Explaining neutralisation

We are learning how to:

- Recall the equation for a neutralisation reaction.
- Explain how water is made during a neutralisation reaction.
- Apply a model to explain neutralisation.

Acids and alkalis 'cancel each other out'. We see a change in colour of indicator when we mix them. This change is a chemical reaction, with new products being formed. A model may help us to understand what is happening during the reaction.

Making water

All acids contain hydrogen, so the symbol H will appear in the formula – for example, hydrochloric acid is HCl. All alkalis contain both hydrogen and oxygen so the formula will have both O and H. We call this combination 'hydroxide' – for example sodium hydroxide is NaOH. When acids and alkalis are mixed a *chemical reaction* takes place, with new products being formed.

The hydrogen and the hydroxide combine to form water, H_2O. **Water** is a product of neutralisation.

Acids have a low pH and alkalis have a high pH. Water is **neutral**. Therefore there is a change in pH as we mix acids and alkalis.

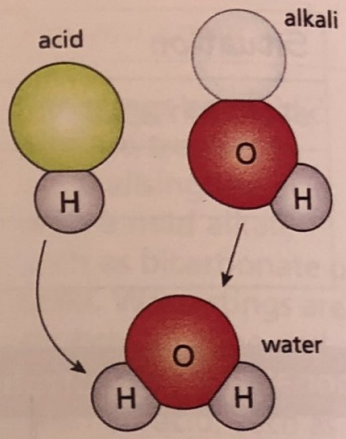

FIGURE 2.4.7a: H in acid and OH in alkali combine to form water, H_2O.

1. Name one of the new products formed when acids and alkalis mix.
2. Describe what combines from each of the acid and the alkali to form water.
3. Suggest the pH of pure water.

The neutralisation equation

Water is just one of the products of neutralisation. The other product is a **salt**. The type of salt produced depends on the acid and alkali that were reacted. We can describe neutralisation using an **equation**:

acid + alkali → salt + water

For example, if hydrochloric acid is neutralised with the alkali sodium hydroxide, the salt produced is sodium chloride.

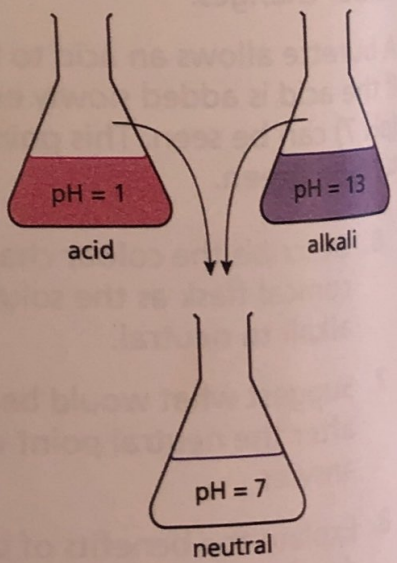

FIGURE 2.4.7b: Neutralisation

4. Write the general equation for neutralisation.
5. Name the product of neutralisation that:
   a) is always the same
   b) depends on the acid and alkali used.
6. Describe the two new products that are formed when hydrochloric acid is mixed with sodium hydroxide

A model for neutralisation

In science, models are often useful for helping us to understand something that we cannot see or touch. We cannot see or touch the individual molecules in an acid and an alkali – so, it can be difficult to understand the reactions that are going on.

In Figure 2.4.7c, hydrogen is shown as a red brick and oxygen is shown as a yellow brick. The rest of the acid is shown as black bricks and the rest of the alkali is shown as blue bricks.

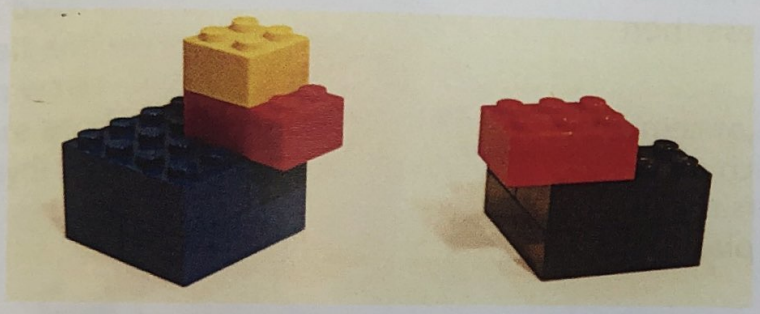

FIGURE 2.4.7c: Which bricks represent the acid?

