IB DP Unit Planner

11 SL/HL Chemistry Term 1 SL HL

TEACHER
Robert Melady

SUBJECT
Chemistry

SHARED GRADES
Year 1

START DATE
Week 1, January

DURATION
10 Weeks

COURSE PART

UNIT DESCRIPTION

INQUIRY & PURPOSE

Essential Understandings

Topic 11: Measurement and data processing

11.1 Uncertainties and errors in measurement and results

Essential idea: All measurement has a limit of precision and accuracy, and this must be taken into account when evaluating experimental results.

11.2 Graphical techniques

Essential idea: Graphs are a visual representation of trends in data.

Topic 2: Atomic structure

2.1 The nuclear atom

Essential idea: The mass of an atom is concentrated in its minute, positively charged nucleus.

2.2 Electron configuration

Essential idea: The electron configuration of an atom can be deduced from its atomic number.

Topic 1: Stoichiometric relationships

1.1 Introduction to the particulate nature of matter and chemical change

Essential idea: Physical and chemical properties depend on the ways in which different atoms combine.

1.2 The mole concept

Essential idea: The mole makes it possible to correlate the number of particles with the mass that can be measured.

1.3 Reacting masses and volumes

Essential idea: Mole ratios in chemical equations can be used to calculate reacting ratios by mass and gas volume.

CURRICULUM

Aims & Objectives

AIMS

Appreciate scientific study and creativity within a global context through stimulating and challenging opportunities
Acquire a body of knowledge, methods and techniques that characterize science and technology
Apply and use a body of knowledge, methods and techniques that characterize science and technology
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 and apply 21st century communication skills in the study of science

11 SL/HL Chemistry Term 1 SL HL

Become critically aware, as global citizens, of the ethical implications of using science and technology
Develop an appreciation of the possibilities and limitations of science and technology
Develop an understanding of the relationships between scientific disciplines and their influence on other areas of knowledge

OBJECTIVES

Demonstrate knowledge and understanding of

- facts, concepts, and terminology
- methodologies and techniques
- communicating scientific information

Apply

- facts, concepts, and terminology
- methodologies and techniques
- methods of communicating scientific information

Formulate, analyse and evaluate

- methodologies and techniques
- primary and secondary data
- scientific explanations

Demonstrate the appropriate research, experimental, and personal skills necessary to carry out insightful and ethical investigations

Syllabus Content

Core

- 1. Stoichiometric relationships
    - 1.1 Introduction to the particulate nature of matter and chemical change
        - Nature of science:
            - Making quantitative measurements with replicates to ensure reliability - definite and multiple proportions.
        - Understandings:
            - Atoms of different elements combine in fixed ratios to form compounds, which have different properties from their component elements.
            - Mixtures contain more than one element and/or compound that are not chemically bonded together and so retain their individual properties.
            - Mixtures are either homogeneous or heterogeneous.
        - Applications and skills:
            - Deduction of chemical equations when reactants and products are specified.
            - Application of the state symbols (s), (l), (g) and (aq) in equations.
            - Explanation of observable changes in physical properties and temperature during changes of state.
    - 1.2 The mole concept
        - Nature of science:
            - Concepts - the concept of the mole developed from the related concept of “equivalent mass” in the early 19th century.
        - Understandings:
            - The mole is a fixed number of particles and refers to the amount, n, of substance.
            - Masses of atoms are compared on a scale relative to ^{12}C and are expressed as relative atomic mass (A r) and relative formula/molecular mass (M r).
            - Molar mass (M) has the units g mol^{-1}.
            - The empirical formula and molecular formula of a compound give the simplest ratio and the actual number of atoms present in a molecule respectively.

- Applications and skills:
    - Calculation of the molar masses of atoms, ions, molecules and formula units.
    - Solution of problems involving the relationships between the number of particles, the amount of substance in moles and the mass in grams.
    - Interconversion of the percentage composition by mass and the empirical formula.
    - Determination of the molecular formula of a compound from its empirical formula and molar mass.
    - Obtaining and using experimental data for deriving empirical formulas from reactions involving mass changes.

- 1.3 Reacting masses and volumes
  - Nature of science:
    - Making careful observations and obtaining evidence for scientific theories - Avogadro's initial hypothesis.

  - Understandings:
    - Reactants can be either limiting or excess.
    - The experimental yield can be different from the theoretical yield.
    - Avogadro’s law enables the mole ratio of reacting gases to be determined from volumes of the gases.
    - The molar volume of an ideal gas is a constant at specified temperature and pressure.
    - The molar concentration of a solution is determined by the amount of solute and the volume of solution.
    - A standard solution is one of known concentration.

