.

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 – 18	19 – 24