CAISL
Carlucci American International School of Lisbon

GRADE 11 ADVANCED CHEMISTRY LEVEL 1 - IB CHEMISTRY Y1

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OTHER SKILLS AND EXPECTATIONS

MATH SKILLS – students should have a fundamental understanding of the following:

- Perform the basic arithmetic functions: addition, subtraction, multiplication and division.
- Carry out calculations involving means, decimals, fractions, percentages, ratios, approximations, reciprocals, and logs.
- Use standard scientific notation.
- Use direct and inverse proportion.
- Solve simple algebraic equations.

- Plot graphs (with suitable scales and axes) including two variables that show linear and non-linear relationships.
- Interpret graphs, including the significance of gradients, changes in gradients, intercepts and areas.
- Draw lines (either curves or linear) of best fit on a scatter plot graph.
- Interpret data presented in various forms (for example, bar charts, histograms and pie charts).
- Express uncertainties to one or two significant figures with justification.

SCIENCE NOTEBOOK

- Every student is responsible for keeping their own laboratory notebook. Lab notebooks will be periodically graded according to the science notebook rubric.
- This laboratory notebook should be separated from and in addition to their notebook with class notes and their folder with handouts.

SCIENTIFIC WRITING

- Students will write Laboratory Reports about experiments conducted in class, related to the subject content, which will include but is not limited to the following requirements:
    - Conduct independent background research to sustain their findings
    - Include in-text citations for research
    - Use multiple reliable sources, correctly cited in MLA format
    - Provide a bibliography created with NoodleTools
    - Submit reports via Turnitin
    - Additional information about research parameters is available on the CAISL website

INFORMATION TECHNOLOGY

- Students are expected to use computational and graphing functions in Excel.
- Students are expected to use digital measuring tools.
- Students are expected to appropriately choose and cite internet resources.

SAFETY EXPECTATIONS

Students are expected to learn and to follow the expectations for safe and appropriate practices during laboratory activities, as shown in the “Science Laboratory Safety” document.

<u>ASSESSMENTS</u>

For students to receive a credit towards their High School Diploma, they must demonstrate proficiency on:

- Summative “quick-checks”
- In-class quizzes and tests
- Research projects
- Laboratory notebook checks
- Laboratory reports
- Interdisciplinary science project
- Final exam

Students who are pursuing the IB Diploma in addition to the High School Diploma must complete both years of the program. While there are no internal assessments sent to the IB nor external exams set by the IB during the 1st year of the program, much of the work done will be revised or adapted early in Year 2 to be evaluated by the IB.

PERFORMANCE INDICATORS

Topic 1: stoichiometric relationships

Deduce chemical equations when reactants and products are specified.

Apply state symbols in equations.

Explain observable changes in physical properties and temperature during changes of state.

Calculate the molar masses of atoms, ions, molecules and formula units.

Solve problems involving the relationships between number of particles, the amount of substance in moles and the mass in grams.

Interconvert percent composition by mass and empirical formulas.

Determine the molecular formula of a compound from its empirical formula and determine empirical formula from data.

Solve problems involving reacting quantities, limiting and excess reactants, theoretical, experimental and percentage yield.

Calculate reacting volumes of gases using Avogadro's law.

Solve problems and analyze graphs involving the relationship between temperature, pressure, and volume for a fixed mass of an ideal gas.

Solve problems relating to the ideal gas equation.

Explain the deviation of real gases from ideal behavior at low temperature and high pressure.

Obtain and use experimental values to calculate molar mass of a gas from the ideal gas equation.

Solve problems involving molar concentration, amount of solute and volume of solution.

Use experimental method of titration to calculate the concentration of a solution by reference to a standard solution.

Topic 2: atomic structure

Use the nuclear symbol notation to deduce the number of protons, neutrons and electrons in atoms and ions.

Calculate non-integer relative atomic masses and abundance of isotopes from given data, including mass spectra.

Describe the relationship between color, wavelength, frequency, and energy across the electromagnetic spectrum.

Distinguish between continuous and line spectra.

Describe the emission spectrum of the hydrogen atom.

Recognize the shape of s and p atomic orbitals.

Apply the Aufbau principle, Hund's rule and the Pauli exclusion principle to write electron configurations for atoms and ions up to Z=36.

Topic 3: Periodic Trends

Deduce the electron configurations of an atom from the element's position on the periodic table, and vice versa.

