

1.3.1 Particle models, polarity and periodic properties

Name: _____ Class: _____ Date: _____ **Total: 25 marks**

KEY WORDS polarising power • polarisability • delocalised electrons

Objective

Use particle models to explain ionic, covalent and metallic properties and to predict an unfamiliar molecular shape. Do not infer every property from one observation.

1 Key knowledge and worked examples

■ Separate particle formation from bonding

Electron transfer forms cations and anions. The ionic bond is the net electrostatic attraction throughout their lattice. In the isoelectronic series N^{3-} , O^{2-} , F^- , Na^+ , Mg^{2+} , Al^{3+} , all ions have ten electrons; increasing nuclear charge pulls them closer and decreases radius.

A small highly charged cation has strong polarising power. A large anion has a readily distorted cloud, so more covalent character can occur. Metallic bonding attracts positive metal ions to delocalised electrons. The electrons conduct in solid metal; ionic solids lack mobile ions.

■ Shape depends on regions around the central atom

Four regions with three bonds and one lone pair give a pyramidal molecule, with a bond angle smaller than the tetrahedral value. A double bond counts as one region. Bond polarity and molecular polarity differ because the bond dipoles may cancel.

2 Practice

2.1 Rank N^{3-} , F^- and Al^{3+} from largest to smallest. Explain using both electron number and nuclear charge. [3]

2.2 Al^{3+} polarises I^- more strongly than Na^+ polarises F^- . Explain the cation and anion contributions to this comparison. [3]

2.3 Explain why solid copper conducts but solid sodium chloride does not, and why molten sodium chloride conducts. [3]

3 Exam-style questions

3.1 PH_3 has three P–H bonds and one lone pair around phosphorus. Use electron-pair repulsion to predict its shape. Explain why a rule subtracting exactly 2.5° for each lone pair cannot reliably predict its angle. [3]

3.2 Compare diamond, graphite and graphene in terms of carbon bonding and electrical conductivity. Give one property-based use of each, with a reason. [6]

3.3 Across Period 3, silicon has a much higher melting temperature than phosphorus, sulfur and argon. Explain the structural change, and why sulfur can melt at a higher temperature than phosphorus despite both being molecular. [4]

3.4 Compare the electrostatic lattice attraction in MgO and NaCl, assuming similar ion separations. Explain why comparing charges is useful but does not alone predict every measured melting temperature. [3]
