Assessment Schedule – 2017

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

Evidence Statement

<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>Particle symbol</th><th>Electron configuration using s, p, d notation)</th><th>Charge</th><th>Atomic number</th></tr>
<tr><td></td><td>$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$</td><td></td><td>17</td></tr>
<tr><td>Ca^{2+}</td><td>$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$</td><td></td><td></td></tr>
<tr><td></td><td>$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5$</td><td>+2</td><td>25</td></tr>
</table>
</td><td>• FIVE of the seven correct.</td><td>• Correct table</td><td></td></tr>
<tr><td>(b)(i)</td><td>Electronegativity is the ability of an atom to attract a bonding pair of electrons to itself.</td><td>• Correct definition.</td><td></td><td></td></tr>
<tr><td>(ii)</td><td>Electronegativity increases as you go across a period.
Both Cl and P are row 3 elements and have valence electrons in their 3rd shell. The electrons are in the same shell so experience the same shielding effect. Chlorine has more protons in its nucleus than phosphorus so its nuclear charge is greater. This means that chlorine will have more attraction for the bonding pair of electrons so its electronegativity is greater.</td><td>• ONE correct statement.</td><td>• Links nuclear charge to chlorine's greater electronegativity.</td><td>• Full and correct explanation of nuclear charge and electrons.</td></tr>
<tr><td>(c)(i)</td><td>$Ca(g) \rightarrow Ca^{+}(g) + e^{-}$</td><td>• Correct equation.</td><td></td><td></td></tr>
<tr><td>(ii)</td><td>The first ionisation energy is the energy required to remove one mole of the most loosely held electrons from one mole of gaseous atoms.
The trend is that the ionisation energy decreases going down the group two elements.
Although the nuclear charge increases due to more protons in the atoms going down a group, it is offset by the increasing distance of the outer electrons from the nucleus as the atomic radius increases due to more energy levels being added.
The full inner energy levels shield the outer electrons from the protons in the nucleus so the electrostatic attraction is less. Additional energy levels result in greater shielding / repulsion between energy levels. The further the outer electron is from the nucleus, the less energy needed to remove it.

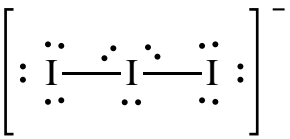
The trend is important, not the 'kink' at Ca, which requires no explanation.</td><td>• ONE correct statement.</td><td>• Links increasing atomic radius / distance between nucleus and outer electron / shielding effect to trend.</td><td>• Explanation acknowledges nuclear charge but fully links the trend to the effect of increasing distance from the nucleus.</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 or omission)	2e

Q	Evidence	Achievement	Merit	Excellence
TWO (a)(i)	**Hydrazine** (N_2H_4) hydrogen bonding, (permanent dipole attractions) temporary dipole attractions. For **iodomethane** (CH_3I) permanent and temporary dipole attractions. The hydrogen bonds between N_2H_4 molecules are stronger than the permanent dipole forces between CH_3I molecules therefore require more energy to break resulting in a higher boiling point. The presence of hydrogen bonding outweighs the expected higher temporary dipole in CH_3I due to the greater molar mass.	• Correctly names all intermolecular forces for TWO of the three substances. • ONE correct statement for (i) excluding the naming of intermolecular forces.	• Links relative strengths of intermolecular forces of both molecules to energy required to boil.	• Justifies the boiling points of hydrazine and iodomethane in terms of all the attractive forces involved.
(ii)	**Iodomethane** (CH_3I) has permanent and temporary dipole attractions. **Decane** ($C_{10}H_{22}$) has temporary dipole attractions. Despite the molecules having the same molar mass, decane $C_{10}H_{22}$ has stronger intermolecular attractions. Decane is a longer molecule, when compared to the spherical shape of iodomethane CH_3I, so it has a greater surface area / electron cloud / number of electrons meaning stronger temporary dipole attractions. Therefore, more energy is needed to break these attractions, resulting in a higher boiling point.	• ONE correct statement for (ii) excluding the naming of intermolecular forces.	• Links the size of the electron cloud / surface area of decane to stronger intermolecular forces.	• Justifies the boiling points of iodomethane and decane in terms of all the attractive forces involved.
(b)	Hydrazine is a polar molecule. Decane is non-polar. As water is a polar solvent, the hydrazine will be more soluble than the decane. The attractive forces between the molecules of hydrazine are less than the attractive forces between the hydrazine and water molecules, and therefore it is more soluble than decane, where the attractive forces between the decane molecules are greater than the attractive forces between the decane and water molecules.	• ONE correct statement for hydrazine or decane regarding polarity / solubility.	• Explanation given for both substances.	
(c)	$10C + 11H_2 \rightarrow C_{10}H_{22}$ $\quad -301$ kJ mol^{-1} $C + O_2 \rightarrow CO_2$ $\quad -393 \times 10$ kJ mol^{-1} $H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ $\quad -286 \times 11$ kJ mol^{-1} $\Delta H = +301 + (10 \times -393) + (11 \times -286)$ $= -6775$ kJ mol^{-1}	• Correct method with errors in calculation.	• Correct answer. May have poor rounding / incorrect units / sign / minor error causing incorrect answer.	• Correct calculation with sign and unit.

