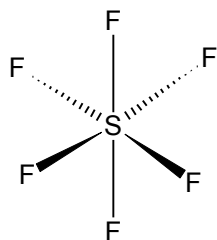
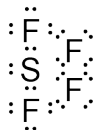
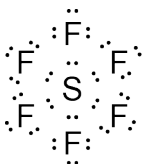


Assessment Schedule – 2012

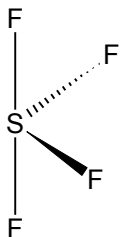
Chemistry: Describe properties of particles and thermochemical principles (90780)

Evidence Statement

Question	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
ONE (a)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^2$ $[\text{Ar}] 3d^{10} 4s^2 4p^2$ $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$ $[\text{Ar}] 3d^{10} 4s^1$ $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$ $[\text{Ar}] 3d^{10}$	<p>For achievement, must show some evidence of understanding concepts in this standard. This would mean providing evidence of at least 4 of the following bullet points.</p> <ul style="list-style-type: none"> • ONE electron configuration correct. • ALL electron configurations correct. 	<p>Answers show ability to link ideas and show some reasoned thinking. The answer is however lacking in some of the detail or some parts are incorrect.</p> <p>Typically this will involve providing evidence of at least 6 of the bullet points listed.</p>	<p>Full answers to all parts of the question with only minor error</p> <p>OR</p> <p>no more than 1 bullet point incorrect or absent.</p>
(b)	<p>Coloured compounds have partially filled/incomplete <i>d</i>-orbitals.</p> <p>Cu^+ all <i>d</i>-orbitals filled/no partially filled <i>d</i>-orbitals $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$</p> <p>$\text{Cu}^{2+}$ has incomplete/partially filled <i>d</i>-orbitals, so is coloured $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$</p>	<ul style="list-style-type: none"> • Coloured compounds have partially filled / incomplete <i>d</i>-orbitals. • Cu^{2+} has partly filled <i>d</i>-orbital while Cu^+ does not. 		
(c)	<p>Ge = 123 pm Cu = 128 pm Cu^+ = 77 pm</p> <p>Both atoms have the same number of electron shells/energy levels / shielding of outer electrons by inner electrons / valence electrons in same energy level. Ge, however, has a greater nuclear charge / number of protons, compared to Cu, so there is a stronger attraction for the valence electrons, bringing them in closer, resulting in a smaller radius.</p> <p>Cu^+ has fewer electron shells than the Cu/Ge atoms (only 3 vs 4) and hence the electrons are closer to the nucleus meaning it is the smallest of the three particles.</p> <p>$\text{Cu} > \text{Ge} > \text{Cu}^+$</p>	<ul style="list-style-type: none"> • Cu = 128pm or Cu^+ = 77pm. • All radii in correct order. • Loss of energy level / loss of electron from 4s orbital for Cu to form Cu^+ hence valence electrons much closer to the nucleus. <p>Recognises smaller radius for Ge, compared to Cu, due to greater electrostatic attraction between nucleus and valence electrons due to fact that:</p> <ul style="list-style-type: none"> • Ge has greater charge / more protons on the nucleus. • Both Ge and Cu have valence electrons in the same energy level. 		

TWO
(a)

Octahedral



See-saw or saw-horse or distorted tetrahedron

For achievement, must show some evidence of understanding concepts in this standard. This would mean providing evidence of at least 4 of the following bullet points.

- Lewis diagram for SF_6 and octahedral shape identified
- Correct Lewis diagram for SF_4
- Correct shape drawn for SF_6
- Correct shape drawn for SF_4 with correct name for shape.

Answers for parts (a) and (b) show ability to link ideas and show some reasoned thinking. The answer is however lacking in some of the detail or some parts are incorrect. Typically this will involve providing evidence of at least 6 of the bullet points listed.

Full answers to all parts of the question with only minor error

OR
no more than 1 bullet point incorrect or absent.