7. Explain why models, such as this one, are used in science.
8. Using the building bricks model, draw:
   a) the water produced
   b) the salt produced.
9. Another type of model uses circles to represent atoms and molecules. Use the model in Figure 2.4.7d to draw the products of the reaction between hydrochloric acid (HCl) and sodium hydroxide (NaOH).

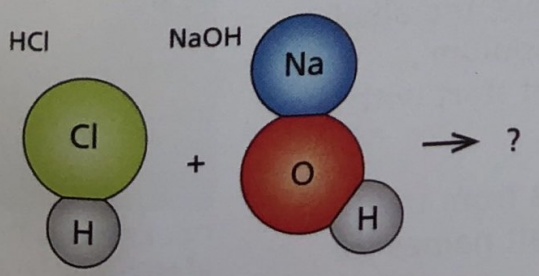

FIGURE 2.4.7d: What are the products of this reaction?

Did you know...?

Pure water is neutral. However, our drinking water is usually slightly acidic or slightly alkaline. This is because this water contains dissolved minerals and gases.

Key vocabulary

water
neutral
salt
equation

Understanding salts

We are learning how to:

- Name examples of salts.
- Describe the uses of common salts.
- Predict the reactants used in and the salts made by different neutralisation reactions.

We usually think of 'salt' as something that we add to food. The scientific name for this type of salt is sodium chloride. However, there are many more types of salt, each with different uses.

Salts and their uses

A **salt** is made in a neutralisation reaction, along with water. The most common salt is sodium chloride. It has many uses – flavouring food, treating icy roads and as a food preservative. Sodium chloride is essential in the human body. In industry, sodium chloride is used to produce chlorine, hydrogen and sodium hydroxide and each of these then have important uses. FeSO4

Magnesium chloride is used in the manufacture of cement and can also be used to absorb dust in places such as excavation sites. Iron sulfate is used by gardeners to kill moss on lawns. Calcium sulfate is used to make plaster of Paris to treat fractures. CaSO4

MgCl2

1. Describe four uses of sodium chloride.
2. List three other examples of salts and describe their uses.
3. Write a definition of a salt.

FIGURE 2.4.8a: There are many types of salts, with far more uses than making your food tasty!

Making predictions

The salt made during a neutralisation reaction can be predicted.

The first part of the name of the salt comes from the alkali, usually from the metal in the alkali. For example, the alkali sodium hydroxide forms salts that start with 'sodium', whereas magnesium hydroxide forms salts that start with 'magnesium'.

The second part of the name of the salt comes from the acid. Table 2.4.8 summarises the ends of the salt names for each of the common acids.

TABLE 2.4.8: The acid used tells us the end of the salt name.

Acid used in neutralisation	forms salts that end in...
hydrochloric acid HCl	chloride
sulfuric acid H_2SO_4	sulfate
nitric acid HNO_3	nitrate

So, if nitric acid is neutralised by copper carbonate, the salt formed will be called copper nitrate.

4. Suggest what the first part of the name of the salt will be if the alkali used is calcium carbonate.
5. Predict the name of the salt formed in a neutralisation reaction between hydrochloric acid and sodium hydroxide.
6. Write an equation for the reaction between hydrochloric acid and magnesium hydroxide. $Mg(OH)_2$

Bases and neutralisation

A **base** is any substance that neutralises an acid to produce a salt and water. An alkali is a soluble base – one that dissolves in water. Therefore, all alkalis are bases, but not all bases are alkalis. Copper oxide is an example of a base. Sodium hydroxide is an example of a base that is also an alkali. CuO

