

1.3.2 Electron diagrams, coordinate bonds and shape

Name: _____ Class: _____ Date: _____

Total: 27 marks

KEY WORDS coordinate bond • lone pair • bond dipole

Objective

Complete electron diagrams and use electron-pair repulsion, ion migration and polarity evidence. Keep electron origin separate from three-dimensional shape.

1 Key knowledge and worked examples

■ Count electrons before drawing

CO₂ has $4 + 2 \times 6 = 16$ outer electrons. Four shared pairs form its two double bonds; the remaining eight electrons are lone pairs on oxygen. N₂ has ten outer electrons: six in its triple bond and one lone pair on each N.

Coordinate bonding uses a pair supplied by one donor. NH₄⁺ has $5 + 4 - 1 = 8$ outer electrons. In Al₂Cl₆, six chlorines and two aluminium atoms supply 48 outer electrons. Each bridging chlorine bonds to both aluminium atoms.

■ Predict shape and then polarity

Count electron regions around the central atom; a multiple bond is one region. CO₂ is linear, so its equal opposing C–O dipoles cancel. H₂O is bent, so its O–H dipoles do not cancel. A flat electron diagram alone does not show these spatial arrangements.

2 Practice

2.1 Draw a dot-and-cross electron diagram for sodium chloride, showing each ion's outer shell, brackets and charges. [3]

2.2 Draw complete outer-electron dot-and-cross diagrams for CO_2 and N_2 , including every lone pair. [5]

2.3 In an aqueous ion-migration demonstration, a coloured cation moves toward the negative electrode. Explain what this shows and why movement in solution differs from solid ionic material. State one limitation of using conductivity alone to conclude a substance is ionic. [3]

3 Exam-style questions

3.1 Draw complete outer-electron diagrams for NH_4^+ and Al_2Cl_6 , distinguishing the origins of electrons in coordinate bonds. [6]

3.2 Give the shape and typical bond angle(s) for BeCl_2 , BCl_3 , NH_4^+ , gaseous PCl_5 and SF_6 . Explain why the double bonds in CO_2 do not make it a four-region tetrahedral molecule. [6]

3.3 A charged rod deflects a thin water jet more strongly than a cyclohexane jet. Explain how this supports a polarity comparison. Why can a molecule containing polar bonds still have no permanent overall dipole? Give an example. [4]
