# Bonding, shape and intermolecular forces

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Show your working where needed.

Name _____ Date _____

## 1. Bonding in three substances

Name the bonding in solid sodium fluoride, in a fluorine molecule and in solid sodium. Describe the attraction involved in each.

## 2. Formation of ammonium

Draw a dot-and-cross diagram for $NH_4^+$, starting from $NH_3$ and $H^+$. Make clear which atom supplies the two electrons for the new bond. Give the shape and approximate H-N-H bond angle.

## 3. Methane, ammonia and water

Rank the bond angles in $CH_4$, $NH_3$ and $H_2O$ from largest to smallest. Give approximate angles and explain the trend.

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### 4. Carbon dioxide and water

Which of $CO_2$ and $H_2O$ has a permanent molecular dipole? Explain your answer by comparing their bonds and shapes.

### 5. Electrical conductivity

Explain why solid magnesium conducts electricity. Magnesium chloride conducts when molten. Predict whether it conducts when solid and identify what carries charge in the molten salt.

### 6. Two forms of carbon

Graphite conducts electricity along its layers. Pure diamond does not conduct. Explain these observations using the way carbon atoms are bonded in each structure.

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### 7. Two compounds of formula $C_2H_6O$

Ethanol has structural formula $CH_3CH_2OH$. Methoxymethane is $CH_3OCH_3$. Predict which compound has the higher boiling point and explain your choice.

### 8. Two isomers of $C_5H_{12}$

Pentane, $CH_3CH_2CH_2CH_2CH_3$, and 2,2-dimethylpropane, $C(CH_3)_4$, have the same molecular formula. Predict which has the higher boiling point. Explain how the shapes affect the intermolecular forces.

### 9. Extra challenge · From molecules to bulk behaviour

Water and hydrogen sulfide are both bent molecules. $H_2O$ boils at 100 °C and $H_2S$ at −60 °C at atmospheric pressure. $H_2S$ has the larger electron cloud.

Explain why water has the higher boiling point despite the difference in electron cloud size. Draw one intermolecular attraction between two water molecules, showing the relevant partial charges and lone pair. Use this attraction to explain why ice is less dense than liquid water.

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