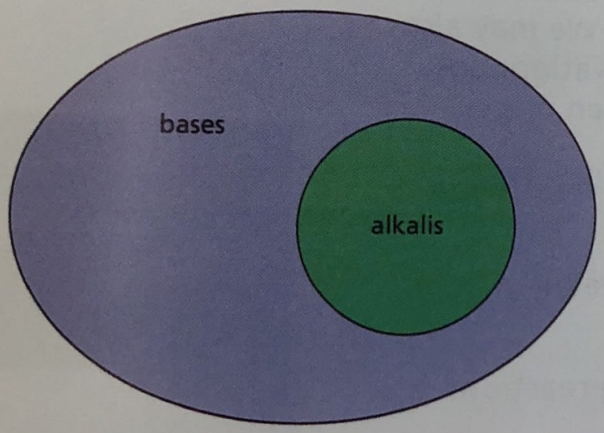

FIGURE 2.4.8b: All alkalis are bases, but only soluble bases are alkalis.

7. Explain the difference between a base and an alkali.
8. Explain why copper oxide is a base, whereas sodium hydroxide is also an alkali.
9. Write an equation for the reaction between an acid and a base. Compare this with the reaction of an acid and an alkali.

Did you know...?

Sodium chloride lowers the melting point of ice. When it is added to icy roads, the ice melts at a lower temperature than it would ordinarily. The ice melts to make the roads less dangerous.

FIGURE 2.4.8c: Why is salt spread on icy roads?

Key vocabulary

salt

base

Exploring the reactions of acids with metals

We are learning how to:

- Describe the reaction between acids and metals.
- Explain the reaction between acids and metals.
- Compare the reactivities of different metals.

Most metals react with acids. The way that a metal reacts varies, depending on its reactivity. Some metals are so reactive that we would never add some acid to them in the laboratory.

Reacting acids with metals

A **chemical reaction** is one in which new products are made. There are clues that we can look for to spot a chemical reaction. These include:

- bubbles of gas being given off
- a change in temperature
- a colour change
- a change in mass.

When we add an acid to most metals, we see bubbles. This is because a gas is produced during the reaction. We may also feel the test tube getting warmer. These observations are both evidence that a chemical reaction has taken place.

1. Describe some of the observations that tell us that a chemical reaction is taking place.
2. Describe two signs that the reaction between an acid and a metal is a chemical reaction.
3. Explain why bubbles are produced during reactions.

What are the new products?

Acids react with most metals. Just like when acids react with alkalis, a **salt** is formed. However, water is *not* formed, unlike in neutralisation. Instead, a gas is formed – gas is **hydrogen**. You can test for hydrogen gas because it burns with a 'pop'. If you put a lighted splint into the top of the test tube in which an acid and metal are reacting, you will hear a 'pop' sound. This is because the flame ignites the hydrogen and it explodes.

FIGURE 2.4.9a: How can you tell that a chemical reaction is taking place between the acid and magnesium?

We can summarise the reaction between acids and metals using an equation:

MASH

acid + metal → salt + hydrogen

The salt produced depends on the type of acid and the metal used. For example, if you react nitric acid with copper metal, copper nitrate is the salt formed.

*mostly dissolved in water

FIGURE 2.4.9b: Copper nitrate

4. Write an equation for the reaction between nitric acid and copper metal.
5. Write an equation for the reaction between hydrochloric acid and magnesium metal.
6. Explain why we should not put a flame near a large amount of hydrogen gas.

Comparing reactivity

A group of students reacted hydrochloric acid with some different metals. They recorded their observations about the **reactivity** of the acid with the metals.

Metal	Observations when acid added
zinc	some bubbles
magnesium	vigorous bubbling
iron	a few bubbles
copper	no bubbles

FIGURE 2.4.9c: Results of reactions between hydrochloric acid and some metals

7. Order the metals in terms of reactivity, going from most to least reactive.
8. The teacher told the students that calcium was too reactive to use in this experiment. Suggest what may be seen if acid was added to calcium.
9. Write a word equation for each of the reactions.

Did you know...?

Precious metals such as gold, silver and platinum do not react with acids. They are so unreactive that they stay as pure metals. This is one reason that they are used to make jewellery.

FIGURE 2.4.9d: Precious metals are unreactive.

Key vocabulary

chemical reaction

salt

hydrogen

reactivity