

### CHAPTER 3 BONDING

- 1 Phosphorus exists in several different forms, two of which are white phosphorus and red phosphorus. White phosphorus consists of  $P_4$  molecules, and melts at  $44^\circ\text{C}$ . Red phosphorus is macromolecular, and has a melting point above  $550^\circ\text{C}$ .

Explain what is meant by the term *macromolecular*. By considering the structure and bonding present in these two forms of phosphorus, explain why their melting points are so different. (5 marks)

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- 2 (a) Predict the shapes of the  $\text{SF}_6$  molecule and the  $\text{AlCl}_4^-$  ion. Draw diagrams of these species to show their three-dimensional shapes. Name the shapes and suggest values for the bond angles. Explain your reasoning. (8 marks)

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(b) Perfume is a mixture of fragrant compounds dissolved in a volatile solvent.

When applied to the skin the solvent evaporates, causing the skin to cool for a short time. After a while, the fragrance may be detected some distance away. Explain these observations. (4 marks)

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**3** Fritz Haber, a German chemist, first manufactured ammonia in 1909. Ammonia is very soluble in water.

(a) State the strongest type of intermolecular force between one molecule of ammonia and one molecule of water.

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(1 mark)

(b) Draw a diagram to show how one molecule of ammonia is attracted to one molecule of water. Include all partial charges and all lone pairs of electrons in your diagram.

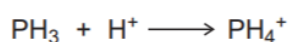
(3 marks)

(c) Phosphine (PH<sub>3</sub>) has a structure similar to ammonia.

In terms of intermolecular forces, suggest the main reason why phosphine is almost insoluble in water.

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(1 mark)

4 The following equation shows the reaction of a phosphine molecule (PH<sub>3</sub>) with an H<sup>+</sup> ion.



(a) Draw the shape of the PH<sub>3</sub> molecule. Include any lone pairs of electrons that influence the shape.

(1 mark)

(b) State the type of bond that is formed between the PH<sub>3</sub> molecule and the H<sup>+</sup> ion. Explain how this bond is formed.

Name of bond .....

How bond is formed .....

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(2 marks)

(c) Predict the bond angle in the PH<sub>4</sub><sup>+</sup> ion.

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(1 mark)

(d) Although phosphine molecules contain hydrogen atoms, there is no hydrogen bonding between phosphine molecules. Suggest an explanation for this.

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(1 mark)

**5** There are several types of crystal structure and bonding shown by elements and compounds.

**(a) (i)** Name the type of bonding in the element sodium.

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(1 mark)

**(ii)** Use your knowledge of structure and bonding to draw a diagram that shows how the particles are arranged in a crystal of sodium. You should identify the particles and show a minimum of six particles in a two-dimensional diagram.

(2 marks)