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FREE LEARNING NOTES FOR ZAMBIA

FORM 2

Chemistry

Bonding: the structure of compounds

Lesson notes for learners · Competence-Based Curriculum

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Water flows easily, yet diamond is one of the hardest substances on earth, and table salt forms tiny crystals in the kitchen. All of them are made from atoms joined together, but the atoms are arranged in different ways. In this note you learn to sort compounds into simple structures and giant structures and to link each structure to the way the substance behaves.

AFTER THESE NOTES YOU SHOULD BE ABLE TO

- Explain what the structure of a compound means
- Describe simple molecules and name examples such as water, carbon dioxide and ammonia
- Describe giant structures: macromolecules and ionic lattices
- Link the structure of a compound to its melting point, boiling point and conduction
- Classify a compound as simple or giant

KEY WORDS

structure of a compound	the arrangement of the atoms and the bonds between them
simple molecule	a small, separate molecule held to its neighbours by weak intermolecular forces
intermolecular forces	the weak forces between one molecule and the next
macromolecule	a large or giant molecule formed from many smaller units joined by covalent bonds
ionic lattice	a large structure made of ions held together by strong electrostatic forces of attraction
giant structure	a very large structure, such as a macromolecule or an ionic lattice

1 What is the structure of a compound

The structure of a compound is the arrangement of its atoms in space and the bonds that join them. Compounds form through chemical bonds such as ionic and covalent bonds, and these give each compound its own three-dimensional structure.

The structure is important because it decides the properties of the compound, such as its melting point, its solubility and how it reacts. If you can describe the structure, you can predict how the substance will behave. Compounds are classified into two groups: simple structures and giant structures.

2 Simple molecules

Simple molecules are separate, small molecules held to each other by weak intermolecular forces. Water (H_2O), carbon dioxide (CO_2) and ammonia (NH_3) are examples.

Each simple molecule has a shape. Water is V-shaped, which is also called bent. Carbon dioxide is linear, which means the atoms lie in a straight line. Ammonia is pyramidal.

Because the forces between the molecules are weak, little energy is needed to pull them apart. Simple molecules therefore have low melting points and low boiling points, and they are usually liquids or gases at room temperature and normal pressure.

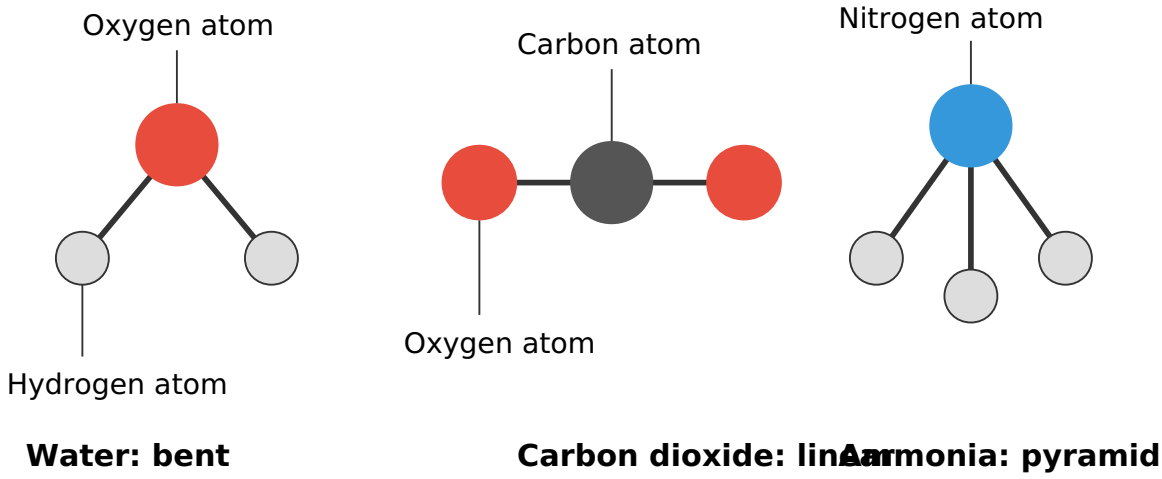

Figure 1. The shapes of three simple molecules

3 Giant structures

Giant structures are very large. There are two kinds in this topic: macromolecules and ionic lattices.