Predict and explain the metallic and non-metallic behavior of an element based on its position in the periodic table.

Compare and contrast properties of elements in the same group, with reference to alkali metals and halogens.

Construct equations to explain the pH changes for reactions of water with the oxides of sodium, magnesium, phosphorous, nitrogen and sulfur.

Topic 4: Chemical Bonding and Structure

Deduce the formula and name of an ionic compound from its component ions, including polyatomic ions.

Explain the physical properties of ionic compounds (volatility, electrical conductivity and solubility) in terms of their structure.

Deduce the polar nature of a covalent bond from electronegativity values.

Deduce Lewis structure of molecules and ions.

Use VSEPR theory to predict the electron domain geometry and molecular geometry for species with two, three and four electron domains.

Predict bond angles from molecular geometry.

Predict molecular polarity from bond polarity and molecular geometry.

Deduce resonance structures.

Explain the properties of covalent network compounds in terms of their structure.

Deduce the types of IMFs present in substances based on their structure and chemical formula.

Explain the physical properties of covalent compounds in terms of their structure and IMFs.

Topic 5: Energetics and Thermochemistry

Calculate the heat change when the temperature of a pure substance is changed.

Complete and evaluate a calorimetry experiment.

Apply Hess's Law to calculate enthalpy changes.

Calculate enthalpy changes using enthalpy of formation data.

Determine enthalpy changes of a reaction that is the sum of multiple reactions with known enthalpy changes.

Calculate the enthalpy changes from known bond enthalpy values and compare to experimentally measured values.

Sketch and evaluate potential energy profiles to determine whether reactions or products are more stable and if the reaction is exothermic or endothermic.

Discuss the bond strength in ozone relative to oxygen and its importance to the atmosphere.

Topic 6: Chemical Kinetics

Describe the kinetic theory in terms of movement of particles whose average kinetic energy is proportional to temperature in kelvin.

Analyze graphical and numerical data form rate experiments.

Explain the effects of temperature, pressure/concentration and particle size on rate of reaction.

Construct Maxwell – Boltzmann energy distribution curves to account for the probability of successful collisions and factors affecting these, including the effects of a catalyst.

Investigate rates of reaction experimentally and evaluate results.

Sketch and explain energy profiles with and without catalysts.

Topic 7: Equilibrium

Describe the characteristics of chemical and physical systems in equilibrium.

Deduce the equilibrium constant expression from an equation for a homogeneous reaction.

Determine the relationship between different equilibrium constants for the same reaction at the same temperature.

Apply Le Chatelier's principle to predict the qualitative effects of changes of temperature, pressure, and concentration on the position of equilibrium and on the value of the equilibrium constant.

Topic 8: Acids and Bases

Deduce the Bronsted-Lowry acid and base in a chemical reaction.

Deduce the conjugate acid or conjugate base in a chemical reaction.

Balance chemical equations for the reactions of acids.

Identify the acid and base needed to make different salts.

Solve problems involving pH, concentration of hydroxide and hydronium ions.

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

Balance equations that describe the combustion of sulfur and nitrogen to their oxides and the subsequent formation of sulfuric, nitric and nitrous acid.

Distinguish between pre-combustion and post-combustion methods of reducing sulfur oxide emissions.

Deduce acid deposition equations for acid deposition with reactive metals and carbonates.

Complete acid-base titrations with different indicators.

Be familiar with the use of a pH meter and universal indicator.

Unit 9: Redox Processes

Deduce the oxidation states of an atom in an ion or a compound.

Deduce the name of a transition metal compound from a given formula, applying oxidation numbers represented by Roman numerals.

Identify the species oxidized and reduced and the oxidizing and reducing agents in redox reactions.

Topic 10: Organic Chemistry

Explain the trends in boiling points of members of a homologous series.

Distinguish between empirical, molecular and structural formulas.

Identify different classes of organic compounds.

Identify typical functional groups in molecules.

Construct 3-D models (real and virtual) of organic molecules.

Apply IUPAC rules in the nomenclature of straight-chain and branched-chain isomers.

Identify primary, secondary, and tertiary carbon atoms.

Discuss the structure of benzene using physical and chemical evidence.

Topic 11: Measurement and Data Processing

Distinguish between random and systematic errors.

Record uncertainties in all measurements as a range to an appropriate precision.

