

3.7 Dot-and-cross diagrams

Name: _____ Class: _____ Date: _____

Total: 9 marks

KEY WORDS dot-and-cross diagrams 点叉图 • electron 电子 • ion 离子 • lone pair 孤对电子
• coordinate bond 配位键

Objective

Build the skills to answer exam questions on **dot-and-cross diagrams** 点叉图 — drawing them for ionic, covalent and coordinate bonding.

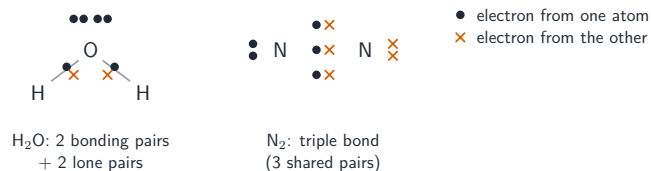
You must be able to:

- draw dot-and-cross diagrams for ionic, covalent and coordinate bonding
- include molecules with an expanded octet or an odd number of electrons

1 Worked examples

■ Drawing dot-and-cross diagrams

Use **dots** for one atom's outer electrons and **crosses** for the other, so you can see where each bonding electron came from. Show **lone pairs** too. For ionic bonds, draw the ions in brackets with their charge.



Water: two bonding pairs + two lone pairs on O. Nitrogen: three shared pairs (a triple bond), one lone pair each



sodium gives its outer electron (×) to chlorine

Ionic NaCl: the transferred electron is shown, and each ion is drawn in brackets with its charge

2 Practice

2.1 State what dots and crosses represent in a dot-and-cross diagram. [1]

2.2 State how many lone pairs are on the oxygen atom in a water molecule. [1]

3 Exam-style questions

3.1 In a dot-and-cross diagram of methane, CH_4 , how many shared (bonding) pairs are shown around the carbon? [1]

- A 1
- B 2
- C 4
- D 8

3.2 Draw a dot-and-cross diagram for a molecule of ammonia, NH_3 (show the bonding pairs and the lone pair on nitrogen). [2]

3.3 Draw a dot-and-cross diagram for carbon dioxide, CO_2 (show the two double bonds).^[2]

3.4 Draw a dot-and-cross diagram for the ammonium ion, NH_4^+ , showing the coordinate bond.^[2]

Solutions

2.1 the outer (valence) electrons of each of the two atoms.

2.2 2 lone pairs.

3.1 C. Methane has four shared pairs (four C–H bonds).

3.2 three N–H bonding pairs, each one dot + one cross; one lone pair shown on the nitrogen.

3.3 carbon in the centre with two double bonds to the oxygens (two shared pairs each); two lone pairs shown on each oxygen.

3.4 four N–H bonds around nitrogen; one shown as a coordinate bond (both electrons from N), with the whole ion in brackets and a + charge.