Chapter 5: Physical and chemical change

5.1 Physical change is a change in shape or appearance

Student book answers (pages 80–81)

Check your learning 5.1

Remember and understand

1 Describe what the following words mean:

a lattice

A three-dimensional arrangement of particles in a regular pattern

b sublimation

A change of state straight from a gas to a solid (or vice versa) without ever existing as a liquid

c condenses

When a gas turns into a liquid

d volatile

A substance that vaporises easily

Apply and analyse

2 A student claimed that the bubbles in boiling water were oxygen. Are they correct? Explain your answer.

The student is incorrect. The bubbles in boiling water are air. Water normally has a lot of air dissolved in it, which enables fish to breathe.

3 Explain why all perfumes are volatile liquids.

The aim of a perfume is to be able to be smelled. Hence, a volatile substance is needed so that it vaporises easily and becomes a gas.

Evaluate and create

4 Draw a diagram with the three major states of water. Name the physical changes the water goes through to form ice and water vapour.

Students should draw a diagram similar to Figure 5.3. Water to ice is freezing or solidification. Water to water vapour is boiling or vaporisation.

5.2 Chemical change produces new substances

Student book answers (pages 82–83)

Check your learning 5.2

Remember and understand

1 When melted chocolate is put in the fridge, it cools quickly producing small crystals that were not present before. This changes the taste of the chocolate. Is this a chemical or physical change?

Physical change

2 What is the evidence for a chemical change?

The evidence for a chemical change includes gas production, irreversible colour change, light or heat being absorbed or produced, or a precipitate being formed.

3 Identify the following as physical or chemical changes.

a Melting cooking chocolate into animal shapes.

Physical

b Burning magnesium ribbon to form a white ash.

Chemical

c Boiling water and condensing the vapour.

Physical

d Dissolving magnesium in acid to produce hydrogen gas.

Chemical

e Separating leaves from woodchips using a garden blower.

Physical

Apply and analyse

4 Why is caramelisation a chemical reaction?

Caramelisation involves the formation of a new substance and is therefore considered to be a chemical reaction.

5 What is the evidence that baking a cake from egg, flour and butter is a chemical reaction?

In a cake, the egg, flour and butter are no longer identifiable. A new substance (the cake) has been formed and the process is not reversible. For these reasons, baking a cake is an example of a chemical reaction.

5.3 Chemical reactions can break bonds and re-form new bonds

Student book answers (pages 84–85)

Check your learning 5.3

Remember and understand

1 Complete the following table. In the final column, include details about the substance’s properties near a flame.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Substance | Formula for substance | Colour | State at room temperature | Chemical properties |
| Hydrogen | H2 | Colourless | Gas | Under normal conditions, it is a colourless, odourless gas. At normal temperature, hydrogen is not a very reactive substance. Near a flame, it is highly reactive. |
| Oxygen | O2 | Colourless | Gas | Under normal conditions, oxygen is a colourless, odourless gas. Oxygen is reactive and will form oxides with all other elements except helium, neon, argon and krypton. Near a flame, oxygen will help things burn. |
| Water | H2O | Colourless | Liquid | Water is a good solvent, transparent, tasteless and odourless, with low electrical conductivity. |

2 How different are reactants and products in chemical reactions?

Reactants and products are generally significantly different in chemical reactions.

3 What does the arrow represent in a chemical equation?

The arrow in a chemical equation represents the chemical change.

4 Why is it unnecessary to write an equation for a physical change?

It is unnecessary to write an equation for a physical change because the reactants are the same as the products. A chemical reaction does not occur in a physical change.

Apply and analyse

5 Compared with a word equation, what extra information does a symbol equation contain?

A symbol equation gives an indication of the amount of the various substances involved and the proportions of atoms contained in each substance. A word equation simply identifies the substance names.

6 Name the reactant and the product in the following chemical reactions.

a Iron ore is made into a steel ship.

Reactant: iron

Product: steel

b Bread is made from flour.

Reactant: flour

Product: bread

c Freezer bags made from polythene are manufactured from ethene.

Reactant: ethene

Product: polythene freezer bags

d Nitrogen fertilisers are made from nitrogen gas and hydrogen gas.

Reactants: nitrogen gas and hydrogen gas

Product: nitrogen fertilisers

e Carbon dioxide is produced when petrol is burnt in a car engine.

Reactant: petrol

Product: carbon dioxide

5.4 Heat can speed up a reaction

Student book answers (pages 86–87)

Check your learning 5.4

Remember and understand

1 How does the particle model of matter help explain the rate of reactions?

Student answers will vary. Typically, the rate of reactions depends on the nature, arrangement and behaviour of particles in the particle model.

