



Hydrogen bonding and methane



Part A Effects of intermolecular hydrogen bonding

Which of the following statements describes a phenomenon which can be explained by intermolecular hydrogen-bonding?

- ☐ The boiling points of the alkanes increase with increasing relative molecular mass.
- ☐ Ice has a lower density than water at 0 °C.
- ☐ The melting points of the Group 1 hydroxides increase with increasing relative molecular mass (M_r)
- ☐ Hydrogen chloride forms an acidic solution when dissolved in water.
- ☐ CH_3OCH_3 ($M_r = 46$) has a higher boiling point than $\text{CH}_3\text{CH}_2\text{CH}_3$ ($M_r = 44$).

Part B Condensed methane

The Voyager 2 probe has shown that the surface of Triton, a moon of the planet Neptune, contains condensed methane which flows rapidly.

Which statement explains the flow within the condensed methane?

- ☐ Methane molecules have a tetrahedral structure.
- ☐ Condensed methane has a metallic structure.
- ☐ Methane molecules contain strong C—H bonds.
- ☐ The intermolecular forces between methane molecules are weak.

Part A adapted with permission from UCLES, A-Level Chemistry, November 1990, Paper 1, Question 4;

Part B adapted with permission from UCLES, A-Level Chemistry, November 1996, Paper 4, Question 4



Physics. *You work it out.*

All materials on this site are licensed under the [Creative Commons license](#), unless stated otherwise.



Ammonia

A Level



Part A Lone pair on ammonia

Which of the following does **not** involve the lone pair of electrons on the nitrogen atom of the ammonia molecule?

- ☐ the formation of NH_4^+ ions in aqueous ammonia
- ☐ the dissolving of silver chloride in aqueous ammonia
- ☐ the formation of NH_2^- ions during the reaction of ammonia with sodium
- ☐ the hydrogen bonding that occurs between molecules of ammonia

Part B Ammonia in water

Which combination of molecules and ions exists in a solution of ammonia in water?

- ☐ ions only
- ☐ simple molecules and hydrogen-bonded molecules only
- ☐ hydrogen-bonded molecules and ions only
- ☐ simple molecules and ions only

Part A adapted with permission from UCLES, A-Level Chemistry, November 1995, Paper 4, Question 18;

Part B adapted with permission from UCLES, A-Level Chemistry, November 1998, Paper 3, Question 18



Breaking hydrogen bonds



Part A Hydrogen bonding between same molecules

Which of the following molecules will **not** form a hydrogen bond with another of its own molecules?

- ☐ CH_4
- ☐ H_2O
- ☐ CH_3OH
- ☐ NH_3

Part B Breaking hydrogen bonds

In which of the following processes will hydrogen bonds be broken?

- ☐ $\text{H}_2(\text{l}) \longrightarrow \text{H}_2(\text{g})$
- ☐ $\text{H}_2(\text{g}) \longrightarrow 2\text{H}(\text{g})$
- ☐ $\text{NH}_3(\text{l}) \longrightarrow \text{NH}_3(\text{g})$
- ☐ $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5(\text{l}) \longrightarrow \text{C}_2\text{H}_5\text{OC}_2\text{H}_5(\text{g})$
- ☐ $2\text{HI}(\text{g}) \longrightarrow \text{H}_2(\text{g}) + \text{I}_2(\text{g})$

Part A adapted with permission from UCLES, A-Level Chemistry, June 1994, Paper 4, Question 8;

Part B adapted with permission from OCSEB, A-Level Chemistry, June 1995, Paper 1, Question 5



Dissolving salts



Part A Barium and magnesium sulfates

Barium sulfate occurs naturally as barite, which is a solid ore. Magnesium sulfate, however, occurs mainly in solution,

Why is this?

- ☐ Barium ions are less readily hydrated than magnesium ions.
- ☐ Barium sulfate has a stronger crystalline lattice.
- ☐ Barium sulfate is more resistant to oxidation than magnesium sulfate.
- ☐ Magnesium sulfate is hydrolysed by naturally acidic solutions, but barium sulfate is not.

Part B Dissolving ammonium nitrate

Which of the following statements correctly explains why the temperature falls when ammonium nitrate dissolves in water?

- ☐ The lattice enthalpy of the salt has a negative value.
- ☐ The lattice enthalpy of the salt is greater in magnitude than the enthalpy of solvation of the ions.
- ☐ Six bonds have to be broken in the crystal and only one is formed in solution.
- ☐ The vapour pressure over a salt solution is always less than that of the pure solvent.
- ☐ The strength of the bonding between ammonium and nitrate ions in the crystal is greater than that between ammonium and hydroxide ions in solution.

Part A adapted with permission from OCR, A-Level Chemistry, November 1999, Paper 3, Question 14;

Part B adapted with permission from OCSEB, A-Level Chemistry, June 1999, Paper 1, Question 7



Dipoles

A Level



Part A Dipoles 1

Which of the following molecules has **no** permanent dipole?

- ☐ CCl_2F_2
 - ☐ CHCl_3
 - ☐ C_2Cl_4
 - ☐ $\text{C}_2\text{H}_5\text{Cl}$
-

Part B **Dipoles 2**

In which pair of molecules is the permanent dipole in molecule **I** greater than that in molecule **II**?