  - Applications and skills:
    - Solution of problems relating to reacting quantities, limiting and excess reactants, theoretical, experimental and percentage yields.
    - Calculation of reacting volumes of gases using Avogadro’s law.
    - Solution of problems and analysis of graphs involving the relationship between temperature, pressure and volume for a fixed mass of an ideal gas.
    - Solution of problems relating to the ideal gas equation.
    - Explanation of the deviation of real gases from ideal behaviour at low temperature and high pressure.
    - Obtaining and using experimental values to calculate the molar mass of a gas from the ideal gas equation.
    - Solution of problems involving molar concentration, amount of solute and volume of solution.
    - Use of the experimental method of titration to calculate the concentration of a solution by reference to a standard solution.

- 2. Atomic structure
  - 2.1 The nuclear atom
    - Nature of science:
      - Evidence and improvements in instrumentation - alpha particles were used in the development of the nuclear model of the atom that was first proposed by Rutherford.
      - Paradigm shifts - the subatomic particle theory of matter represents a paradigm shift in science that occurred in the late 1800s.

    - Understandings:
      - Atoms contain a positively charged dense nucleus composed of protons and neutrons (nucleons).
      - Negatively charged electrons occupy the space outside the nucleus.
      - The mass spectrometer is used to determine the relative atomic mass of an element from its isotopic composition.

    - Applications and skills:
      - Use of the nuclear symbol notation AZX to deduce the number of protons, neutrons and electrons in atoms and ions.
      - Calculations involving non-integer relative atomic masses and abundance of isotopes from given data, including mass spectra.

- 2.2 Electron configuration
  - Nature of science:
    - Developments in scientific research follow improvements in apparatus - the use of electricity and magnetism in Thomson's cathode rays.
    - Theories being superseded—quantum mechanics is among the most current models of the atom.
    - Use theories to explain natural phenomena - line spectra explained by the Bohr model of the atom.

  - Understandings:
    - Emission spectra are produced when photons are emitted from atoms as excited electrons return to a lower energy level.
    - The line emission spectrum of hydrogen provides evidence for the existence of electrons in discrete energy levels, which converge at higher energies.
    - The main energy level or shell is given an integer number, n, and can hold a maximum number of electrons, $2n^2$.
    - A more detailed model of the atom describes the division of the main energy level into s, p, d and f sub-levels of successively higher energies.
    - Sub-levels contain a fixed number of orbitals, regions of space where there is a high probability of finding an electron.
    - Each orbital has a defined energy state for a given electronic configuration and chemical environment and can hold two electrons of opposite spin.

  - Applications and skills:
    - Description of the relationship between colour, wavelength, frequency and energy across the electromagnetic spectrum.
    - Distinction between a continuous spectrum and a line spectrum.
    - Description of the emission spectrum of the hydrogen atom, including the relationships between the lines and energy transitions to the first, second and third energy levels.
    - Recognition of the shape of an s atomic orbital and the px, py and pz atomic orbitals.
    - Application of the Aufbau principle, Hund's rule and the Pauli exclusion principle to write electron configurations for atoms and ions up to Z = 36.

- 11. Measurement and data processing
  - 11.1 Uncertainties and errors in measurement and results
    - Nature of science:
      - Making quantitative measurements with replicates to ensure reliability - precision, accuracy, systematic, and random errors must be interpreted through replication.

    - Understandings:
      - Qualitative data includes all non-numerical information obtained from observations not from measurement.
      - Quantitative data are obtained from measurements, and are always associated with random errors/ uncertainties, determined by the apparatus, and by human limitations such as reaction times.
      - Propagation of random errors in data processing shows the impact of the uncertainties on the final result.
      - Experimental design and procedure usually lead to systematic errors in measurement, which cause a deviation in a particular direction.
      - Repeat trials and measurements will reduce random errors but not systematic errors.

    - Applications and skills:
      - Distinction between random errors and systematic errors.
      - Record uncertainties in all measurements as a range (±) to an appropriate precision.
      - Discussion of ways to reduce uncertainties in an experiment.
      - Propagation of uncertainties in processed data, including the use of percentage uncertainties.
      - Discussion of systematic errors in all experimental work, their impact on the results and how they can be reduced.
      - Estimation of whether a particular source of error is likely to have a major or minor effect on the final result.

- Calculation of percentage error when the experimental result can be compared with a theoretical or accepted result.
- Distinction between accuracy and precision in evaluating results.