(b)	<p>ClF₃ <i>Shape</i></p> <ul style="list-style-type: none"> • there are 5 regions of electron density around the Cl central atom • these repel to take a trigonal bipyramidal arrangement/ minimise repulsion / to get as far apart as possible • there are only 3 bonding electron pairs/2 lone pairs, • thus forming a T-shape arrangement. <p><i>Polarity</i></p> <ul style="list-style-type: none"> • the Cl-F bond is polar because of electronegativity difference • the molecule is NOT symmetrical • bond dipoles do not cancel OR charge is not symmetrically distributed over the molecule, • so the molecule is polar. <p>AsF₅ <i>Shape</i></p> <ul style="list-style-type: none"> • has 5 electron pairs around the As central atom • these repel to take a trigonal bipyramidal shape/ minimise repulsion / to get as far apart as possible • there are 5 bonding electron pairs/ all electron pairs are bonding, • thus forming a trigonal bipyramidal arrangement. <p><i>Polarity</i></p> <ul style="list-style-type: none"> • As-F bond is polar because of electronegativity difference • molecule is symmetrical • bond dipoles do cancel, • so the molecule is non-polar. 	<ul style="list-style-type: none"> • Links shape to total number of regions of electron density / electron pairs / negative charge that repel and move as far apart as possible. • Also links shape to number of bonding and non-bonding pairs for both molecules – hence ClF₃ is T-shaped and AsF₅ is trigonal bipyramidal. • Identifies polar bonds due to differences in electronegativity of atoms involved. • Recognises molecules are non-polar (AsF₅) or polar (ClF₃). • Links non-polar molecule to the fact that the charge is symmetrically distributed (bond dipoles / polar bonds cancel) while in polar molecule charge is not symmetrically distributed (bond dipoles/ polar bonds do not cancel). 		
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THREE (a)(i)	The heat evolved / energy change when one mole of a substance is combusted / burnt in oxygen / reacted completely in oxygen under standard conditions	For achievement, must show some evidence of an understanding of the concepts in this standard.	Answers show ability to link ideas and show some reasoned thinking. The answer is however lacking in some of the detail or some parts are incorrect.	Full answers to all parts of the question with only minor error
(ii)	$8\text{C} + 9\text{H}_2 \rightarrow \text{C}_8\text{H}_{18} \quad \mathbf{2 (250)} = 500$ $\text{C} + \text{O}_2 \rightarrow \text{CO}_2 \quad \mathbf{16 (-394)} = -6304$ $\text{H}_2 + 1/2\text{O}_2 \rightarrow \text{H}_2\text{O} \quad \mathbf{18(-286)} = -5148$ $-10\,952 / 2 = -5476 \text{ kJ mol}^{-1}$ <p>OR</p> $2\text{C}_8\text{H}_{18}(\ell) + 25\text{O}_2(\text{g}) \rightarrow 16\text{CO}_2(\text{g}) + 18\text{H}_2\text{O}(\ell)$ $\Delta_r H^\circ = \sum \Delta_f H^\circ_{\text{products}} - \sum \Delta_f H^\circ_{\text{reactants}}$ $= 16(-394) + 18(-286) - 2(-250) = -10952 \text{ kJ mol}^{-1}$ $\Delta_c H^\circ = -10952 / 2 = -5476 \text{ kJ mol}^{-1}$	<p>This would mean providing evidence of at least 4 of the following bullet points.</p> <ul style="list-style-type: none"> • Definition correct for (a) • Correct method for determining enthalpy change using heats of formation or Hess's law • Correct substitution of values to get $\Delta_r H^\circ$ (-10952 kJ mol⁻¹) • $\Delta_c H^\circ = 1/2 \times \Delta_r H^\circ$ • (Answer of -5476 kJ mol⁻¹) 	Typically this will involve providing evidence of at least 6 of the bullet points listed.	OR no more than 1 bullet point incorrect or absent.
(b)	<p>Enthalpy change = $\Sigma(\text{bonds broken}) - \Sigma(\text{bonds formed})$</p> $x = E_{(\text{C}=\text{O})}$ <p>Bonds broken = $7(\text{C-H}) + 2(\text{C-C}) + 1(\text{C-O}) + 1(\text{O-H}) + 4.5(\text{O}=\text{O})$</p> $= 7(414) + 2(346) + 358 + 463 + 4.5(498)$ $= 2898 + 692 + 358 + 463 + 2241$ <p>Bonds broken = 6 652 kJ mol⁻¹</p> <p>Bonds formed = $6(\text{C}=\text{O}) + 8(\text{O-H})$</p> $= 6(x) + 8(463)$ $= 6(x) + 3704$ $-2010 = (6652) - (6(x) + 3704)$ $-2010 = 2948 - 6(x)$ $-4958 = -6(x)$ <p>$E_{(\text{C}=\text{O})} = \mathbf{826 \text{ kJ mol}^{-1}}$ OR $\mathbf{826.3 \text{ kJ mol}^{-1}}$</p>	<ul style="list-style-type: none"> • In (b) calculates the difference of sum of bonds broken minus sum of bonds formed. • Correct process for substitution of bond enthalpies. • Correct answer of $E_{(\text{C}=\text{O})} = 826 \text{ kJ mol}^{-1}$. 		
(c)	<p>The bond enthalpy is the energy required to break one mole of bonds between (pairs of) atoms (in the gaseous state).</p> <p>C=O bond enthalpy is larger than C-O bond enthalpy as more energy is required to break the double bond than a single bond.</p>	<ul style="list-style-type: none"> • Correct definition of bond enthalpy. • Understands that the double bond requires more energy to break than the single bond. 		

