3. Chemical bonding

3.4 Covalent bonding and coordinate bonding

Paper 1

Question Paper

1 Phosphorus forms a compound with hydrogen called phosphine, PH_3. This compound can react with a hydrogen ion, H^+.

Which type of interaction occurs between PH_3 and H^+?

A dative covalent bond

B dipole–dipole forces

C hydrogen bond

D ionic bond

2 When solid aluminium chloride is heated, Al_2Cl_6 is formed.

Which bonding is present in Al_2Cl_6?

A covalent and coordinate (dative covalent)

B covalent only

C ionic and coordinate (dative covalent)

D ionic only

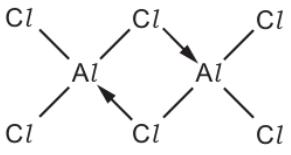
3 In which species does the underlined atom have an incomplete outer shell?

A $\underline{B}F_3$ **B** $\underline{C}H_3^-$ **C** $F_2\underline{O}$ **D** $H_3\underline{O}^+$

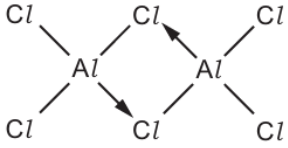
4 Solid aluminium chloride sublimes at 178 °C.

Which structure best represents the species in the vapour at this temperature?

A



B



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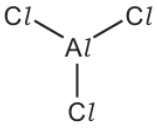


D

$Al^{3+}(Cl^-)_3$

5 In the sodium chloride lattice the number of chloride ions that surround each sodium ion is called the coordination number of the sodium ions.

What are the coordination numbers of the sodium ions and the chloride ions in the sodium chloride lattice?

	coordination number of sodium ions	coordination number of chloride ions
A	4	6
B	6	4
C	6	6
D	8	6

6 The compound $(CH_3)_3NAlCl_3$ has a simple molecular structure.

Which statement about $(CH_3)_3NAlCl_3$ is correct?

A $(CH_3)_3NAlCl_3$ molecules attract each other by hydrogen bonds.

B The Al atom in $(CH_3)_3NAlCl_3$ has an incomplete valence shell of electrons.

C The bonds around the Al atom are planar.

D The molecules contain coordinate bonding.

7 Which statement about aluminium chloride is correct?

A Aluminium chloride has a much higher melting point than magnesium chloride due to the small size of the aluminium ion.

B Anhydrous aluminium chloride reacts vigorously with water to form a solution with a pH greater than 7.

C Each Al_2Cl_6 molecule found in aluminium chloride vapour contains two coordinate bonds.

D The bonding between aluminium and chlorine is strongly ionic due to the large difference in electronegativity.

8 Ethane and ethene are both hydrocarbon molecules.

What is a feature of **both** molecules?

A a planar structure

B bond angles of 109°

C σ covalent bonds

D π covalent bonds

9 Ammonia can undergo an acid–base reaction with hydrogen chloride to form ammonium chloride.

Which statement is correct?

A The ammonium ion is basic.

B The hydrogen atom from HC*l* donates a lone pair of electrons to the nitrogen atom.

C The H–N–H bond angle in ammonia is the same as the H–N–H bond angle in the ammonium ion.

D The H–N–H bond angle in the ammonium ion is the same as the H–C–H bond angle in methane.

10 Water and ammonia take part in a reaction that produces the ammonium ion.

Which statement about this reaction is correct?

A The ammonia molecule and the ammonium ion do not have dipole moments.

B The bond angle changes from 109.5° in the ammonia molecule to 107° in the ammonium ion.

C The reaction is a redox reaction.

D The water is acting as an acid.

11 When considering one molecule of ethene, which row describes both the hybridisation of the atomic orbitals in the carbon atoms and the overall bonding?

	hybridisation	bonding
A	sp^2	4 σ bonds 1 π bond
B	sp^2	5 σ bonds 1 π bond
C	sp^3	4 σ bonds 1 π bond
D	sp^3	5 σ bonds 1 π bond

12 Four compounds are shown.

C_2H_4 C_2H_5OH CH_3CHO CH_3CO_2H

How many of these compounds have an odd number of σ bonds?

A 1 **B** 2 **C** 3 **D** 4

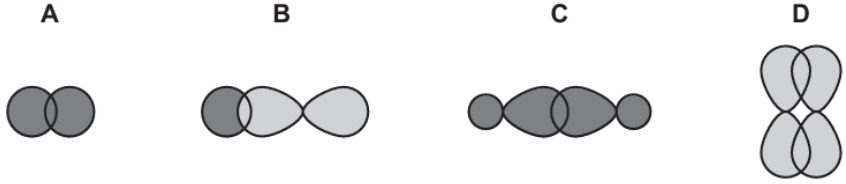
13 In which species is there a lone pair of electrons?

A CH_3 **B** CH_3^+ **C** CH_3^- **D** CH_4

14 A σ bond is made between two carbon atoms in a molecule of ethene.

Which diagram shows the orbital overlap that occurs to form this bond?

A **B** **C** **D**



15 Which feature is present in both ethene and poly(ethene)?

A bond angles of 109°

B π covalent bonds

C σ covalent bonds

D sp^3 orbitals

16 The dative covalent bond can be represented by an arrow, →. The arrow points towards the atom receiving the lone pair.

Which diagram of an ammonium ion is correct?

A **B** **C** **D**