Year 11 Science: Particles and forces in the five types of material

Name: _____ Date: _____

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

Practice

1. Iodine crystals are used to make an antiseptic. A student warms iodine and salt crystals side by side in a warm water bath. The iodine slowly gives off a purple vapour, but the salt crystals do not change. (a) Name the type of material iodine is and the type salt is. (b) Describe the particles and the forces between them in each substance. (c) Explain why the iodine turns to vapour at this temperature but the salt does not change.

2. Name the particles in copper wire and the force that holds them together.

3. A white solid does not conduct electricity, but it conducts once dissolved in water. What type of material is it, and why does dissolving change things?

4. Diamond and graphite are both pure carbon. Why does graphite conduct electricity when diamond does not?

5. Why is low-density polyethylene less dense than high-density polyethylene?

6. Carbon dioxide is a gas at room temperature. Which forces are weak in carbon dioxide, and which are strong?

Fix the mistake

7. Correct this statement: "When water boils, the covalent bonds in the water molecules break."

8. Correct this statement: "Salt is made of sodium and chlorine molecules."

9. Correct this statement: "Graphite conducts because its layers slide."

10. Correct this statement: "Polymers are held together by weak forces, so they are weak."

Answer key (for parents and tutors)

1. Iodine crystals are used to make an antiseptic. A student warms iodine and salt crystals side by side in a warm water bath. The iodine slowly gives off a purple vapour, but the salt crystals do not change. (a) Name the type of material iodine is and the type salt is. (b) Describe the particles and the forces between them in each substance. (c) Explain why the iodine turns to vapour at this temperature but the salt does not change.
   (a) Iodine is a molecular substance; salt is an ionic material. (b) Iodine is made of I_2 molecules, each two atoms held by a strong covalent bond, with weak intermolecular forces between molecules. Salt is a 3D lattice of alternating Na^+ and Cl^- ions held by strong ionic bonds in every direction. Getting (a) right and describing one structure earns Achieved. (c) To become a vapour, the iodine molecules only need to separate from each other, which means overcoming the weak forces between molecules; the covalent bonds inside each I_2 do not break. Little heat energy does this, so a warm water bath is enough. To melt salt, the strong ionic bonds between ions all through the lattice must be overcome, which needs far more energy, so the salt stays solid. Explaining one substance this way is Merit; comparing both, naming which forces break in each and linking the difference in force strength to what the student saw, is Excellence.

2. Name the particles in copper wire and the force that holds them together.
   Positive copper ions (cations) and delocalised electrons, held by metallic bonding: the strong attraction between the cations and the sea of electrons.

3. A white solid does not conduct electricity, but it conducts once dissolved in water. What type of material is it, and why does dissolving change things?
   Ionic; in the solid the ions are fixed in the lattice, but in solution they are free to move and carry charge.

4. Diamond and graphite are both pure carbon. Why does graphite conduct electricity when diamond does not?
   In graphite each carbon bonds to only three others, leaving one delocalised electron free to move; in diamond all four outer electrons are used in covalent bonds, so none are free.

5. Why is low-density polyethylene less dense than high-density polyethylene?
   LDPE chains have side branches that stop them packing closely, so there is less mass in each cubic centimetre; HDPE's straight chains pack tightly.

6. Carbon dioxide is a gas at room temperature. Which forces are weak in carbon dioxide, and which are strong?
   The forces between CO_2 molecules are weak; the covalent bonds between the carbon and oxygen atoms inside each molecule are strong.

7. Correct this statement: "When water boils, the covalent bonds in the water molecules break."
   Boiling only overcomes the weak forces between molecules; each H_2O molecule stays whole in the steam.

8. Correct this statement: "Salt is made of sodium and chlorine molecules."
   Salt is an ionic lattice of Na^+ and Cl^- ions; there are no molecules in an ionic material.

9. Correct this statement: "Graphite conducts because its layers slide."
   Graphite conducts because each carbon has one delocalised electron free to move; sliding layers explain softness, not conduction.

10. Correct this statement: "Polymers are held together by weak forces, so they are weak."
    Bonds along each chain are strong covalent bonds; only the forces between chains are weak, and long chains have many of them.