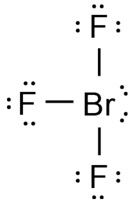
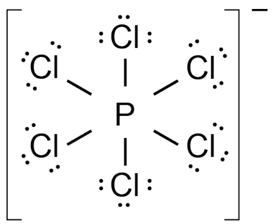
Assessment Schedule – 2013

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)	Se: $[Ar]3d^{10}4s^24p^4$ or $4s^23d^{10}4p^4$ V: $[Ar]3d^34s^2$ or $4s^23d^3$ V^{3+}: $[Ar]3d^2$ where [Ar]: $1s^22s^22p^63s^23p^6$	• TWO correct from (a).		
(b)(i) (ii) (iii)	Se has more shells/electrons in energy levels further from the nucleus than O, with increased shielding from inner shells. This means there is a weaker electrostatic attraction between the nucleus and the bonded electrons, so Se has a lower electronegativity than O. Cl^- has an extra electron in its outermost/same energy level. This causes increased repulsion between electrons in the valence shell, so the electrons move further apart. This makes Cl^- bigger than Cl. Both Cl and Cl^- have the same number of protons/attractive force of the nucleus remains the same. Cl has more protons than Li. Therefore there is a greater attraction between the nucleus and outer electrons/electrons held more tightly so it is harder to remove an electron from Cl than Li. Even though the valence electrons of Cl are in the 3rd energy level/has an extra energy level the extra shielding is not as significant as the effect of the increased nuclear charge, so Cl has a higher first ionisation energy than Li.	• Two valid statements from any of b(i) (ii) or (iii).	• Full discussion in one of the three parts and any two other valid points.	• Two full discussions and one other valid point.

(c)(i)	BrF_3: T-shaped:  PCl_6^-: Octahedral 	• TWO correct Lewis diagrams. OR TWO correct shapes. OR ONE correct Lewis diagram and corresponding name.	• ALL correct	
(ii)	There is a difference in electronegativity between S and F, so the S-F bonds are polar covalent. SF_4 has a see-saw shape (distorted tetrahedron) due to the repulsions between four bonding regions and one non-bonding region of charge, which is asymmetric therefore the polarities/dipoles do not cancel. As a result, SF_4 is a polar molecule. There is a difference in electronegativity between Xe and F, so the Xe-F bonds are polar covalent. XeF_4 has a square planar shape, due to the repulsions between four bonding regions and two non-bonding regions of charge; therefore the polarities/dipoles do cancel. As a result, XeF_4 is a non-polar molecule.	• Both shapes correct OR Both polarities correct OR One shape and corresponding polarity • Identifies polar bonds due to F having a different electronegativity to both Xe and S. OR Links polarity to symmetrical or asymmetrical arrangement of polar bonds.	• Both polarities correct and full discussion of polarity for both molecules. OR Both shapes correct and full discussion of shape for both. OR Shape and polarity correct and full discussion for one molecule. OR Both shapes and polarities correct with essentially correct discussions but omissions in both.	• Correct discussion for polarities of BOTH molecules.

Not Achieved			Achievement		Merit		Excellence	
NØ No response; no relevant evidence.	N1 1a	N2 2a	A3 3a	A4 4a	M5 2m	M6 3m	E7 2e with minor error/omission	E8 2e

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
TWO (a)(i)	The enthalpy change when one mole of liquid water is converted to gaseous water under standard conditions. OR $H_2O(\ell) \rightarrow H_2O(g)$	• Correct definition or equation.		
(ii)	Find $H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(\ell)$ Given $H_2O(\ell) \rightarrow H_2O(g)$ $\Delta H = 44$ kJ mol^{-1} (reverse) $H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(g)$ $\Delta H = -242$ kJ mol^{-1} $\Delta_f H°(H_2O(\ell)) = -44 + (-242) = -286$ kJ mol^{-1}	• Correct process with minor error. OR Writes 2 correct equations	• Correct working and answer, with units.	• Both merit answers
(iii)	At 100°C, energy is used to change liquid water to water vapour. At its boiling point, the heat energy is used to break the intermolecular forces /hydrogen bonds between the H_2O molecules.	• Relates energy use to change of state/breaking of intermolecular forces	• Relates energy use to change of state and intermolecular forces	
(b)(i)	$q = mc\Delta T = 50 \times 4.18 \times 6.5 = 1358.5$ J $= 1.3585$ kJ n = c x V = 1 x 0.025 = 0.025 mol $\Delta_r H° = \frac{-q}{n} = \frac{-1.3585 \text{ kJ}}{0.025 \text{ mol}}$ $= -54.3 \text{ kJ mol}^{-1}$	• Calculates energy correctly. OR Calculates number of moles correctly.	• Correct answer. May have poor rounding /incorrect units/sign OR Incorrect moles as the only error.	• Correct calculation, with – sign, units and appropriate significant figures.
(ii)	Conditions were not standard. Needed to carry out under standard conditions. OR Heat lost to atmosphere / beaker / surroundings. Insulate equipment; ensure all / as much of the energy produced as possible is collected and measured.	• Provides a valid reason for the discrepancy in the result AND suggests an improvement.		

