Quiz (Physical Properties of Substances)

1. The table below lists the boiling points of some covalent substances:

	CO_2	SO_2	H_2O_2	SiO_2
Boiling point (°C)	–78	–10	150	2230

Account for the difference in boiling points of the above substances.

2. Explain the following phenomenon:

The evaporation rate of hydrogen chloride is much higher than that of hydrogen fluoride.

3. The table below lists the boiling points of some covalent substances:

Covalent substance	Boiling point (°C)
Ethane	–88.6
Chloroethane	12.3
Ethanol	78.0
Ethane-1,2-diol	197.3

Account for the difference in boiling points of the above substances.

Suggested Answer

1. SiO_2 has the highest boiling point. It has a **giant covalent structure** in which all atoms are held together by **strong covalent bonds**.

   As a result, a lot of energy is needed to separate the atoms.

   CO_2, SO_2 and H_2O_2 all have **simple molecular structures**. H_2O_2 molecules are held together by **hydrogen bonds and van der Waals' forces** while both CO_2 and SO_2 molecules are held together by **van der Waals' forces only**.

   As the intermolecular forces in H_2O_2 are stronger than those in CO_2 and SO_2, H_2O_2 has a much higher boiling point.

   SO_2 has a **larger molecular size** than CO_2. Hence, the van der Waals' forces between SO_2 molecules are stronger.

   More energy is needed to separate the SO_2 molecules during boiling.

2. Hydrogen chloride molecules are held together by van der Waals' forces but hydrogen fluoride molecules are held together mainly by hydrogen bonds.

   As the intermolecular forces in hydrogen fluoride are stronger than those in hydrogen chloride, it is easier for hydrogen chloride molecules to escape into the air.

3. Ethanol and ethane-1,2-diol have higher boiling points as their molecules are held together mainly by hydrogen bonds.

   Among them, each ethane-1,2-diol molecule can form two hydrogen bonds on average while each ethanol molecule can form only one hydrogen bond on average. Therefore, ethane-1,2-diol has a higher boiling point than ethanol.

   The intermolecular forces between chloroethane molecules and between ethane molecules are weak van der Waals' forces.

   Since chloroethane has a larger molecular size than ethane, the van der Waals' forces between chloroethane molecules are stronger than those between ethane molecules. Therefore, chloroethane has a higher boiling point than ethane.