Summary

- The state of a substance depends on the temperature.
- As particles have more energy and move faster, the temperature of a substance increases.
- Changes of state can be explained by changes in the movement of the particles.
- The melting point and freezing point of a pure substance is the fixed temperature at which melting or freezing occurs.
- The boiling point of a liquid is the fixed temperature at which the liquid rapidly changes into a gas.
- Sublimation is changing from a solid straight to a gas (or gas to a solid).
- Gases are easily compressed as their particles are furthest apart. (Solids and liquids are not easily compressed.)
- Diffusion occurs when the particles of a substance mix with another substance.

Questions

1 Copy and complete the following sentences.
When a solid is heated its particles get more _____ and vibrate _____. The temperature of the solid _____. If the heating is continued the solid will eventually _____ and form a _____. The particles in a liquid can move _____ each other. *[Total 3]*

2 Write a sentence for each of the following words or phrases to explain what each word or phrase means:
a) temperature *[1]*
b) boiling point *[1]*
c) sublimation. *[1]*
[Total 3]

3 The particle theory of matter can be used to explain many physical changes in nature. Use this theory to answer the following questions.
a) What happens when a solid is heated and its temperature rises (without melting)? *[1]*
b) What changes occur when a liquid boils? *[2]*
c) Why is it more difficult to compress a liquid than a gas? *[2]*
[Total 5]

4 Imagine that you are one of the particles in a drop of water. Describe what happens to you as the drop of water freezes when the temperature falls.
[Total 3]

1 The beginnings of chemistry

Figure 1 *The iron age began when we learned to extract iron from its ore.*

When did the study of chemistry begin? Who were the first chemists? How has chemistry changed through the years? What did we learn from the early chemists?

Our first chemical reactions

Early humans used fire to keep themselves warm and cook their food. In time, they found ways to use fire to get metals, like copper and tin, out of rocks. These early chemical reactions improved their lives by giving them better tools and weapons.

Alchemy

The philosophers of ancient Greece thought about the nature of substances but didn't do experiments. The early Egyptians and Arabs combined the philosophy of the Greeks with their methods and practical skills. In Arabic the study of matter became known as "al-kimiya", when the ideas reached Europe it became **alchemy**. Like the ancient Greeks alchemists believed that everything was made up of four elements; earth, fire, air and water and that any substance could be made my mixing the correct amounts of each element. Many mixtures were investigated. Some spent their time trying to make gold, others tried to make a potion that would make you live forever. Ordinary people were frightened of the alchemists, as they seemed to have the ability to bring about changes, like magic. Alchemists encouraged this fear by using mysterious symbols so that no one else could understand their writings.

1 What happens in all chemical reactions? *[1]*
2 How can you tell that burning wood is a chemical reaction? *[1]*
3 Which of the Greeks four elements are actually elements? *[1]*
4 Why were ordinary people scared of alchemists? *[1]*

The first chemists

In 1661 Robert Boyle published a book called The Sceptical Chymist. The book challenged many of the old ideas about alchemy, including the ideas about the elements. Boyle's book didn't cause an instant change, but from this time on the study of substances was more often called chemistry.

Modern chemistry has learned a great deal from the alchemists. Their experiments produced many useful substances and they invented a number of useful practical techniques, like filtration and distillation.

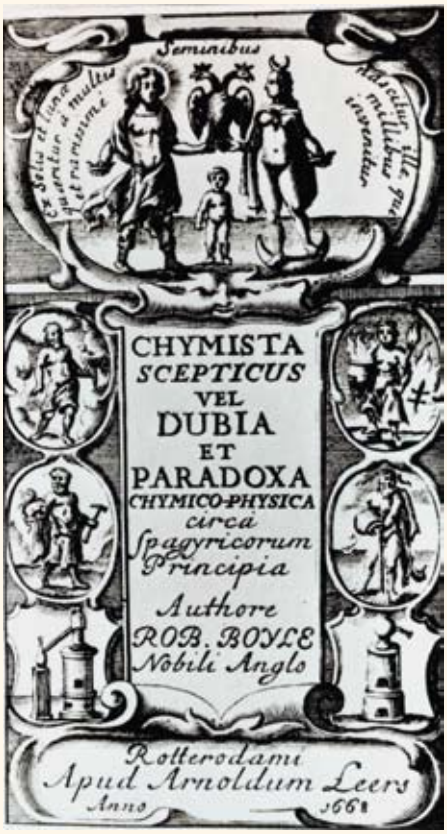

Figure 3 *Robert Boyle described an element as a substance that couldn't be broken down into a simpler substance.*

However modern chemists are much more organised in their experiments than the alchemists. They make careful plans with specific aims and are able to take precise measurements and observations. Most importantly they record their findings clearly, so others can check their work and add their own knowledge and ideas.

Figure 4 *A chemist at work.*

! The writings of one the early alchemists, Geber, was so difficult to understand that it gave rise to the term gibberish.

? **5** Name four measuring instruments used by modern chemists that wouldn't have been used by the alchemists? *[1]*

Questions

1 Give two examples of how early man used fire to bring about chemical reactions. *[Total 2]*

2 Alchemists, believed that everything was made up of four elements.
a) Where did the word alchemy come from? *[1]*
b) What were the four elements? *[1]*
[Total 3]

3 a) The word chemistry first appeared in the 17th century. Name the title of the book, its author and the year of publication. *[3]*
b) Robert Boyle used a book to challenge the ideas of the early alchemists. How do scientists share their discoveries and challenge others' work today? *[3]*
[Total 6]

4 a) How was alchemy different from the philosophy of the Greeks? *[1]*
b) Describe how modern chemists are different from alchemists. *[3]*
[Total 4]

5 Why do you think the alchemists tried to keep their work secret? *[Total 2]*