Assessment Schedule – 2014

Chemistry: Demonstrate understanding of thermochemical principles and the properties of particles and substances (91390)

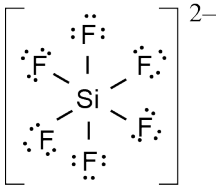
Evidence Statement

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
ONE (a)	K $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$ [Ar] $4s^1$ Cr $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$ [Ar] $3d^5\ 4s^1$ As $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^3$ [Ar] $3d^{10}\ 4s^2\ 4p^3$	• Two correct.	• All correct.	
(b)	The K^+ ion has a smaller radius than the K atom, as the ion has lost an electron from the valence/outer energy level, and therefore has fewer shells. This results in greater attraction between the nucleus and the valence electrons, as the outer electrons are now closer to the nucleus. There is less repulsion between the remaining electrons. Both species have the same number of protons / amount of nuclear charge.	• K^+ is smaller, as it has lost a shell / or other correct statement.	• K^+ is smaller, both species have the same number of protons / charge AND lost a shell OR less electron-electron repulsion linked to a greater attraction in the ion.	• Full explanation
(c)	*lowest* B N Ne He *highest*	• Correct order.		
(d)(i)	1. δ– δ+ F---Cl 2. δ+ δ– At---Cl	• Both correct.		
(ii)	Bromine circled (greater electronegativity). Lower electronegativity means less attraction of a bonded atom for a bonding pair of electrons. The lower value for iodine indicates that the attraction for the bonding pair in compounds is less than the attraction for bonding pairs in compounds of bromine. As the radii of atoms increase, electronegativity decreases, despite the increased nuclear charge. This is due to more energy levels being added. Iodine has a greater number of shells (5th row) than bromine (4th row). This factor outweighs the increased nuclear charge (53 protons) of the iodine atom, as compared to the bromine atom (35 protons).	• One correct statement.	• (c) and (d)(i) all correct, with Br circled. • Links electronegativity to more energy levels being further away.	• Justification showing all factors correctly linked.

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

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
TWO (a)	NH_3 = Hydrogen bonds, instantaneous dipoles F_2 = Instantaneous dipoles HCl = Permanent dipoles, instantaneous dipoles	• Any TWO significant forces correct.	• Links the strength of attraction to the boiling point AND Correctly compares the significant intermolecular forces in the three species. OR Correctly compares all the intermolecular forces for two species.	• Full discussion.
(b)	NH_3 and HCl both have temporary and permanent dipoles, as they are polar molecules. However, NH_3 has H-bonding, which means the boiling point is higher due to these stronger forces of attraction. HCl has a permanent dipole, but not H-bonding. F_2 has the lowest boiling point, due to having only temporary dipoles.	• Outlines a reason for the boiling point for one of the substances.		
(c)	$\Delta_r H° = \Sigma\Delta_f H°$ products $- \Sigma\Delta_f H°$ reactants $= (-314) - (-46 + -92)$ $= -176$ kJ mol^{-1}	• Correct process.	• Correct with units.	
(d)	Between A and B, molecules of ammonia are gaining kinetic energy, and hence the temperature increases. Between B and C, molecules of ammonia change from liquid to gas. Energy supplied is used to overcome the intermolecular forces rather than increase the kinetic energy of the particles; thus the temperature does not increase until all the NH_3 is in the gas phase. Between C and D, the molecules of ammonia gas are again gaining kinetic energy, and so the temperature increases.	• Recognises the increase in energy of particles for one section / speed of particles. OR Overcoming intermolecular forces for section B → C.	• Correctly explains two sections and links to the correct states OR phase change.	• Justification of all three sections. This must be related to kinetic energy.

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

<table>
<tr><th>Q</th><th>Evidence</th><th>Achievement</th><th>Achievement with Merit</th><th>Achievement with Excellence</th></tr>
<tr><td>THREE
(a)</td><td>
<table>
<tr><td></td><td>SiF_6^{2-}</td></tr>
<tr><td>Lewis diagram</td><td>  </td></tr>
<tr><td>Shape</td><td>Octahedral</td></tr>
</table>
</td><td>• Lewis diagram or shape correct.</td><td>• Both correct.</td><td></td></tr>
<tr><td>(b)</td><td>Positive; or entropy increases. Ions in solution (generally) have higher entropy than solids as there is an increase in the dispersal of matter / degree of disorder.</td><td>• Correct change.</td><td>• Correct change and explanation.</td><td></td></tr>
<tr><td>(c)</td><td>
<table>
<tr><td>✓</td><td>The entropy of the system increases</td></tr>
<tr><td></td><td>The entropy of the surroundings increases</td></tr>
<tr><td></td><td>The entropy of the system decreases</td></tr>
<tr><td>✓</td><td>The entropy of the surroundings decreases</td></tr>
</table>
As a solid is converted into a gas, the entropy of the system increases due to the greater dispersal of matter, as the random motion of the gases is higher.

The entropy of the surroundings decreases because heat is transferred from the surroundings. This results in less random motion of the particles in the surroundings.</td><td>• Ticks both correct.
OR
Outlined in the justification.</td><td>• One explanation.</td><td>• Justification.</td></tr>
</table>

(d)(i)	$3H_2O + 2CO_2 \rightarrow C_2H_5OH + 3O_2$ +1367 $2C + 2O_2 \rightarrow 2CO_2$ -394×2 (788) $3H_2 + 1½O_2 \rightarrow 3H_2O$ -286×3 (858) $½\ O_2 + 2C + 3H_2 \rightarrow C_2H_5OH$ -279 kJ mol^{-1}	• Uses a recognised process but errors made in the calculations.	• Correct process leading to an incorrect answer.	• Correct process leading to the correct answer with units.
(ii)	The enthalpy change would be more positive. Heat energy is absorbed when converting a liquid to a gas. Therefore if the ethanol formed were in the gaseous state, less energy would be released in its formation / products would have a higher enthalpy.	• Enthalpy change would decrease OR Be more positive.	• Change in enthalpy would decrease AND Recognises that gas has a higher enthalpy over a liquid OR Energy is required to convert a liquid to a gas.	

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

Cut Scores

	Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
Score range	0 – 8	9 – 13	14 – 18	19 – 24