2 What is the collision theory?

The collision theory states that for substances to react, their particles must come into contact with each other, or collide, with sufficient force. The more collisions that occur between the particles, the more likely it is they will react.

3 How does particle size affect the rate of a reaction?

The smaller the size of the particles, the faster the rate of the reaction.

4 What effect do enzymes have on the rate of a reaction?

Enzymes help speed up reactions.

5 Describe what happens to the number of particles when you increase the concentration of a substance.

When you increase the concentration of a substance, the number of particles is increased.

6 How does increasing the concentration of reactants increase the rate of a reaction?

When you increase the concentration of reactants in a chemical reaction, the rate of the reaction also increases.

Apply and analyse

7 Does increasing the rate of a reaction change the amount of product produced? Explain your reasoning.

No. There is still the same number of particles present, so no more product could be formed. Increasing the rate of the reaction just increases how fast the product is formed.

5.5 Science as a human endeavour: Many substances exist because of the work of scientists

Student book answers (pages 88–89)

Extend your understanding 5.5

1 What is the role of chemistry in purifying crude oil in an oil refinery?

In an oil refinery, chemists are required to identify the necessary factors (e.g. boiling point) for separating crude oil into its components.

2 Describe how chemists have improved on natural glues and adhesives.

Chemists have been instrumental in producing glues and adhesives that are specifically suited to certain materials and situations.

3 What colour were the first natural dye and the first synthetic dye?

The first natural dye was purple and made from purple-dye murex shells. The first synthetic dye was discovered accidentally by William Perkin and was also purple or mauve.

4 List five materials that are made by chemists.

Student answers will vary because a large number of materials are made by chemists. Students are likely to stick with the sections suggested in the text, covering medicines, plastics, glues and dyes. Additional categories may include foodstuffs, paints, cleaning products or fuels.

5.6 Science as a human endeavour: Physical and chemical changes are used to recycle household waste

Student book answers (pages 90–91)

Extend your understanding 5.6

1 Examine your rubbish and write a list of the plastics that can be recycled.

Student answers will vary.

2 Draw a picture of what happens at each stage of the mechanical recycling process.

Student answers will vary, but should follow steps 1–6 listed on page 90.

3 Why is the chemical recycling of plastics expensive?

The chemical recycling of plastics is expensive because it requires a lot of energy as it is trying to reverse the initial chemical change that created the plastic.

4 What is corrosion?

Corrosion is a chemical reaction between a substance and its environment.

5 What happens when iron rusts?

When iron rusts, iron and oxygen combine to form iron oxide (rust), which is a brittle, brown material..

Review 5

Student book answers (pages 92–93)

Remember and understand

1 Use the particle model to explain:

a melting

When a substance melts, the particles gain energy, speed up and move further apart, changing their arrangement from a solid to that of a liquid.

b freezing

When a substance freezes, the particles lose energy and slow down, becoming closer together, changing their arrangement from a liquid to that of a solid.

c sublimation

When a substance sublimes, the particles gain energy and speed up, becoming much further apart, changing their arrangement from a solid to that of a gas OR when a substance sublimes, the particles lose energy and slow down, becoming much closer together, changing their arrangement from a gas to that of a solid.

d condensation

During condensation, the particles lose energy and slow down, becoming closer together, changing their arrangement from a gas to that of a liquid.

2 What is a reactant in a chemical reaction?

A reactant is a starting substance in a chemical reaction.

3 What changes might be observed during a chemical change?

Changes that may be observed during a chemical change include the production of a gas, permanent change of colour, change of state, change in smell, energy production (heat) and light.

4 What is the difference between a physical change and a chemical change?

A physical change occurs when the substance still consists of the same particles but looks different. A chemical change occurs when new substances are formed.

5 Using your knowledge of particles, explain why most physical changes can be reversed.

Most physical changes can be reversed because the particles in these reactions are not changed, just rearranged.

6 Name four ways to speed up a chemical reaction. Use the particle model to explain why each method works.

To speed up a chemical reaction, use smaller particles, increase the temperature, increase the concentration and use a catalyst.

7 Describe three uses of chemicals in the home.

Student answers will vary. Typically, toasting bread, cooking and baking, washing with soap, using sparklers and candles on a cake.

8 Why is nylon described as a synthetic material?

Nylon is regarded as ‘synthetic’ because it is a man-made, non-natural substance.

9 Name an object that is made from PVC.

Student answers will vary. Typically: food packaging, shampoo and medication bottles, food trays etc. (anything in recycling group 3).

Apply and analyse

10 Chemists would never write a chemical equation for the melting of chocolate. Why is this?

Melting chocolate is a physical change. There is no chemical reaction involved. Melting simply turns solid chocolate into liquid chocolate.