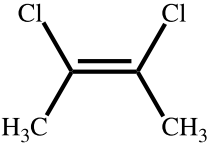
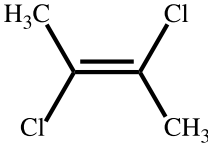

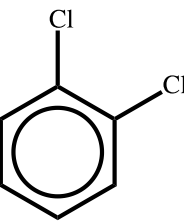
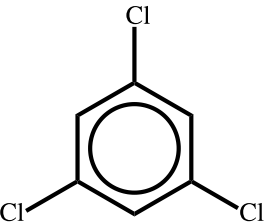
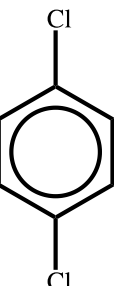
	I	II
A		
B	<chem>CH3CH2Cl</chem>	<chem>CH3CHCl2</chem>
C		
D		

Figure 1: Dipoles.

- ☐ A
- ☐ B
- ☐ C
- ☐ D

Part A adapted with permission from UCLES, A-Level Chemistry, June 1994, Paper 4, Question 9;

Part B adapted with permission from UCLES, A-Level Chemistry, June 1999, Paper 3, Question 18



Van der Waals and paraffin wax



Part A Van der Waals forces

Which of the following solids consists of atoms or molecules held together only by van der Waals forces (due to some form of dipole-dipole interaction)?

- ☐ CO₂
- ☐ Cu
- ☐ H₂O
- ☐ MgO
- ☐ SiO₂

Part B Melting point of paraffin wax

The melting point of paraffin wax (a mixture of saturated hydrocarbons which have high relative molar mass) is determined by

- ☐ covalent bonds within hydrocarbon molecules.
- ☐ covalent bonds between hydrogen carbon molecules.
- ☐ ionic bonds between molecules.
- ☐ hydrogen bonds between molecules.
- ☐ van der Waals (London dispersion) forces between the molecules.

Part A adapted with permission from UCLES, A-Level Chemistry, November 1990, Paper 1, Question 1;

Part B adapted with permission from OCSEB, A-Level Chemistry, June 1994, Paper 1, Question 3



Hydrogen bonding

Which of the following contain hydrogen bonds?

1 NH_4Cl (s)

2 NH_3 (l)

3 HNO_3 (l)

- ☐ **1, 2 and 3**
- ☐ **1 and 2 only**
- ☐ **2 and 3 only**
- ☐ **1 only**
- ☐ **3 only**

Adapted with permission from UCLES, A-Level Chemistry, November 1998, Paper 3, Question 31



Dry ice and carbon tetrachloride



Part A Interactions in dry ice

Solid carbon dioxide, CO_2 (s), (dry ice) is used as a refrigerating agent because it readily changes directly from the solid into vapour state at a low temperature.

What does this indicate the main intermolecular interactions in CO_2 (s) to be?

- ☐ covalent bonding
- ☐ hydrogen bonding
- ☐ ionic bonding
- ☐ van der Waals' forces

Part B Liquid tetrachloromethane

Which type of interaction is responsible for intermolecular forces in liquid tetrachloromethane, CCl_4 ?

- ☐ covalent bonding
- ☐ hydrogen bonding
- ☐ induced dipole - dipole attractions
- ☐ permanent dipole - dipole attractions

Part A adapted with permission from OCR, A-Level Chemistry, June 1998, Paper 3, Question 7;

Part B adapted with permission from UCLES, A-Level Chemistry, June 1998, Paper 3, Question 5



Sulfates and detergents

Part A Solubility of sulfates

Which of the following factors helps to explain the differing solubility in water of magnesium sulfate compared with that of barium sulfate?

- 1 Barium sulfate has a numerically (in terms of magnitude) larger lattice energy than magnesium sulfate.
- 2 The enthalpy change of hydration of magnesium ions is more exothermic than that of barium ions.
- 3 The charge density of magnesium ions is greater than that of barium ions.

- ☐ 1, 2 and 3 are correct
- ☐ 1 and 2 only are correct
- ☐ 2 and 3 only are correct
- ☐ 1 only is correct
- ☐ 3 only is correct
-

Part B Detergents

Long-chain alkanes are converted on an industrial scale into alkyl sulfates for use as detergents, e.g. sodium lauryl sulfate.

Which of the following are properties of this substance?

- 1 It possesses both a water-attracting and a water-repelling part.
- 2 The sulfate group is anionic in aqueous solutions.
- 3 The alkyl chain is soluble in oil droplets.

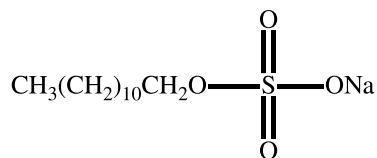


Figure 1: Sodium lauryl sulfate

- ☐ 1, 2 and 3 are correct
- ☐ 1 and 2 only are correct
- ☐ 2 and 3 only are correct
- ☐ 1 only is correct
- ☐ 3 only is correct

Part A adapted with permission from UCLES, A-Level Chemistry, November 1995, Paper 4, Question 35;

Part B adapted with permission from UCLES, A-Level Chemistry, November 1990, Paper 1, Question 32