Using iron and sulfur to demonstrate the difference between a mixture and a compound

Gather your students round the front. Demonstrate the properties of iron (magnetic, sinks in water) and sulfur (not magnetic and floats in water). Mix them together and ask your students to suggest how they might be separated. Based on their responses, demonstrate that it is easy to separate them by using a bar magnet or putting the mixture in water (iron sinks and sulfur floats). When you heat them together, they glow bright red (exothermic) and a new substance (iron sulfide) is formed, which cannot easily be separated.

Heat the mixture in a boiling tube. (If possible use 5.6 g of iron and 3.2 g of sulfur, or a similar ratio). The boiling tube will glow red as they react. When the reaction has finished, wrap the tube in a towel (to make sure that hot glass does not burn you) and break it with a hammer. Ask students to predict if the substance formed can be separated as before. Ask them to draw their conclusions on the demonstration. Indicate that a new compound has been formed by heating and that it cannot be separated into iron and sulfur.

Reaction between iron and sulfur

Elements, mixtures and compounds

Elements are substances that are made from one type of atom. An element cannot be broken down into any other substance. There are 92 naturally occurring elements and everything in the universe is made from these basic building blocks. Common examples include carbon, sulfur, oxygen, iron, copper, aluminium. Elements are represented by symbols.

Compounds are substances made from atoms of different elements joined by chemical bonds. They can only be separated by a chemical reaction. Common examples are water (H₂O), salt (sodium chloride, NaCl), methane (CH₄). The symbols indicate which elements the compounds contain and the number tells you the ratio in which the atoms of the elements combine.

A mixture is made by simply mixing together elements and compounds. No new chemical bonds are formed. Mixtures can be separated using techniques such as filtration, chromatography, evaporation, magnetisation, flotation and distillation.

Atoms are the basic building blocks. In the activities in this unit, we represent the atoms by circles. By shading the circles differently and drawing them different sizes, we can represent different types of atom.

A molecule is a group of atoms that are chemically joined together. It is possible for a molecule to be an element (e.g. oxygen, O₂) or a compound (e.g. water, H₂O). You can tell the difference because in an element there is only one type of atom.

Adapted from BBC Bitesize revision, www.bbc.co.uk/schools/ks3bitesize/science/chemical_material_behaviour/compounds_mixtures/revise1.shtml
How can you tell when a chemical change has taken place?

- A new substance is formed (a compound) which looks different from the starting materials and has different properties.
- There is an energy change – the reaction mixture gets hot or cold.
- It is difficult to reverse the process.

When a compound is formed, a chemical bond is made between the atoms. There are different kinds of chemical bond; covalent bonds as in methane, CH$_4$, and water, H$_2$O, and ionic bonds as in sodium chloride, NaCl. The properties of a substance are determined by the type of bonds between the atoms and molecules.

Useful analogies

- You can consider the elements to be like the letters of the alphabet. They can be joined together in different ways to give different words (compounds).
- The elements are like bricks. You can join them together in different ways to make new structures.

Other contexts in which you could use these ways of probing students’ understanding

- Acids, bases and salts – matching definitions with words, demonstrating how to make a salt, predicting reactions.
- Separation techniques – choosing a method to separate a mixture and explaining why it works.
- Naming pieces of apparatus – matching the apparatus with its uses.
- Physical and chemical change – understanding definitions and classifying examples.
- Chemical bonding – understanding definitions, building models to represent molecules or ionic crystals.