Chapter 4: Chemical elements

Experiment 4.1: Comparing states of matter

Experiment worksheet answers (pages 62–63 and 178)

Discussion

1 Which substances had a measurable mass?

Solids, liquids and gases all have a measurable mass.

2 Did each substance take up space? Was there any variation in the shapes each substance was able to take?

Gases fill the space available in the containers. Liquids fill the bottom of the containers, Solids maintain their shape and do not change if put into a different container. Liquids and gases were able to vary their shape.

3 Which states of matter took on the shape of their containers?

gas and liquid

4 Which state of matter can be compressed into a smaller space? Describe what happened.

Gas can be compressed into a smaller state. Student descriptions will vary.

Conclusion

Write a short paragraph to describe what you know about the states of matter.

Student answers will vary.

Challenge 4.3A: Modelling matter

Experiment worksheet answers (pages 66–67 and 179)

Discussion

1 How well do your particles represent the characteristics of real particles?

Student answers will vary according to the materials they used.

2 How well does your model represent the position and arrangement of real particles?

Student answers will vary. They may find it difficult to model the movement of gas particles.

3 Can your model represent the movement of real particles?

Student answers will vary.

4 How well could your model help to explain the properties of real substances, such as the melting of solids?

Student answers will vary. They should reflect on the increased kinetic energy of the particles when a solid starts melting.

5 Is there a better material (or different objects) that you could use to represent the particles? How would this improve the model?

Student answers will vary.

Challenge 4.3B: Making a cuppa

Experiment worksheet answers (pages 66–67 and 179)

Discussion

1 Which beaker of water did the brown tea diffuse through the fastest?

The brown tea will diffuse through hot water the fastest.

2 Use your own words to describe how the brown tea molecules spread through the water molecules.

Student answers will vary.

Experiment 4.4: The density den

Experiment worksheet answers (pages 68–69 and 180)

Discussion

Station A

1 The standard value for the density of water is 1.00 g/mL at 25°C. How does your average value compare with this?

Student answers will vary.

2 What could have caused your results to differ from the standard value of the density of water?

The accuracy of the scales or measurement of volume may have caused error.

3 When you calculate the density of water, does the amount of water used make any difference? Explain the reasons for your answer.

No. It is the overflow of water that represents the volume of the item, not the starting amount of water.

4 Why do scientists repeat experiments?

They check for errors in their results and ensure that random errors are detected.

Station C

1 What were some of the difficulties you had using the displacement method for calculating density?

Student answers will vary.

2 What were some advantages of using the displacement method for measuring volume?

The volume of any shaped object could be determined in this manner.

3 How does the density of water compare with those of the other objects you measured? Use the results from all the experiments to rank the objects from lowest to highest density.

Student answers will vary.

4 How would our world be different if the density of water was five times as much (i.e. 5 g/mL)? How would this affect your mass, your life and the world generally?

If the density of water was five times as much, more things would float. It may even be possible for humans to walk on water. Water animals may also have difficulty staying under the water.

Conclusion

What do you know about how density affects the behaviour of objects?

Student answers will vary.

Experiment 4.5A: Effect of heat

Experiment worksheet answers (pages 70–71 and 182)

Discussion

Station 1: Heating a solid

1 What happened to change the size of the metal ball?

The metal ball was heated. As a result, the metal ball expanded.

2 Use the kinetic theory of matter to explain what was happening to the particles in the solid when heat was applied.

Heating the metal ball caused the particles to gain kinetic energy. The increased movement of the particles meant the metal ball took up more space.

3 Do objects return to their original size when they cool to their original temperature?

Yes

Station 2: Heating a liquid

1 Describe what happened to the water in the tube as the flask was heated.

The water in the tube expanded and the water level rose.

2 What happened to the level of the water in the tube as the water cooled?

The level of water in the tube decreased.

3 Use the kinetic theory of matter to explain why the liquid expanded when heated.

When the water in the tube was heated, the water particles gained kinetic energy. This meant they took up more room, causing the water level to rise.

Station 3: Heating gases

1 What happened to the size of the balloon as the temperature went from cold to hot?

The size of the balloon increased.

2 Was any air added to change the size of the balloon?

No

3 Use the ideas of the particle model of matter to explain how the balloon expanded and contracted with the changes in temperature.

