

Marietta City Schools

2023–2024 District Unit Planner

IB Chemistry PLC		Subject Group and Course		Group 4 - Chemistry	
Course Part and Topic	<b>UNIT 1 - KINETIC MOLECULAR THEORY</b> Structure 1.1 - Introduction to the particulate nature of matter Structure 1.2 - The nuclear atom Structure 1.3 - Electron configurations Structure 1.4 - Counting particles by mass: the mole Structure 1.5 - Ideal gases	SL or HL / Year 1 or 2	SL Year 1	Dates	Semester 1 - Weeks 1 to 9
Unit Description and Texts		DP Assessment(s) for Unit			
Resources for 2025 “New” Syllabus <ul style="list-style-type: none"> <li>• Textbook TBD – pending evaluation of resources</li> <li>• <a href="#">IB Chemistry Guide First Assessment 2025</a></li> <li>• InThinking IB subject site for Chemistry</li> <li>• IB Chemistry Schoology Course</li> </ul> Resources for 2016 “Old” Syllabus <ul style="list-style-type: none"> <li>• Murphy et al. <i>Oxford IB Diploma Programme: Chemistry Course Companion</i>, 2014 edition.</li> <li>• Brown and Ford. <i>Pearson Baccalaureate Standard Level Chemistry</i>, 2nd edition.</li> <li>• Hodder Study and Revision Guide for the IB Diploma</li> <li>• Hodder IA Internal Assessment for Chemistry</li> </ul>		<ul style="list-style-type: none"> <li>• Unit 01 Summative Assessment - <i>Paper 1 and 2 questions modeled after the real IB Exam Papers (2025 syllabus)</i></li> </ul>			

## ***INQUIRY: establishing the purpose of the unit***

### **Transfer Goals**

*List here one to three big, overarching, long-term goals for this unit. Transfer goals are the major goals that ask students to “transfer” or apply their knowledge, skills, and concepts at the end of the unit under new/different circumstances, and on their own without scaffolding from the teacher.*

Phenomenon: The molar mass of butane gas can be experimentally determined using the model of ideal gas behavior, shedding light on the specific properties and characteristics of this volatile compound.

Statement of Inquiry: The Kinetic Molecular Theory helps us understand how the behavior of molecules at the microscopic level influences the macroscopic properties of matter.

1. **Students can** model the particulate nature of matter.
2. **Students can** explain how the nuclei of atoms differ.
3. **Students can** model the energy states of electrons in atoms.
4. **Students can** quantify matter on the atomic scale.
5. **Students can** apply the model of ideal gas behavior to predict the behavior of real gases.

