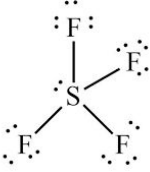
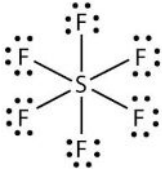
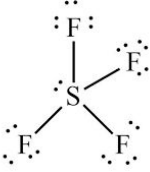
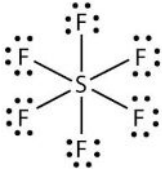
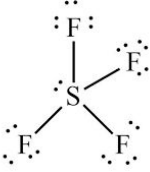
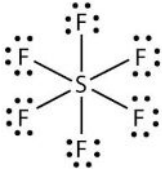


Assessment Schedule – 2023

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

Evidence Statement

Q	Evidence	Achievement	Merit	Excellence									
ONE (a)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th data-bbox="331 424 618 472"></th> <th data-bbox="618 424 896 472">SF₄</th> <th data-bbox="896 424 1173 472">SF₆</th> </tr> </thead> <tbody> <tr> <td data-bbox="331 472 618 676" style="text-align: center;">Lewis Structure</td> <td data-bbox="618 472 896 676" style="text-align: center;">  </td> <td data-bbox="896 472 1173 676" style="text-align: center;">  </td> </tr> <tr> <td data-bbox="331 676 618 724" style="text-align: center;">Shape</td> <td data-bbox="618 676 896 724" style="text-align: center;">seesaw</td> <td data-bbox="896 676 1173 724" style="text-align: center;">octahedral</td> </tr> </tbody> </table>		SF ₄	SF ₆	Lewis Structure			Shape	seesaw	octahedral	<ul style="list-style-type: none"> Two correct. 	<ul style="list-style-type: none"> All correct. 	
	SF ₄	SF ₆											
Lewis Structure													
Shape	seesaw	octahedral											
(b)	<p>PF₃Cl₂ has five areas of electron density around the central P atom, all of which are bond pairs. Repulsion between these five areas of electron density results in the trigonal bipyramidal shape to maximise separation and therefore minimise repulsion.</p> <p>F and Cl are each more electronegative than P, so the P–F and P–Cl bonds are polar covalent. Although the dipoles are symmetrically arranged, Fluorine has a different electronegativity to Chlorine so the P–F dipoles have a differing strength/are different from the P–Cl dipoles. As a result, the dipoles do not cancel out, and therefore PF₃Cl₂ is a polar molecule.</p>	<ul style="list-style-type: none"> Recognises influence of electronegativity difference or shape on polarity. OR Correct shape and recognises polar bonds are present. 	<ul style="list-style-type: none"> Fully explains polarity. OR Fully explains shape. OR Minor errors in both parts. 	<ul style="list-style-type: none"> Fully explains the shape and polarity of PF₃Cl₂. 									

(c)(i)	$\text{N}_2\text{H}_4(\ell) \rightarrow \text{N}_2\text{H}_4(\text{g})$	<ul style="list-style-type: none"> • Correct equation with state symbols. 		
(ii)	The enthalpy of vaporisation of hydrazine is an endothermic process since heat energy is required / absorbed to break / overcome the intermolecular forces between the hydrazine molecules to change from a liquid to a gas.	<ul style="list-style-type: none"> • Endothermic with some reasoning 	<ul style="list-style-type: none"> • Explains that enthalpy of vaporisation is endothermic since heat energy is absorbed to break the intermolecular forces. 	
(iii)	<p>The entropy of the system increases since the liquid hydrazine forms gaseous products and the number of molecules increases from two reactants to three products. This means there is a greater dispersal of matter and energy in the system.</p> <p>Since the reaction is exothermic, this means heat energy is released into the surroundings, so particles in the surroundings gain heat energy / kinetic energy / move faster. This results in a greater dispersal of matter and energy in the surroundings, so the entropy of the surroundings increases.</p> <p>Since the entropy of both the system and the surroundings increases, this means the total entropy change will be positive and therefore the reaction will be spontaneous.</p>	<ul style="list-style-type: none"> • Recognises entropy increases when there is an increase in disorder / increased in number of particles / liquid changes to gas. <p>OR</p> <p>Identifies the reaction releases heat energy due to being exothermic.</p> <p>OR</p> <p>Particles gain E_k /move faster.</p>	<ul style="list-style-type: none"> • Provides a partial explanation of the entropy changes in both the system and the surroundings. <p>OR</p> <p>One full explanation.</p>	<ul style="list-style-type: none"> • Justifies the spontaneous nature of the reaction, in terms of the entropy changes in the system and surroundings.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	1a	2a	3a	4a	3m	4m	e2m	2e