When the air in the balloon was heated, it gained kinetic energy. This meant the particles in the gaseous air moved faster and with more energy when they hit the sides of the balloon, causing it to expand. When the heat energy was removed from the air particles (by cooling the air in the balloon), the particles moved with less kinetic energy as they hit the sides of the balloon, allowing the balloon to decrease in size.

Conclusion

What do you know about the effects of heat on solids, liquids and gases?

Student answers will vary.

Experiment 4.5B: From ice to steam

Experiment worksheet answers (pages 70–71 and 184)

Discussion

1 a At what temperature did you measure the melting point of ice?

b How does your measured melting point of ice compare with the standard measurement of 0°C?

Student answers will vary.

2 a At what temperature did you measure the boiling point of water?

b How does your measured boiling point of water compare with the standard measurement of 100°C?

Student answers will vary.

3 Were there times when it was difficult to read the thermometer? Why?

Student answers will vary.

4 Compare your results with those of the rest of the class. Suggest why there is a variation in the answers.

Most thermometers used in science laboratories have not been calibrated for accuracy. Therefore there will be variation between groups.

Conclusion

What do you know about the melting and boiling points of water?

Student answers will vary.

Challenge 4.6A: Classifying elements

Experiment worksheet answers (pages 72–73 and 185)

Discussion

2 How many elements have a one-letter symbol? How many have a two-letter symbol? Why is classifying elements according to their symbol a bad idea?

Seven of the elements shown have a one-letter symbol. Twelve elements in the whole periodic table have a one-letter symbol.

Eleven of the elements shown have a two-letter symbol, but 106 elements in the whole periodic table have a two-letter symbol. NOTE: the four symbols with three-letter symbols have not been officially named and have been given two-letter symbols.

Classifying elements according to their symbol is a bad idea because the symbol given to an element is chosen by the scientist who discovered it.

3 Sort the cards according to the colour of the element. How many elements are silver? How many elements have another colour? Why is classifying elements according to their colour a bad idea?

Six of the elements are classified as silver.

Four elements are grey; and one each of brown, yellow-green, black, yellow, red, red-brown and two colourless.

Classifying elements according to their colours is a bad idea because some elements have the same colour.

4 Sort the cards according to whether they are solids, liquids or gases. How many elements are solids, liquids and gases? Why is classifying elements according to their state a bad idea?

Thirteen elements are solids, two are liquids and three are gases.

Classifying elements according to their state is a bad idea because elements can change their state as they gain or lose heat.

Challenge 4.6B: Identifying the elements in the periodic table

Experiment worksheet answers (pages 72–73 and 186)

Discussion

Student answers will vary based on the elements they have selected to research.

Experiment 4.6: Properties of the elements

Experiment worksheet answers (pages 72–73 and 187)

Discussion

1 What similarities do you observe between the elements you tested?

Metals (steel wool, copper, magnesium, zinc and iron) will be shiny, malleable and conduct electricity. Non-metals such as graphite will not have these properties.

2 Can you divide all the materials into two groups? What properties do you use to separate the materials?

Metals are shiny, malleable and conduct electricity. Non-metals do not have these properties.

3 If you discovered a new material that was shiny and that bent when you dropped it, which groups would you put it in? Explain. What other properties might you expect it to have?

Metal, as all metals are shiny and malleable. This new substance should also conduct electricity.

Conclusion

Describe what you know about the physical and chemical properties of these materials.

Physical properties include appearance and malleability. Chemical properties include the ability to conduct electricity.

Experiment 4.7: Decomposing copper carbonate

Experiment worksheet answers (pages 74–75 and 188)

Discussion

1 What happened to the copper carbonate? Consider the colour and any change in mass.

The copper carbonate gives off carbon dioxide, and leaves copper oxide. The copper oxide is black in colour, and the mass of the final product is less than that of the copper carbonate because carbon dioxide is released.

2 What evidence is there that copper carbonate is a compound and not an element?

It is evident that copper carbonate is a compound because carbon dioxide is released and a black residue of copper oxide is left.

3 What are the possible sources of error in this experiment?

A possible source of error in this experiment is the condensation in the top of the heated test tube containing the copper carbonate.

Conclusion

What happens when copper carbonate decomposes?

When copper carbonate decomposes, carbon dioxide is released and a black residue called copper oxide is left.