- Ammonia ($NH_3$) has a boiling point of –33 °C and phosphine ($PH_3$) has a boiling point of –83 °C. Explain the difference in these boiling points in terms of the intermolecular forces present.

**2**

- Explain, in terms of chemical bonding and intermolecular forces, the following trend in melting points: $CH_4 < I_2 < NaCl <$ silica ($SiO_2$)

**3**

- Explain briefly, in terms of intermolecular forces, why an analogue of DNA could not be made with phosphorus atoms replacing some nitrogen atoms, while still retaining a double-helical structure.

**3**

- Explain, in terms of chemical bonding and intermolecular forces, the following trend in melting points: $CH_4 < I_2 < NaCl <$ silica ($SiO_2$)

**2**

| | Marks |
|---|---|
| • What physical state would water adopt under ambient conditions (1 atm and 25 °C) if it did not possess hydrogen bonding? Explain. | **2** |
| | |

**Marks 7**

- Glycine, $NH_2CH_2COOH$, the simplest of all naturally occurring amino acids, has a melting point of 292 °C. The p$K_a$ of the acid group is 2.35 and the p$K_a$ associated with the amino group is 9.78. Draw a Lewis structure that indicates the charges on the molecule at the physiological pH of 7.4.

Use your structure to illustrate the concept of resonance.

Describe the hybridisation of the two carbon atoms and the nitrogen atom in glycine and the molecular geometry of the atoms surrounding these three atoms.

Glycine has an unusually high melting point for a small molecule. Suggest a reason for this.

Do you expect glycine to be water soluble? Give a reason for your answer.