Not Achieved			**Achievement**		**Merit**		**Excellence**	
NØ No response; no relevant evidence.	N1 1a	N2 2a	A3 3a	A4 4a	M5 2m	M6 3m	E7 e in (b) and m in (a)(ii) or (iii)	E8 2e

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
THREE (a)	N_2H_4 is a polar molecule. (Due the presence of the highly polar N-H bonds), there is hydrogen bonding between N_2H_4 molecules. CH_3F is also a polar molecule. (Due to the presence of the C-F bond), there are permanent dipole attractions between the CH_3F molecules. The attractive forces due to permanent dipoles in CH_3F must be weaker than the attractive forces due to hydrogen bonding in N_2H_4, because CH_3F boils at a lower temperature and they are similar masses so temporary dipole attractions are similar. $C_{10}H_{22}$ is a non-polar molecule. The only attractive forces between the $C_{10}H_{22}$ molecules are due to temporary dipoles. However, since $C_{10}H_{22}$ is a significantly larger molecule than N_2H_4, and CH_3F, it is more polarisable / has more electrons / greater molar mass, so its temporary dipole attractions are even stronger than the hydrogen bonds in N_2H_4. As a result, $C_{10}H_{22}$ requires the most heat energy to break its intermolecular forces and therefore has the highest boiling point.	• Identifies most significant type of intermolecular bonding for ONE molecule. • Recognises that more electrons cause stronger temporary dipoles. OR The stronger the intermolecular force the higher the boiling point/more energy required	• Correct description of intermolecular bonding for two molecules and a valid comparison.	• Full discussion for all THREE molecules.
(b)	$\Delta_c H° = \Sigma\Delta_f H(\text{products}) - \Sigma\Delta_f H(\text{reactants})$ $=[(10 \times -393) + (11 \times -286)] - (-250)$ $= -6\ 826\ \text{kJ mol}^{-1}$ or $(-6\ 830\ \text{kJ mol}^{-1})$	• Correct process (evidence of 10×-393, 11×-286 and 1×-250)	• Correct calculation, with correct units and sign.	
(c)	Enthalpy change: The combustion of liquid hydrazine is an exothermic process since $\Delta_c H°$ is negative. Exothermic reactions form products that have lower energy than the reactants / energy is released and this favours the spontaneous / forward reaction. Entropy change: Exothermic reactions release heat to the surroundings, which makes the entropy change of the surroundings positive. As both the surroundings and the system gain entropy, this favours the spontaneous / forward reaction. OR The combustion reaction has more gas molecules in the products / goes from liquid to gas / increase in number of particles. Therefore the entropy of the system increases and this favours the spontaneous / forward reaction. As both enthalpy and entropy are favoured, then hydrazine readily burns / the reaction is spontaneous.	• Recognises entropy increases which favour the reaction. OR Recognises reaction is exothermic which favours the reaction.	• Partial explanation refers to both entropy and enthalpy changes. OR Full explanation for enthalpy or entropy change.	• Full explanation.

Not Achieved			Achievement		Merit		Excellence	
NØ No response; no relevant evidence.	N1 1a	N2 2a	A3 3a	A4 4a	M5 2m	M6 3m	E7 2e, with minor error / omission	E8 2e

Judgement Statement

	Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
Score range	0 – 7	8 – 12	13– 18	19 – 24