## ***ACTION: teaching and learning through inquiry***

Content / Skills / Concepts - Essential Understandings	Learning Process
<p><b>Structure 1.1.1</b> Elements are the primary constituents of matter, which cannot be chemically broken down into simpler substances. Compounds consist of atoms of different elements chemically bonded together in a fixed ratio. Mixtures contain more than one element or compound in no fixed ratio, which are not chemically bonded and so can be separated by physical methods. <i>Distinguish between the properties of elements, compounds and mixtures.</i></p> <ul style="list-style-type: none"> <li>Solvation, filtration, recrystallization, evaporation, distillation and paper chromatography should be covered. The differences between homogeneous and heterogeneous mixtures should be understood.</li> </ul> <p><b>Structure 1.1.2</b> The kinetic molecular theory is a model to explain physical properties of matter (solids, liquids and gases) and changes of state. <i>Distinguish the different states of matter.</i> <i>Use state symbols (s, l, g and aq) in chemical equations.</i></p> <ul style="list-style-type: none"> <li>Names of the changes of state should be covered: melting, freezing, vaporization (evaporation and boiling), condensation, sublimation and deposition.</li> </ul> <p><b>Structure 1.1.3</b> The temperature, T, in Kelvin (K) is a measure of average kinetic energy (<math>E_k</math>) of particles. <i>Interpret observable changes in physical properties and temperature during changes of state.</i> <i>Convert between values in the Celsius and Kelvin scales.</i></p> <ul style="list-style-type: none"> <li>The kelvin (K) is the SI unit of temperature and has the same incremental value as the Celsius degree (<math>^{\circ}\text{C}</math>).</li> </ul> <p><b>Structure 1.2.1</b> Atoms contain a positively charged, dense nucleus composed of protons and neutrons (nucleons). Negatively charged electrons occupy the space outside the nucleus. <i>Use the nuclear symbol <math>{}^A_Z\text{X}</math> to deduce the number of protons, neutrons and electrons in atoms and ions.</i></p> <ul style="list-style-type: none"> <li>Relative masses and charges of the subatomic particles should be known; actual values are given in the data booklet. The mass of the electron can be considered negligible.</li> </ul> <p><b>Structure 1.2.2</b> Isotopes are atoms of the same element with different numbers of neutrons. <i>Perform calculations involving non-integer relative atomic masses and abundance of isotopes from given data.</i></p> <ul style="list-style-type: none"> <li>Differences in the physical properties of isotopes should be understood.</li> </ul>	<p><i>Check the boxes for any pedagogical approaches used during the unit. Aim for a variety of approaches to help facilitate learning.</i></p> <p>Learning experiences and strategies/planning for self-supporting learning:</p> <p><input checked="" type="checkbox"/> Lecture</p> <p><input type="checkbox"/> Socratic seminar</p> <p><input checked="" type="checkbox"/> Small group/pair work</p> <p><input checked="" type="checkbox"/> PowerPoint lecture/notes</p> <p><input checked="" type="checkbox"/> Individual presentations</p> <p><input checked="" type="checkbox"/> Group presentations</p> <p><input checked="" type="checkbox"/> Student lecture/leading</p> <p><input type="checkbox"/> Interdisciplinary learning</p> <p>Details:</p> <p><i>Students will learn through a combination of presentations, small group work, practice problems, and lab work.</i></p> <p><input checked="" type="checkbox"/> Other(s): <i>practice problems, lab work</i></p> <p><b>Formative assessment(s):</b></p> <p><i>Short closer quizzes for each lesson</i></p>