Q	Evidence	Achievement	Merit	Excellence
TWO (a)(i)	$\text{Ga(g)} \rightarrow \text{Ga}^{\text{+}}(\text{g}) + \text{e}^{-}$.	<ul style="list-style-type: none"> Correct equation with state symbols. 		
(ii)	Se has a greater first ionisation energy than Ga. Although the valence electrons are in the same energy level with the same repulsion / shielding from inner shells, the number of protons increases across a period. So, the electrostatic attraction between the positive nucleus and the valence electrons increases, and therefore more energy is required to remove the outermost electron, so Se has a greater first ionisation energy than Ga.	<ul style="list-style-type: none"> Recognises Se has a greater first ionisation energy than Ga. 	<ul style="list-style-type: none"> Explains first ionisation energy trend with reference to at least TWO of: energy levels, number of protons, repulsion from inner energy levels, strength of electrostatic attraction. 	<ul style="list-style-type: none"> Fully explains the trends in both first ionisation energy AND atomic radius
(iii)	Going down a group, valence electrons are added to an energy level further from the nucleus with increased repulsion / shielding from inner shells. Although the number of protons increases down a group, this attraction is offset by the increasing distance between the nucleus and the valence electrons. So, the electrostatic attraction between the positive nucleus and its valence electrons decreases, and therefore the atomic radius of Ga is bigger than the atomic radius of B.	<ul style="list-style-type: none"> Recognises one factor influencing trends. 	<ul style="list-style-type: none"> Explains atomic radius trend with reference to at least TWO of: energy levels, number of protons, repulsion from inner energy levels, strength of electrostatic attraction. 	
(b)(i)	$-89.0 = [\Delta_f H^\circ(\text{CO}(\text{NH}_2)_2 + (-242))] - [(2 \times -46.0) + -394]$ $-89.0 = \Delta_f H^\circ(\text{CO}(\text{NH}_2)_2) + 244$ $\Delta_f H^\circ(\text{CO}(\text{NH}_2)_2) = -89.0 - 244$ $\Delta_f H^\circ(\text{CO}(\text{NH}_2)_2) = -333 \text{ kJ mol}^{-1}$	<ul style="list-style-type: none"> Correct process with error. 	<ul style="list-style-type: none"> Correct answer. 	
(ii)	If liquid water was produced instead of gaseous water, heat energy would be released as (intermolecular) bonds form between the liquid water molecules. As a result, the enthalpy change would be more negative / more exothermic. (in reverse – less energy is required to turn liquid water to a gas so more energy is released and therefore more exothermic)	<ul style="list-style-type: none"> Recognises energy is released to change water from a gas to a liquid. OR More exothermic / negative with some explanation. 	<ul style="list-style-type: none"> Correct explanation related to bond forming . 	

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	1a	2a	3a	4a	3m	4m	e2m	2e

Q	Evidence	Achievement	Merit	Excellence
THREE (a)(i)	S: $1s^22s^22p^63s^23p^4$ Co: $[\text{Ar}]3d^74s^2$ Cr ³⁺ : $[\text{Ar}]3d^3$	<ul style="list-style-type: none"> TWO electron configurations correct. 	Full explanation.	
(ii)	The Ca atom loses its two valence/outer shell electrons when it forms the Ca ²⁺ ion. Therefore the Ca atom has four occupied energy levels, whereas the Ca ²⁺ ion only has three occupied energy levels. As a result, the Ca ²⁺ ion has a smaller radius.	<ul style="list-style-type: none"> Recognises the Ca atom loses electrons / shell to form its ion. 		
(b)(i)	Propan-1-amine: temporary dipole, permanent dipole, hydrogen bonding Chloroethane: temporary dipole, permanent dipole Decane: temporary dipole	<ul style="list-style-type: none"> TWO rows correct. 	<ul style="list-style-type: none"> Relates the higher boiling point of propan-1-amine to the presence and relative strength of hydrogen bonding and the presence of N-H bond. 	<ul style="list-style-type: none"> Fully justifies boiling point differences for both (ii) AND (iii).
(ii)	Propan-1-amine and chloroethane both have electron clouds of a similar size and therefore the temporary dipole attractions between the molecules are of similar strength. Both chloroethane and propan-1-amine have permanent dipole attractions between their molecules, (due to the C–Cl dipole and the N–H dipole, respectively). However, propan-1-amine also has hydrogen bonding between its molecules, due to the strong N–H dipole / the large difference in electronegativity between N and H. As a result, more heat energy is required to overcome the intermolecular forces between propan-1-amine, so it has a higher boiling point than chloroethane.	<ul style="list-style-type: none"> Recognises hydrogen bonding is stronger than permanent / temporary dipole attractions. OR Relates the presence of hydrogen bonding to the higher boiling point of propan-1-amine. 		
(iii)	Chloroethane has permanent dipole attractions between its molecules (due to the C–Cl dipole), as well as temporary dipole attractions. However, since decane has a much larger electron cloud due to its larger molar mass, the sum of its temporary dipole interactions is greater, so more heat energy is required to separate decane molecules compared to chloroethane molecules. As a result, decane has a higher boiling point than chloroethane.	<ul style="list-style-type: none"> Recognises electron cloud size / molar mass / chain length / surface area influences strength of temporary dipole attractions / boiling point 		

(c)	$\text{C}_6\text{H}_{12}\text{O}_6(\text{s}) \rightarrow 6\text{C}(\text{s}) + 6\text{H}_2(\text{g}) + 3\text{O}_2(\text{g}) \quad +1270$ $6\text{C}(\text{s}) + 6\text{O}_2(\text{g}) \rightarrow 6\text{CO}_2(\text{g}) \quad 6 \times -394 = -2364$ $6\text{H}_2(\text{g}) + 3\text{O}_2(\text{g}) \rightarrow 6\text{H}_2\text{O}(\ell) \quad 6 \times -286 = -1716$ $6\text{H}_2\text{O}(\ell) \rightarrow 6\text{H}_2\text{O}(\text{g}) \quad 6 \times +6.01 = +36.06$ $\Delta_r H = +1270 + (-2364) + (-1716) + (+36.06) = -2774 \text{ kJ mol}^{-1}$	<ul style="list-style-type: none"> • Correctly manipulates two equations / enthalpy changes. 	<ul style="list-style-type: none"> • Correct process with one error. 	<ul style="list-style-type: none"> • Correct answer with unit, sign, and significant figures (accept 2–4).
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NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	1a	2a	3a	4a	3m	4m	e2m	2e

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 8	9 – 14	15 – 18	19 – 24