Summary

Acids & Bases

Subject	Year	Start date	Duration
Chemistry	IB2	Week 4, October	5 weeks 20 hours

Course Part

Core / HL Extension

Inquiry & Purpose

Inquiry / Higher Order Questions

Type	Inquiry Questions
Concept-based	Acid and base behaviour can be explained using different theories. How are the explanations in chemistry different from explanations in other subjects such as history?

Curriculum

Aims

Develop an ability to analyse, evaluate and synthesize scientific information

Develop a critical awareness of the need for, and the value of, effective collaboration and communication during scientific activities

Develop experimental and investigative scientific skills including the use of current technologies

Develop an understanding of the relationships between scientific disciplines and their influence on other areas of knowledge

Objectives

Demonstrate knowledge and understanding of

- methodologies and techniques

Apply

- facts, concepts, and terminology

Formulate, analyse and evaluate

- hypotheses, research questions and predictions
- primary and secondary data
- scientific explanations

Syllabus Content

Core

8. Acids and bases

8.1 Theories of acids and bases

Nature of science:

Falsification of theories - HCN altering the theory that oxygen was the element which gave a compound its acidic properties allowed for other acid-base theories to develop.

Theories being superseded - one early theory of acidity derived from the sensation of a sour taste, but this had been proven false.

Public understanding of science - outside of the arena of chemistry, decisions are sometimes referred to as "acid test" or "litmus test".

Understandings:

A Brønsted–Lowry acid is a proton/H+ donor and a Brønsted–Lowry base is a proton/H+ acceptor.

Amphiprotic species can act as both Brønsted-Lowry acids and bases.

A pair of species differing by a single proton is called a conjugate acid-base pair.

Applications and skills:

Deduction of the Brønsted-Lowry acid and base in a chemical reaction.

Deduction of the conjugate acid or conjugate base in a chemical reaction.

8.2 Properties of acids and bases

Nature of science:

Obtaining evidence for theories - observable properties of acids and bases have led to the modification of acid-base theories.

Understandings:

Most acids have observable characteristic chemical reactions with reactive metals, metal oxides, metal hydroxides, hydrogen carbonates and carbonates.

Salt and water are produced in exothermic neutralization reactions.

Applications and skills:

Balancing chemical equations for the reaction of acids.

Identification of the acid and base needed to make different salts.

Candidates should have experience of acid-base titrations with different indicators.

8.3 The pH scale

Nature of science:

Occam’s razor - the pH scale is an attempt to scale the relative acidity over a wide range of H+ concentrations into a very simple number.

Understandings:

pH=−log[H+(aq)] and [H+]=10−pH.

A change of one pH unit represents a 10-fold change in the hydrogen ion concentration [H +].

pH values distinguish between acidic, neutral and alkaline solutions.

The ionic product constant, Kw=[H+][OH−]=10−14 at 298 K.

Applications and skills:

Solving problems involving pH, [H+] and [OH-].

Students should be familiar with the use of a pH meter and universal indicator.

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.

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

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.

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.

8.5 Acid deposition

Nature of science:

Risks and problems - oxides of metals and non-metals can be characterized by their acid-base properties. Acid deposition is a topic that can be discussed from different perspectives. Chemistry allows us to understand and to reduce the environmental impact of human activities.

Understandings:

Rain is naturally acidic because of dissolved CO_2 and has a pH of 5.6. Acid deposition has a pH below 5.6.

Acid deposition is formed when nitrogen or sulfur oxides dissolve in water to form HNO_3, HNO_2, H_2SO_4 and

H_2SO_3.

Sources of the oxides of sulfur and nitrogen and the effects of acid deposition should be covered.

Applications and skills:

Balancing the equations that describe the combustion of sulfur and nitrogen to their oxides and the subsequent formation of H_2SO_3, H_2SO_4, HNO_2 and HNO_3.

Distinction between the pre-combustion and post-combustion methods of reducing sulfur oxides emissions.

Deduction of acid deposition equations for acid deposition with reactive metals and carbonates.

Additional higher level

18. Acids and bases

18.1 Lewis acids and bases

Nature of science:

Theories can be supported, falsified or replaced by new theories - acid-base theories can be extended to a wider field of applications by considering lone pairs of electrons. Lewis theory doesn't falsify Brønsted-Lowry but extends it.

Understandings:

A Lewis acid is a lone pair acceptor and a Lewis base is a lone pair donor.

When a Lewis base reacts with a Lewis acid a coordinate bond is formed.

A nucleophile is a Lewis base and an electrophile is a Lewis acid.

Applications and skills:

Application of Lewis' acid-base theory to inorganic and organic chemistry to identify the role of the reacting species.

18.2 Calculations involving acids and bases

Nature of science:

Obtaining evidence for scientific theories - application of the equilibrium law allows strengths of acids and bases to be determined and related to their molecular structure.

Understandings:

The expression for the dissociation constant of a weak acid (K a) and a weak base (K b).

For a conjugate acid base pair, K a × K b = K w .

The relationship between K a and pK a is (pK a = -log Ka), and between Kb and pK b is (pK b = -log K b).

Applications and skills:

Solution of problems involving [H+ (aq)], [OH-(aq)], pH, pOH, K a, pK a, K b and pK b.

Discussion of the relative strengths of acids and bases using values of K a, pK a, K b and pK b.

18.3 pH curves

Nature of science:

Increased power of instrumentation and advances in available techniques - development in pH meter technology has allowed for more reliable and ready measurement of pH.

Understandings:

The characteristics of the pH curves produced by the different combinations of strong and weak acids and bases.

An acid–base indicator is a weak acid or a weak base where the components of the conjugate acid–base pair have different colours.

The relationship between the pH range of an acid–base indicator, which is a weak acid, and its pK a value.

The buffer region on the pH curve represents the region where small additions of acid or base result in little or no change in pH.

The composition and action of a buffer solution.

Applications and skills:

The general shapes of graphs of pH against volume for titrations involving strong and weak acids and bases with an explanation of their important features.

Selection of an appropriate indicator for a titration, given the equivalence point of the titration and the end point of the indicator.

While the nature of the acid–base buffer always remains the same, buffer solutions can be prepared by either mixing a weak acid/base with a solution of a salt containing its conjugate, or by partial neutralization of a weak acid/base with a strong acid/base.

Prediction of the relative pH of aqueous salt solutions formed by the different combinations of strong and weak acid and base.

ATL Skills

Approaches to Learning

Communication

- In this unit, we will

  ask students to explain their understanding of a text or idea to each other

  construct a task around the use of different vocabulary and examples when speaking to different audiences

  have students give an oral presentation without reading from their notes

  ask students to monitor and check the quality of their writing

  construct a task so that students practise their listening skills

  assess or give feedback on speaking or writing concisely

  provide opportunities for students to read and understand different types of texts

  encourage or require students to plan a response before they begin

  ask students to formulate arguments clearly and coherently

  encourage all students to contribute to discussions

Research

- In this unit, we will

  require students to formulate/construct a focused research question (either in class or in a homework assignment)

  reward or encourage correct citing and referencing

  assign a task that required students to use the library

  require students to practise effective online search skills (for example, use of Booleans and search limiters)

  provide opportunities for students to reflect on how they determine the quality of a source, or analyse contradictory sources

  require students to record their search for sources in steps (types of search engines, search terms, and so on)

  give students advice on (or provide an opportunity for students to practise) narrowing the scope of a task to make it more manageable

  discuss or model the importance of academic honesty and clear acknowledgment of sources

Developing IB Learners

Learner Profile

Inquirers

Knowledgeable