

Learning objectives

After studying this topic, you should be able to:

- ✓ name some strong and weak acids
- ✓ describe acids in terms of pH, hydrogen ion concentration, and electrical conductivity
- ✓ explain the differences between strong and weak acids

Key words

weak acid, strong acid, hydrogen ions, ionise, electrode, electrolysis, electrical conductivity



▲ Vinegar contains ethanoic acid, a weak acid

- A** At the same concentration, acid A has a pH of 2 and acid B has a pH of 5. Which one is the weak acid, and why?

Eating acid

Vinegar contains ethanoic acid. This gives vinegar the pleasant, sharp taste that makes it a popular addition to fish and chips. While you can safely consume vinegar, it would be very unwise to swallow hydrochloric acid. This is because ethanoic acid is a **weak acid**, but hydrochloric acid is a **strong acid**. Nitric acid and sulfuric acid are strong acids, too.

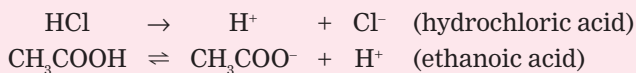
Differences in pH

Strong acids and weak acids have different pH values, even if they are at the same concentration. A strong acid will have a lower pH than a weak acid of the same concentration. Its solution will be more strongly acidic. The differences in pH can be measured using universal indicator and a pH colour chart, or using a pH meter. The reason for these differences is due to **hydrogen ions** produced by the acids.

Acids **ionise** in water to produce hydrogen ions, H^+ . Strong acids such as hydrochloric acid completely ionise in solution. Weak acids such as ethanoic acid only partially ionise in water. Many of their molecules do not release hydrogen ions. Unlike the reaction for strong acids, the reaction is reversible, and an equilibrium mixture is produced.

Acid strength and concentration

The concentration of an acid is a measure of the number of moles of acid in 1 dm^3 . The higher the concentration, the more moles of acid are dissolved in the same volume of water. The strength of an acid is a measure of how ionised the acid is in water. The stronger the acid, the more ionised it is. Hydrochloric acid is completely ionised in water, whereas ethanoic acid is only partially ionised in water:



So, for a given concentration of acid, the concentration of hydrogen ions is greater in hydrochloric acid than it is in ethanoic acid. This is why the pH of a strong acid is much lower than the pH of a weak acid at the same concentration.

Electrolysis of acids

Solutions containing ions conduct electricity because the ions are free to move. They carry charge from one electrode to the other. Acids in solution contain hydrogen ions and other ions, so they conduct electricity. Hydrogen gas is made at the negative **electrode** during the **electrolysis** of either hydrochloric acid or ethanoic acid. This is because the positively charged hydrogen ions are attracted to the negatively charged electrode, where they gain electrons and become hydrogen gas:



B What gas is produced at the negative electrode during the electrolysis of acids?

However, although the electrolysis of both strong and weak acids produces hydrogen gas, there is a difference in the **electrical conductivity** of the acids. It is more 'difficult' for current to pass through a weak acid than it is through a strong acid at the same concentration. For a given potential difference or voltage, the current will be lower through the weak acid. The electrical conductivity of ethanoic acid is lower than it is for hydrochloric acid at the same concentration, because ethanoic acid solution contains fewer hydrogen ions.



◀ The ammeter on the left is measuring the current through ethanoic acid, and the one on the right is measuring the current through hydrochloric acid at the same concentration

More on conductivity

Ethanoic acid is less conductive than hydrochloric acid at the same concentration because it is a weak acid, whereas hydrochloric acid is a strong acid. There is a lower concentration of hydrogen ions to carry the charge through ethanoic acid than there is in hydrochloric acid.

Exam tip

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- ✓ The lower the pH, the more strongly acidic a solution is.
- ✓ Make sure you understand the difference between strength and concentration in acids.

Questions

- 1 Which will have the lower pH, 0.1 mol/dm³ ethanoic acid or 0.1 mol/dm³ hydrochloric acid? **L**
- 2 Which will have the lower electrical conductivity, 0.1 mol/dm³ ethanoic acid or 0.1 mol/dm³ hydrochloric acid? **L**
- 3 In terms of ions and ionisation, explain why ethanoic acid is a weak acid but hydrochloric acid is a strong acid. **S**
- 4 Explain why hydrogen is produced at the negative electrode during the electrolysis of acids. **S**
- 5 Explain the difference between acid strength and acid concentration. Include balanced equations referring to ethanoic acid and hydrochloric acid. **H**