8.4 Strong and weak acids and bases

Nature of science:

Improved instrumentation—the use of advanced analytical techniques has allowed the relative strength of different acids and bases to be quantified. (1.8)

Looking for trends and discrepancies—patterns and anomalies in relative strengths of acids and bases can be explained at the molecular level. (3.1)

The outcomes of experiments or models may be used as further evidence for a claim—data for a particular type of reaction supports the idea that weak acids exist in equilibrium. (1.9)

Understandings:

- Strong and weak acids and bases differ in the extent of ionization.
- Strong acids and bases of equal concentrations have higher conductivities than weak acids and bases.
- A strong acid is a good proton donor and has a weak conjugate base.
- A strong base is a good proton acceptor and has a weak conjugate acid.

Applications and skills:

- Distinction between strong and weak acids and bases in terms of the rates of their reactions with metals, metal oxides, metal hydroxides, metal hydrogen carbonates and metal carbonates and their electrical conductivities for solutions of equal concentrations.

Guidance:

- The terms ionization and dissociation can be used interchangeably.
- See section 21 in the data booklet for a list of weak acids and bases.

Theory of knowledge:

- The strength of an acid can be determined by the use of pH and conductivity probes. In what ways do technologies, which extend our senses, change or reinforce our view of the world?

Utilization:

Syllabus and cross-curricular links:
Topic 1.3—solution chemistry
Topic 7.1—weak acids and basis involve reversible reactions

Aims:

- **Aim 6**: Students should have experimental experience of working qualitatively with both strong and weak acids and bases. Examples to include: H_2SO_4 (aq), HCl (aq), HNO_3 (aq), NaOH (aq), NH_3 (aq).
- **Aim 7**: Students could use data loggers to investigate the strength of acid and bases.

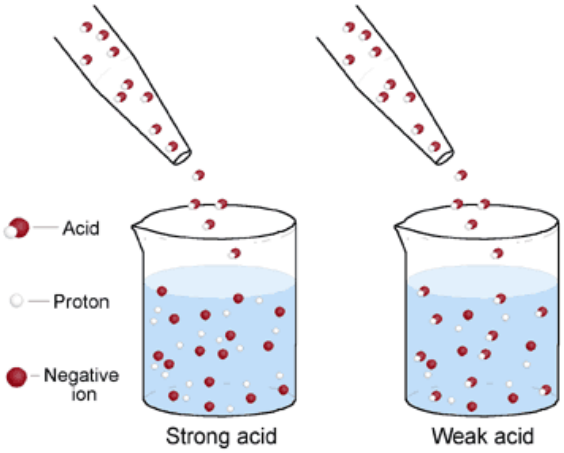
UNIT 8.4 – STRONG AND WEAK ACIDS AND BASES

LEVEL OF IONISATION

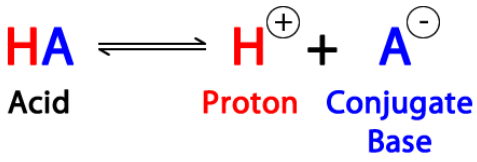
Strong Acids/Bases: All molecules react with water to produce H^+ ions. Virtually completely ionised in water.

Sulphuric Acid	H_2SO_4
Nitric Acid	HNO_3
Hydrochloric Acid	HCl
Hydrobromic Acid	HBr
Hydroioic Acid	Hl
Perchloric Acid	$HClO_4$

Weak Acids/Bases: Only a small % of molecules react. Only partially ionised.



DISSOCIATION



If an acid completely dissociates in water then a single arrow is used.

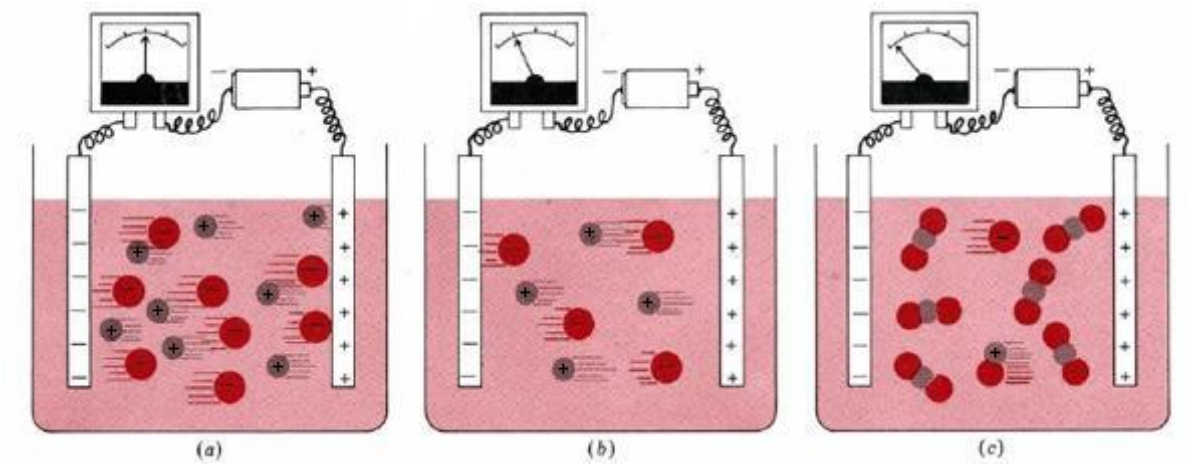
If an acid only partially dissociates then the double arrow is used as it exists in an equilibrium.

CONDUCTIVITY

A strong acid is a good proton donator and has a weak conjugate base.

A strong base is a good proton accepter and has a weak conjugate acid.

If two acids of equal strength are compared, a solution of weaker acid will be a poorer conductor of electricity than a stronger acid. This is because there are more ions dissociated from the stronger acid and hence more free flowing charged particles.



Strong **Dilute** **Weak**

CONCENTRATION AND STRENGTH

Concentration: How much of a solution the acid takes up

Strength: Its ability or tendency to lose/gain a proton

DETERMINING STRENGTH

The relative strengths of acids can be determined if their concentrations are the same, and experimental data such as conductivity; rate of reaction with a metal, base, or carbonate; or pH is known.

ENTHALPY OF NEUTRALISATION

When an acid and base mix it creates an **exothermic** reaction.

The weaker the acid/base in the reaction the more endothermic the dissociation reaction is, hence the lower the enthalpy change of neutralisation.