Discuss ways to reduce uncertainties in an experiment.

Propagate uncertainties in processed data, including the use of percentage uncertainty.

Discuss systematic errors in all experimental work, their impact on the results, and how they can be reduced.

Estimate whether a particular source of error is likely to have a major or minor effect on the final result.

Calculate percentage error when the experimental result can be compared with a theoretical or accepted result.

Distinguish between accuracy and precision in evaluating results.

Draw graphs of experimental results, including the correct choice of axes and scale.

Interpret graphs in terms of the relationships of dependent and independent variables.

Produce and interpret best-fit lines or curves through data points, including an assessment of when these can and cannot be considered as a linear function.

Calculate quantities from graphs by measuring slope (gradient) and intercept, including appropriate units.

Energy Option: Nuclear Fusion and Fission

Construct nuclear equations for fusion and fission reactions.

Explain fusion and fission reactions in terms of binding energy per nucleon.

Explain the atomic absorption spectra of hydrogen and helium, including the relationship between the lines and electron transitions.

Discuss the storage and disposal of nuclear waste.

Solve radioactive decay problems involving integral numbers of half-lives.

ADVANCED STUDY / HIGHER LEVEL TOPICS

Those students wishing to pursue advanced study (including IBHL) will also study the following:

Unit 12: Atomic Structure

Solve problems using E=hv

Calculate the value of the first ionization energy from spectral data which gives the wavelength or frequency of the convergence limit.

Deduce the group of an element from its successive ionization energy data.

Explain the trends and discontinuities in data on first ionization energy across a period.

Unit 14: Chemical Bonding and Structure

Predict whether sigma or pi bonds are formed from the linear combination of atomic orbitals.

Deduce the Lewis structures of molecules and ions showing all valence electrons for up to six electron pairs on each atom.

Apply FC to ascertain which Lewis structure is preferred.

Deduce electron domain geometry and molecular geometry with five and six electron domains and associated bond angles using VSEPR theory.

Explain the wavelength of light required to dissociate oxygen and ozone.

Describe the mechanism of catalysis of ozone depletion when catalyzed by CFCs and NOx.

Explain the formation of hybrid orbitals in methane, ethane, and ethyne.

Identify and explain the relationships between Lewis structures, electron domains, molecular geometries, and types of hybridization.

Unit 15: Energetics and Thermochemistry

Construct Born-Haber cycles for group 1 and 2 oxides and chlorides.

Construct energy cycles from hydration, lattice, and solution enthalpy.

Calculate the enthalpy changes from Born-Haber or dissolution energy cycles.

Relate size and charge of ions to lattice and hydration enthalpies.

Perform laboratory experiments which could include single replacement reactions in aqueous solutions.

Topic 16: Chemical Kinetics

Deduce the rate equation from experimental data and solve problems involving the rate equation.

Sketch, identify, and analyze graphical representations for zero, first and second order reactions.

Evaluate proposed reaction mechanisms to be consistent with kinetic and stoichiometric dat.

Analyze graphical representations of the Arrhenius equation in its linear form.

Use the Arrhenius equation in exponential form.

Describe the relationship between temperature and rate constant; frequency factor and complexity of molecules colliding.

Determine and evaluate values of activation energy and frequency factors from data.

Topic 17: Equilibrium

Solution of homogeneous equilibrium problems using the expression for Kc.

Apply the relationship between change in Gibbs free energy and the equilibrium constant.

Calculate using the equation $\Delta G=-RT\ln K$

Topic 20: Organic Chemistry

Construct 3-D models of a wide range of stereoisomers.

Explain stereoisomerism in no-cyclic alkenes and cycloalkanes with 3 and 4 carbons.

Compare physical and chemical properties of enantiomers.

Describe and explain optical isomers in simple organic molecules.

Distinguish between optical isomers using a polarimeter.

Energy Option: Nuclear Fusion and Fission

Calculate the mass defect and binding energy of a nucleus.

Apply the Einstein mass-energy equivalence relationship, to determine the energy produced in a fusion reaction.

Apply the Einstein mass-energy equivalence relationship to determine the energy produced in a fission reaction.

Discuss the different properties of uranium dioxide and uranium tetrafluoride in terms of bonding and structure.

Solve problems involving radioactive half-life.

Explain the relationship between Graham's Law of effusion and the kinetic energy.

Solve problems on the relative fate of effusion using Graham's law.