<p>FOUR (a)(i)(ii)</p>	<p>$\Delta_{\text{fus}}H^\circ$ $\text{H}_2\text{O}(s) \rightarrow \text{H}_2\text{O}(l) \quad \Delta_{\text{fus}}H^\circ(\text{H}_2\text{O}) = 6.01 \text{ kJ mol}^{-1}$ $\Delta_{\text{vap}}H^\circ$ $\text{H}_2\text{O}(l) \rightarrow \text{H}_2\text{O}(g) \quad \Delta_{\text{vap}}H^\circ(\text{H}_2\text{O}) = 40.67 \text{ kJ mol}^{-1}$</p> <p>Less energy is required to overcome the attractive forces/hydrogen bonds between the solid molecules to turn them into a liquid, as only some of these forces need to be broken.</p> <p>However, more energy is required to fully break all forces /hydrogen bonds between molecules in the liquid phase to vapourise the substance to turn them into a gas. Hence the $\Delta_{\text{vap}}H^\circ$ is always greater than the $\Delta_{\text{fus}}H^\circ$.</p>	<p>For achievement, must show some evidence of the understanding of concepts in this standard. This would mean providing evidence of at least 4 of the following bullet points.</p> <ul style="list-style-type: none"> • Correct equation for $\Delta_{\text{fus}}H^\circ(\text{H}_2\text{O})$. (States needed) • Correct equation for $\Delta_{\text{vap}}H^\circ(\text{H}_2\text{O})$. (States needed) • Links melting and boiling to breaking of intermolecular forces • Identifies types of intermolecular forces, in particular hydrogen bonds between molecules • Links smaller value of the $\Delta_{\text{fus}}H^\circ$ to partial breaking of intermolecular forces whereas $\Delta_{\text{vap}}H^\circ$ involves fully breaking the intermolecular forces so that molecules can move far apart. • Considers similarity of instantaneous dipole attractions due to similar sized electron cloud. • Identifies that molecules are polar and have permanent dipole attractions between molecules. • Identifies that $\text{HOCH}_2\text{CH}_2\text{Cl}$ has hydrogen bonding between the molecules. • $\text{HOCH}_2\text{CH}_2\text{Cl}$ has higher boiling point as intermolecular forces are stronger. 	<p>Answers show ability to link ideas and show some reasoned thinking. The answer is however lacking in some of the detail or some parts are incorrect.</p> <p>Typically this will involve providing evidence of at least 6 of the bullet points listed.</p>	<p>Full answers to all parts of the question with only minor error</p> <p>OR</p> <p>no more than 1 bullet point incorrect or absent.</p>
<p>(b)</p>	<p>The instantaneous-induced dipoles (temporary dipoles/dispersion forces/London forces) in each substance are the same as the molar mass and hence the size of the electron cloud is the same.</p> <p>$\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$ is a polar molecule so also has permanent dipole force between the molecules.</p> <p>$\text{HOCH}_2\text{CH}_2\text{Cl}$ is a polar molecule, so also has permanent dipole forces between the molecules.</p> <p>$\text{HOCH}_2\text{CH}_2\text{Cl}$ has an H atom bonded to an atom of high electronegativity (oxygen), so can form hydrogen bonds (H bond) between the molecules. These are strongest of the intermolecular forces.</p> <p>So the forces of attraction between $\text{HOCH}_2\text{CH}_2\text{Cl}$ molecules are stronger thus this substance has a higher boiling point.</p>	<p>(Continuation of bullet points from the top row)</p>	<p>(Continuation of text from the top row)</p>	<p>(Continuation of text from the top row)</p>

Judgement Statement

Achievement	Achievement with Merit	Achievement with Excellence
3A or 2M	3M or 2E + 1A	3E or 2E + 2M