Year 12 Science: Structure and properties of solids

Name: _____ Date: _____

Try these without your notes first, then check the answer key.

Practice

1. What type of solid is magnesium, Mg?

2. What type of solid is silicon dioxide, SiO_2?

3. What type of solid is dry ice, solid CO_2?

4. Does solid potassium bromide, KBr, conduct electricity?

5. Will iodine, I_2, dissolve in hexane?

Exam-style question: copper, magnesium chloride and iodine

Copper, Cu, is used for electrical wiring; magnesium chloride, $MgCl_2$, is a salt found in seawater; and iodine, I_2, is a dark grey solid.

6. Give the type of solid and the particles in each of copper, magnesium chloride and iodine.

7. Explain why copper conducts electricity as a solid, but magnesium chloride conducts only when molten or dissolved.

8. Explain why iodine has a much lower melting point than magnesium chloride.

9. Predict and explain whether magnesium chloride and iodine will dissolve in hexane, a non-polar solvent.

Fix the mistake

10. Correct this statement: "When iodine melts, the covalent bonds between the iodine atoms break."

11. Correct this statement: "Solid sodium chloride conducts because it is made of ions."

12. Correct this statement: "Metals conduct because their positive ions move through the metal."

13. Correct this statement: "Graphite conducts because its layers can slide over each other."

Answer key (for parents and tutors)

1. What type of solid is magnesium, Mg?
   Metallic: a lattice of Mg cations in delocalised electrons.
2. What type of solid is silicon dioxide, SiO_2?
   Covalent network: Si and O atoms joined by covalent bonds in 3D.
3. What type of solid is dry ice, solid CO_2?
   Molecular: CO_2 molecules held by weak intermolecular forces.
4. Does solid potassium bromide, KBr, conduct electricity?
   No: K^+ and Br^- ions are fixed in the lattice; it conducts only when molten or dissolved.
5. Will iodine, I_2, dissolve in hexane?
   Yes: I_2 and hexane are both non-polar, so their attractions to each other are similar to those they replace.
6. Give the type of solid and the particles in each of copper, magnesium chloride and iodine.
   Copper: metallic, cations in delocalised electrons. Magnesium chloride: ionic, Mg^{2+} and Cl^- ions. Iodine: molecular, I_2 molecules (Achieved for all three).
7. Explain why copper conducts electricity as a solid, but magnesium chloride conducts only when molten or dissolved.
   Merit: copper has delocalised valence electrons that are free to move through the lattice, so it conducts as a solid. In solid $MgCl_2$ the ions are held in fixed positions; when molten or dissolved the lattice breaks up and the ions are free to move and carry charge.
8. Explain why iodine has a much lower melting point than magnesium chloride.
   Merit: melting iodine only overcomes weak intermolecular forces between I_2 molecules, which needs little energy. Melting $MgCl_2$ means breaking strong ionic bonds between Mg^{2+} and Cl^- ions throughout the lattice, which needs much more energy, so its melting point is much higher.
9. Predict and explain whether magnesium chloride and iodine will dissolve in hexane, a non-polar solvent.
   Excellence: iodine dissolves: I_2 and hexane are both non-polar, and the weak attractions between them are similar in strength to the ones broken in each. Magnesium chloride does not: hexane has no partial charges to attract the ions, so there are no attractions strong enough to overcome the strong ionic bonds.
10. Correct this statement: "When iodine melts, the covalent bonds between the iodine atoms break."
    Only the weak intermolecular forces between I_2 molecules are overcome; the I–I covalent bonds stay intact.
11. Correct this statement: "Solid sodium chloride conducts because it is made of ions."
    The ions in a solid are held in fixed positions, so it conducts only when molten or dissolved.
12. Correct this statement: "Metals conduct because their positive ions move through the metal."
    The cations stay in the lattice; it is the delocalised electrons that move and carry the current.
13. Correct this statement: "Graphite conducts because its layers can slide over each other."
    Sliding layers explain softness; graphite conducts because of the delocalised electrons in each layer.