Macromolecules are large molecules in which the atoms are joined by covalent bonds. Diamond, graphite and silicon dioxide are examples. The covalent bonds between the atoms are strong, so a lot of energy is needed to break them. Macromolecules have high melting points and high boiling points, and they are usually solids at room temperature. They are usually non-conductors, except graphite.

Ionic lattices are large ionic structures, for example sodium chloride (NaCl), magnesium oxide (MgO) and calcium fluoride (CaF_2). The ions are held together by strong electrostatic forces of attraction.

4 Simple or giant: comparing the two

Use the table to decide whether a substance has a simple or a giant structure. The key question is what holds the particles together and how strong it is.

Feature	Simple molecule	Macromolecule
Examples	H_2O, CO_2, NH_3	Diamond, graphite, silicon dioxide
What joins the particles	Weak intermolecular forces	Strong covalent bonds between atoms
Melting and boiling points	Low	High
State at room temperature	Liquids or gases	Usually solids

Figure 2. Simple molecules compared with macromolecules

WORKED EXAMPLE

Sodium chloride has a giant structure but carbon dioxide has a simple structure. Which one is more likely to be a gas at room temperature, and why?

Carbon dioxide is a simple molecule

Its molecules are held by weak intermolecular forces

Little energy is needed to separate them, so the melting and boiling points are low

So carbon dioxide is the one that is a gas at room temperature

TRY THIS

Build models with modelling clay or marshmallows for atoms and toothpicks for bonds. Make H_2O (bent), CO_2 (linear) and NH_3 (pyramidal). Then build a small block of sodium chloride showing alternating ions. Label each model and write two properties beside it.

REMEMBER

- The structure of a compound is how its atoms are arranged and bonded
- Structure decides properties such as melting point and reactivity
- Simple molecules (H_2O, CO_2, NH_3) have weak forces between molecules, low melting and boiling points and are liquids or gases
- H_2O is bent, CO_2 is linear and NH_3 is pyramidal
- Macromolecules (diamond, graphite, silicon dioxide) have strong covalent bonds, high melting and boiling points, and are solids
- Ionic lattices (NaCl, MgO, CaF_2) are held by strong electrostatic forces

? Check yourself

1. What is meant by the structure of a compound?
2. State the shape of a water molecule and of a carbon dioxide molecule.
3. Name two examples of macromolecules.
4. Why do simple molecules have low boiling points?
5. Name one ionic lattice and the force that holds it together.
6. A pupil at a school in Luangwa is given two white substances. Substance A melts at a low temperature and is a gas when heated slightly. Substance B does not melt in a hot flame. (a) Which one is more likely to have a simple structure? (b) Which one is more likely to be a giant structure? (c) Explain
7. A teacher shows a class a pencil lead (graphite), a diamond ring and a glass of water. (a) Say which of the three is a simple molecule. (b) Say which two are macromolecules. (c) Explain why diamond and graphite are both solids at room temperature even though water is a liquid.

ANSWERS

1. The arrangement of the atoms and the bonds between them in three dimensions.
2. Water is V-shaped (bent); carbon dioxide is linear.
3. Any two of diamond, graphite and silicon dioxide.
4. The forces between the molecules are weak, so little energy is needed to separate them.
5. Sodium chloride (or MgO or CaF_2), held by strong electrostatic forces of attraction.
6. (a) Substance A. (b) Substance B. (c) A has weak forces between its molecules, so little energy separates them. B has strong bonds or forces throughout, so a lot of energy is needed to break them.
7. (a) Water. (b) Diamond and graphite. (c) The atoms in diamond and graphite are joined by strong covalent bonds, so a lot of energy is needed to break them and they stay solid. The molecules of water are held only by weak intermolecular forces, so water is a liquid.

Written by 25Schools to follow the Form 2 Chemistry syllabus of the Zambian competence-based curriculum. Free for learners to read, download and share. More notes and quizzes at 25schools.com.