(d)	System – as the number of gaseous molecules is greater on the product side than the reactant side, then there is an increase in disorder / the dispersal of matter / degree of randomness / dispersal of energy, thus the entropy of the system increases. Surroundings – as the reaction is exothermic the entropy of the surroundings increases, as there is an increase in disorder / the dispersal of matter / degree of randomness / dispersal of energy.	• One correct statement.	• Explains the entropy changes in the system / surroundings OR a partial explanation of both.	• Explains the entropy changes of the system and the surroundings.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	1a	2a	3a	4a	4m	5m	2e	3e

Q	Evidence	Achievement	Merit	Excellence
THREE (a)(i)	First box ticked (temporary dipole – dipole attractions).	• Correct AND ONE correct statement.		
(ii)	Bromine is a larger molecule than chlorine so the temporary dipole intermolecular attractions are greater. Thus, more energy is required to separate the molecules and so Br_2 has a higher boiling point and is a liquid at room temperature		• Correct explanation comparing bromine and chlorine.	
(b)(i)	$I_2(s) \rightarrow I_2(g)$	• Correct OR Correct definition.		
(ii)	This is the **heat energy** required to change one mole of a substance from solid state to gaseous state (at a given combination of temperature and pressure).			
(iii)	Spontaneity is determined by the total entropy change (system + surroundings). Entropy of the system increases as the solid becomes a gas because the gas particles are more disordered. The increase in entropy of the system outweighs the decreased entropy of the surroundings due to the positive enthalpy OR positive enthalpy due to the endothermic process of breaking bonds is offset by entropy changes in the system.	• ONE Correct statement.	• Links entropy of system to sublimation OR Links positive enthalpy to entropy of surroundings OR Contrast entropy of system to entropy of surroundings.	• Complete explanation of entropy and enthalpy considerations linked to spontaneity of sublimation process.
(c)(i)		• Correct Lewis Structure.		
(ii)	Arrangement of areas of electron density around the central I atom is trigonal bipyramidal due to five regions of negative charge. These areas all repel each other. As there are three non-bonding pairs (in the equatorial area) and two bonded atoms, the shape is linear.	• ONE Correct statement.	• Correct explanation.	
(iii)	Polar. The I-F bond is polar due to a difference in electronegativity. There are six regions of negative charge giving IF_5 an octahedral geometry. The five bonded and one lone pair around the central iodine atom gives it the square pyramid shape. This means the molecule is asymmetric so the bond polarities dipoles don't cancel causing the molecule to be polar.	• Polar, with ONE correct statement.	• Link shape of IF_5 to electron arrangement around the central atom OR Link shape to polarity.	• Full explanation of shape and polarity of IF_5.

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

Cut Scores

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