- 11.2 Graphical techniques
  - Nature of science:
    - The idea of correlation - can be tested in experiments whose results can be displayed graphically.
  - Understandings:
    - Graphical techniques are an effective means of communicating the effect of an independent variable on a dependent variable, and can lead to determination of physical quantities.
    - Sketched graphs have labelled but unscaled axes, and are used to show qualitative trends, such as variables that are proportional or inversely proportional.
    - Drawn graphs have labelled and scaled axes, and are used in quantitative measurements.
  - Applications and skills:
    - Drawing graphs of experimental results including the correct choice of axes and scale.
    - Interpretation of graphs in terms of the relationships of dependent and independent variables.
    - Production and interpretation of best-fit lines or curves through data points, including an assessment of when it can and cannot be considered as a linear function.
    - Calculation of quantities from graphs by measuring slope (gradient) and intercept, including appropriate units.

Content, Skills & Concepts

CONTENT

11.1 Uncertainties and errors in measurements and results

- Understand the difference between qualitative and quantitative data
- Define the difference between random uncertainties and systematic error
- Explain the difference between precision and accuracy
- Understand how to quote values with uncertainties
- Understand the difference between significant figures and decimal places
- Define what is meant by absolute uncertainties and percentage uncertainties

11.2 Graphical techniques

- Understand that graphs are an effective way of communicating the relationship between two variables

2.1 The nuclear atom

- Explain understand that an atom is made up of protons, neutrons and electrons
- Define mass number, atomic number and isotope
- Discuss the properties of isotopes
- Understand that a mass spectrometer can be used to determine the isotopic composition of a sample

2.2 Electron configuration

- Describe the electromagnetic spectrum
- Describe the emission spectrum of hydrogen
- Explain how emission spectra arise

1.1 Stoichiometric relationships

- Describe the three states of matter
- Understand the changes involved when there is a change in state
- Understand that compounds have different properties to the elements they are made from
- Understand how to balance chemical equations

- Understand how to use state symbols in chemical equations
- Describe the difference s between elements, compounds and mixtures

1.2 The mole concept

- Define relative atomic mass and relative molecular mass
- Understand what is meant by one mole of a substance

1.3 Reacting masses and volumes

- Understand the terms of limiting reactant and excess reactant and solve problems involving these
- Understand the relationship between pressure, volume and temperature for an ideal gas

SKILLS

11.1 Uncertainties and errors in measurements and results

- Quote the result of a calculation involving multiplication/division or involving addition/subtraction to the appropriate number of decimal places
- Understand how to combine uncertainties in calculations
- Quote the result of a calculation to the appropriate number of significant figures

11.2 Graphical techniques

- Plot graphs of experimental results and interpret the graphs
- Calculate the gradient and intercept in graphs

2.1 The nuclear atom

- Work out the numbers of protons, neutrons and electrons in atoms and ions
- Calculate relative atomic masses and abundances of isotopes

1.2 The mole concept

- Calculate the mass of one mole of a substance
- Work out the number of particles in a specified mass of a substance and also the mass of one molecule
- Calculate the number of moles present in a specific mass of a substance

1.3 Reacting masses and volumes

- Solve the problems involving masses of substances
- Calculate the theoretical and percentage yield in a reaction
- Understand Avogadro's law and use it to calculate reacting volumes of gases
- Use the molar volume of a gas in calculations at standard temperature and pressure
- Solve the problems using the equation $P_1V_1/T_1 = P_2V_2/T_2$
- Solve problems using the ideal gas equation

ASSESSMENT

Formative assessment

Regular quizzes, regular worksheets, interactive questioning

Summative assessment

Exams: Paper 1, Paper 2

Topic Test

Peer and self assessment

Students communicate using scientific literacy and numeracy skills in independent and collaborative settings.

11 SL/HL Chemistry Term 1 SL HL

Standardization and moderation

Moderation occurs between chemistry teachers within the school and through International collaboration

Assessment criteria

Assessment objectives as per Chemistry guide.

SL Criteria

External Assessment

Paper 1

Multiple-choice questions on the core material

Paper 2

Short-answer and extended-response questions on the core material

HL Criteria

External Assessment

Paper 1

Multiple-choice questions on the core and higher level material

Paper 2

Short-answer and extended-response questions on the core and higher level material

LEARNING EXPERIENCES

Prior learning experiences

Students have completed Pre-DP 10 Chemistry.

Each topic is taught with an initial review of the concepts covered in Pre-DP 10 before the delivery of new knowledge and students are formatively assessed.

Pedagogical approaches

Pedagogy base on inquiry questioning and experimental learning.

Methodologies include:

- Lecture based lessons
- Collaborative peer activities
- Practical based lessons
- White board activities

Feedback

Regular questioning and quizzes to review material and track student understanding.

Student expectations

Students will be exposed to sample exam questions, responses and mark schemes.

