

Name: **ANSWERS**

Mark = ____ / 46

Part 1: Multiple Choice Section**10 marks**1. **B** 2. **A** 3. **D** 4. **B** 5. **A** 6. **C** 7. **C** 8. **A** 9. **C** 10. **B****Part 2: Written Section****36 marks**

1. The melting points of the metals Sodium, Aluminium and Potassium are given in the table below. Fill in the table to assign the melting points of the three elements.

Element	Melting point (°C)
K	63.25
Na	97.81
Al	660.37

Explain your reasoning in assigning these melting points:

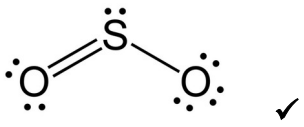
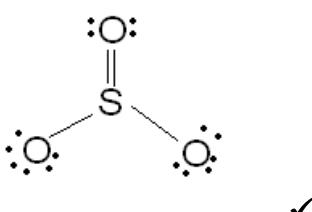
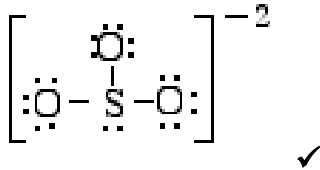
(1, 5 marks)

The strength of the metallic bond depends on the cationic radius and the magnitude of the cationic charge. Stronger bond results from greater ion charge and smaller radius. ✓

K < Na: Both K and Na have a charge of +1 ✓, but the increased radius of the K results in a weaker metallic bond hence K has a lower m.pt ✓

Na < Al: Both are in the same period so there is only a small difference in the ionic radius, ✓ however Al ion is Al³⁺ whereas Na is Na⁺, hence the metallic bond in Al is stronger than in Na. ✓

2. For each species listed in the table below:
- Draw the structural formula, including all valence shell electron pairs and representing each pair as : or –
 - Indicate the shape of each species by either a sketch or name
 - The polarity of the molecule

Species	Structural formula (showing all valence shell electrons)	Shape (sketch or name)	Polar or Non-Polar
SO ₂		Bent of V-shape ✓	Polar ✓
SO ₃		Trigonal Planar ✓	Non-polar ✓
SO ₃ ²⁻		Pyramidal ✓	Not applicable

(8 marks)

Referring to the above answers explain why SO₂ boils at -10°C while SO₃ boils at 45°C.

SO₂ being a polar molecule has dipole-dipole and dispersion forces of attraction between molecules. ✓

SO₃ being non-polar only has dispersion forces between molecules. ✓

You would expect that the SO₂ would have the higher boiling point since dipole-dipole bonds are stronger than dispersion for similar mass. ✓

Since SO₃ has a higher boiling point then the dispersion forces in SO₃ must be stronger than the dipole-dipole in SO₂ due to the increase in number of electrons in SO₃. ✓

(4 marks)

3. Consider the elements in Group 15 of the Period Table (N, P, As, Sb, Bi)
- (a) Which element would most easily form a monatomic negative ion? **N** ✓
 - (b) Which of the hydrides of Group 15 would have the lowest melting point? **P** ✓
 - (c) Which element is the most metallic? **Bi** ✓
 - (d) Name the shape of the molecule of the hydride of phosphorus? **pyramidal** ✓

(4 marks)

4. Which of the elements sodium, sulphur, chlorine, bromine and iodine is the most electronegative?

Chlorine ✓

Define the term electronegativity and hence justify your choice

Electronegativity is the measure of the attraction an atom has for the shared pair of electrons in a covalent bond. ✓

Across the period, $\text{Cl} > \text{S}$ since the nuclear charge increases (constant shielding effect) there is a greater force of attraction between the nucleus and the valence electrons. ✓

Down a group, $\text{Cl} > \text{Br} > \text{I}$ since there is an increased distance of valence electrons from the nucleus. ✓

(Although the nuclear charge increases so does the shielding effect and hence the effective nuclear charge decreases)

(4 marks)

5. The following five substances have their boiling points (at 1 atm) listed in the table below:

Ethanol,	$\text{CH}_3\text{CH}_2\text{-O-H}$
Hydrogen chloride,	HCl
Hydrogen fluoride,	HF
Methane,	CH_4
Ethan-1,2-diol,	$\text{H-O-CH}_2\text{CH}_2\text{-O-H}$

Consider the intermolecular forces between the molecules and so match the boiling points to the substances listed and complete the table.

Boiling Point ($^{\circ}\text{C}$)	Substance
-162	CH_4
- 85	HCl
19	HF
78	$\text{CH}_3\text{CH}_2\text{-O-H}$
198	$\text{H-O-CH}_2\text{CH}_2\text{-O-H}$

1 mark if 2 correct

2 marks if three correct

**3 marks if all correct
(3 marks)**

Boiling point depends on the strength of attraction between molecules. ✓

CH_4 is non-polar molecule with weak dispersion forces between molecules, hence has the lowest boiling point. ✓

$\text{HCl} < \text{HF}$, both are linear polar molecules. HCl has dipole-dipole forces of attraction between its molecules whereas HF has H-bonding. In this case the H-bonding is stronger than the dipole-dipole + dispersion forces in HCl . ✓✓

Ethanol and ethan-1,2-diol are polar molecules with H-bonding between molecules. ✓

Since they both have a greater number of electrons than HF , their dispersion forces are considerably stronger and hence have higher boiling points than HF . ✓

Ethan-1,2-diol > ethanol since there are two OH and hence there are two places for H-bonding interaction to occur, hence it has a higher boiling point. ✓

(7 marks)

END OF TEST