11 In one experiment, you observed the reaction between copper sulfate solution and iron to make copper and iron sulfate solution.

a Complete the following table to summarise the changes observed in this reaction.

|  |  |  |  |
| --- | --- | --- | --- |
| Name of reactants | Description | Name of products | Description |
| Copper sulfate | Blue crystals | Copper | Brown metal |
| Iron | Silver-grey metal | Iron sulfate | Green solid |

b Use the information in the table to explain why this is an example of a chemical change.

This is an example of a chemical change because new substances were formed and the properties of the products are different from those of the reactants.

12 Dyes can be synthetic or natural in origin.

a Describe one advantage and one disadvantage of using natural dyes.

The advantages of using natural dyes are the extraordinary diversity of rich and complex colours that complement each other (e.g. dyes from plants may have dozens of compounds and their proportions vary with soil type and the weather) and natural dyes are non-toxic. The disadvantages would be the amount of dye needed to dye a single object and that the use of natural dyes exploits living organisms in order to obtain the dye.

b Describe one advantage and one disadvantage of using synthetic dyes.

Advantages of using synthetic dyes include that much less is needed than with natural dyes, that living organisms are not necessarily exploited to obtain the dye, they may last longer, and the results can be replicated accurately.

Disadvantages of using synthetic dyes is a lack of the variation that can be achieved with natural dyes, they are hard to remove from waterways or other environments, and they may be toxic.

13 The use of chemistry to produce new materials has affected people’s lives in a range of ways.

a Describe how new materials have changed the type of clothes that people wear.

New materials have changed the types of clothing people wear by being more durable, softer, stronger (important for safety gear) etc.

b Describe how new materials have changed the type of food that people eat.

New materials have changed the types of food that people eat by increasing shelf life, offering new tastes or combinations of tastes, making a wider variety of food available, making non-allergenic (e.g. gluten-free or lactose-free) food available etc.

14 Describe a chemical change that may be harmful to the environment if it is allowed to occur in an uncontrolled way.

Student answers will vary. Chemical changes that may be harmful to the environment if allowed to occur in an uncontrolled way would be pollution from car exhausts, dumping of chemicals into waterways (changes the chemical composition of the water) or the creation of new materials.

15 The following are descriptions of interactions that occur around us in our daily lives. Describe what the products of these interactions might be and explain whether you think the changes described are useful or harmful.

a A bike is left out in the rain so that parts of the bike that are made of steel are in contact with water for a few hours.

The product is rust, which is harmful.

b A barbecue fuelled by propane gas is turned on.

This is helpful for cooking.

c A hairdresser applies bleach to someone’s hair.

This is helpful for the person wanting to change the colour of their hair. It could be harmful to the hair and to the environment if the bleach is washed into waterways.

16 Some of the chemical changes that occur with food are described as biochemical reactions. Why do you think that is?

Biochemical reactions are chemical reactions in living cells that allow them to grow, multiply and carry out their daily tasks. Some changes that occur with food are described as biochemical reactions because they rely on some of these processes for changes to occur.

Evaluate and create

17 Think about what you do on a daily basis, including eating, washing, travelling, working and playing. Describe how these activities would be different if you were only able to use natural materials.

Student answers will vary. Students should understand that we use many synthetic materials and our current lifestyle would change substantially if only natural substances were available for use.

18 An environmental action group wanted to ban the use of chemicals in your school. Either:

a Write a letter to your school principal explaining why you think this would be a good idea;

or:

b Write a letter to the leader of the environmental group explaining why you think this is a bad idea.

Student answers will vary.

19 Substances can change when they interact with each other. In each of the following situations, a change is described. For each change, describe the interactions that have caused the change to occur. The first one has been done for you.

a Glue makes a bond between two pieces of wood. *Possible answer: The glue interacts with the oxygen in the air, which causes it to set hard, which joins the two pieces of wood together.*

Completed example (no answer needed).

b Sugar turns into caramel.

Sugar rises in temperature and begins changing colour. Once it gets past a golden brown colour (caramel), it burns very quickly!

c Charcoal burns in air to form the gas carbon dioxide.

When charcoal is burned, the pure carbon is actually burning. This combines with oxygen from the air to form carbon dioxide.

d Starch is digested in our stomach to form simple sugars, such as glucose.

The human digestive process breaks down the starches into glucose units with the aid of enzymes, and those glucose molecules can circulate in the bloodstream as an energy source.

e A loaf of bread rises in an oven as carbon dioxide gas is produced.

Yeast is what causes the dough to rise. The yeast ferments carbohydrates in the flour, including any sugar, and produces carbon dioxide.