Support materials

Examples
Sample Exam Questions
Mark Schemes

Learning Process

Lecture
Small group/pair work
PowerPoint lecture/notes

Differentiation

Affirm identity - build self-esteem
Value prior knowledge
Scaffold learning
Extend learning

Lessons are differentiated to target learning styles or students (auditory, kinaesthetic and visual) through the use of conceptual analogies, stories, diagrams, colour, physical movement, and communication skills

CONNECTIONS

Approaches to Learning

Thinking
Social
Communication

Thinking: Students reflect on uncertainties in experimentation and move towards higher-order thinking skills to analyse and evaluate the degree that these uncertainties affect the experimental results.

Social: Building a supporting team that collaborates well and celebrates success. Working together for peer-to-peer revision.

Communication: Scientific Literacy skills to process information and clearly communicate the data. Develop the ability to listen to, and understand, various spoken messages in a classroom setting and between collegeues.

Learner Profile

Inquirers

Being creative and resourceful in the analysis of the prescribed practicals. Students must seek justification for their results and attempts to justify the data using scientific theory and secondary data.

Knowledgeable

Appreciate scientific study and creativity within a global context through validating research and challenging concepts.

Thinkers

Nature of Science Objectives promote open-ended questioning.

Communicators

Use of collaborative activities to promote the ATL's

Principled

Promote strong values of academic honesty and respect for plagiarism.

Open-minded

Understand that knowledge is superseded over time.

Caring

Supportive of each other

Peers assisting those students that are struggling with content or revision strategies.

Risk-takers (Courageous)

Explore a challenging concepts in Chemistry

Be prepared to fail and use the experience for further development

Balanced

Ensure a schedule is used to balance existing work, review / topic note completion, extra-curricular activities and workload.

Reflective

Review exams through explicit links to the syllabus.

Reflect on individual style of learning (auditory, kinaesthetic, visual etc) and use this knowledge to improve study notes and learning practices.

International Mindedness

As a result of collaboration between seven international organizations, including IUPAC, the International Standards Organization (ISO) published the Guide to the Expression of Uncertainty in Measurement in 1995. This has been widely adopted in most countries and has been translated into several languages.

Charts and graphs, which largely transcend language barriers, can facilitate communication between scientists worldwide.

Isotope enrichment uses physical properties to separate isotopes of uranium, and is employed in many countries as part of nuclear energy and weaponry programmes.

Radioisotopes are used in nuclear medicine for diagnostics, treatment and research, as tracers in biochemical and pharmaceutical research, and as “chemical clocks” in geological and archaeological dating.

Chemical symbols and equations are international, enabling effective communication amongst scientists without need for translation.

IUPAC (International Union of Pure and Applied Chemistry) is the world authority in developing standardized nomenclature for both organic and inorganic compounds.

The SI system (Système International d’Unités) refers to the metric system of measurement, based on seven base units.

Academic Honesty

Students sign a contract for academic honesty in IA's and Turn-it-in used to gauge student's work.

Information Communication Technology

Collaborative data analysis activities including yenka simulations, excel, Moodle, ImageJ and macrophotography.

Language and learning

Activating background knowledge
Scaffolding for new learning
Acquisition of new learning through practice

TOK Connections

Personal and shared knowledge
Ways of knowing
Areas of knowledge
The knowledge framework

Science has been described as a self-correcting and communal public endeavour. To what extent do these characteristics also apply to the other areas of knowledge?

Graphs are a visual representation of data, and so use sense perception as a way of knowing. To what extent does their interpretation also rely on the other ways of knowing, such as language and reason?

Richard Feynman: “If all of scientific knowledge were to be destroyed and only one sentence passed on to the next generation, I believe it is that all things are made of atoms.” Are the models and theories which scientists create accurate descriptions of the natural world, or are they primarily useful interpretations for prediction, explanation and control of the natural world?

No subatomic particles can be (or will be) directly observed. Which ways of knowing do we use to interpret indirect evidence, gained through the use of technology?

Heisenberg’s Uncertainty Principle states that there is a theoretical limit to the precision with which we can know the momentum and the position of a particle. What are the implications of this for the limits of human knowledge?

“One aim of the physical sciences has been to give an exact picture of the material world. One achievement ... has been to prove that this aim is unattainable.” —Jacob Bronowski. What are the implications of this claim for the aspirations of natural sciences in particular and for knowledge in general?

Chemical equations are the “language” of chemistry. How does the use of universal languages help and hinder the pursuit of knowledge?

The discovery of oxygen, which overturned the phlogiston theory of combustion, is an example of a paradigm shift. How does scientific knowledge progress?

The magnitude of Avogadro’s constant is beyond the scale of our everyday experience. How does our everyday experience limit our intuition?

Assigning numbers to the masses of the chemical elements has allowed chemistry to develop into a physical science. Why is mathematics so effective in describing the natural world?

The ideal gas equation can be deduced from a small number of assumptions of ideal behaviour. What is the role of reason, perception, intuition and imagination in the development of scientific models?