<ul style="list-style-type: none"> <li>Specific examples of isotopes need not be learned.</li> </ul> <p><b>Structure 1.3.1</b> Emission spectra are produced by atoms emitting photons when electrons in excited states return to lower energy levels. <i>Qualitatively describe the relationship between colour, wavelength, frequency and energy across the electromagnetic spectrum.</i> <i>Distinguish between a continuous and a line spectrum.</i></p> <ul style="list-style-type: none"> <li>Details of the electromagnetic spectrum are given in the data booklet.</li> </ul> <p><b>Structure 1.3.2</b> The line emission spectrum of hydrogen provides evidence for the existence of electrons in discrete energy levels, which converge at higher energies. <i>Describe the emission spectrum of the hydrogen atom, including the relationships between the lines and energy transitions to the first, second and third energy levels.</i></p> <ul style="list-style-type: none"> <li>The names of the different series in the hydrogen emission spectrum will not be assessed.</li> </ul> <p><b>Structure 1.3.3</b> The main energy level is given an integer number, <math>n</math>, and can hold a maximum of <math>2n^2</math> electrons. <i>Deduce the maximum number of electrons that can occupy each energy level.</i></p> <p><b>Structure 1.3.4</b> A more detailed model of the atom describes the division of the main energy level into s, p, d and f sublevels of successively higher energies. <i>Recognize the shape and orientation of an s atomic orbital and the three p atomic orbitals.</i></p> <p><b>Structure 1.3.5</b> Each orbital has a defined energy state for a given electron configuration and chemical environment, and can hold two electrons of opposite spin. Sublevels contain a fixed number of orbitals, regions of space where there is a high probability of finding an electron. <i>Apply the Aufbau principle, Hund's rule and the Pauli exclusion principle to deduce electron configurations for atoms and ions up to <math>Z = 36</math>.</i></p> <ul style="list-style-type: none"> <li>Full electron configurations and condensed electron configurations using the noble gas core should be covered.</li> <li>Orbital diagrams, i.e. arrow-in-box diagrams, should be used to represent the filling and relative energy of orbitals.</li> <li>The electron configurations of Cr and Cu as exceptions should be covered.</li> </ul> <p><b>Structure 1.4.1</b> The mole (mol) is the SI unit of amount of substance. One mole contains exactly the number of elementary entities given by the Avogadro constant. <i>Convert the amount of substance, <math>n</math>, to the number of specified elementary entities.</i></p> <ul style="list-style-type: none"> <li>An elementary entity may be an atom, a molecule, an ion, an electron, any other particle or a specified group of particles.</li> <li>The Avogadro constant <math>N_A</math> is given in the data booklet. It has the units <math>\text{mol}^{-1}</math>.</li> </ul> <p><b>Structure 1.4.2</b> Masses of atoms are compared on a scale relative to <math>^{12}\text{C}</math> and are expressed as relative atomic mass <math>A_r</math> and relative formula mass <math>M_r</math>.</p>	<p><i>Practice with Tools and Inquiries</i> <i>Daily formative checks</i></p> <p><b>Summative assessments:</b></p> <p>Unit Exam - Paper 1 and 2 questions modeled after the real IB Exam Papers (2025 syllabus)</p> <p>Laboratory Assignment - assessing Tools and Inquiries practiced in the Unit</p> <p><b>Differentiation:</b></p> <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Affirm identity - build self-esteem</li> <li><input checked="" type="checkbox"/> Value prior knowledge</li> <li><input checked="" type="checkbox"/> Scaffold learning</li> <li><input checked="" type="checkbox"/> Extend learning</li> </ul> <p><b>Details:</b></p> <ul style="list-style-type: none"> <li>SWD/504 – Accommodations Provided</li> <li>ELL – Reading &amp; Vocabulary Support</li> <li>Intervention Support</li> <li>Extensions – Enrichment Tasks and Project</li> </ul> <p><b>Tools and Inquiries:</b></p> <p><b>Structure 1.1.1</b></p> <ul style="list-style-type: none"> <li>Tool 1—What factors are considered in choosing a method to separate the components of a mixture?</li> <li>Tool 1—How can the products of a reaction be purified?</li> </ul> <p><b>Structure 1.3.2</b></p>
--	--

Determine relative formula masses  $M_r$  from relative atomic masses  $A_r$ .

- Relative atomic mass and relative formula mass have no units.
- The values of relative atomic masses given to two decimal places in the data booklet should be used in calculations.

#### **Structure 1.4.3**

**Molar mass  $M$  has the units  $\text{g mol}^{-1}$ .**

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

- The relationship  $n = m/M$  is given in the data booklet.

#### **Structure 1.4.4**

**The empirical formula of a compound gives the simplest ratio of atoms of each element present in that compound. The molecular formula gives the actual number of atoms of each element present in a molecule.**

*Interconvert the percentage composition by mass and the empirical formula.*

*Determine the molecular formula of a compound from its empirical formula and molar mass.*

#### **Structure 1.4.5**

**The molar concentration is determined by the amount of solute and the volume of solution.**

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

- The use of square brackets to represent molar concentration is required.
- Units of concentration should include  $\text{g dm}^{-3}$  and  $\text{mol dm}^{-3}$  and conversion between these.
- The relationship  $n = CV$  is given in the data booklet.

#### **Structure 1.4.6**

**Avogadro's law states that equal volumes of all gases measured under the same conditions of temperature and pressure contain equal numbers of molecules.**

*Solve problems involving the mole ratio of reactants and/or products and the volume of gases.*

#### **Structure 1.5.1**

**An ideal gas consists of moving particles with negligible volume and no intermolecular forces. All collisions between particles are considered elastic.**

*Recognize the key assumptions in the ideal gas model.*

#### **Structure 1.5.2**

**Real gases deviate from the ideal gas model, particularly at low temperature and high pressure.**

*Explain the limitations of the ideal gas model.*

- No mathematical coverage is required.

#### **Structure 1.5.3**

**The molar volume of an ideal gas is a constant at a specific temperature and pressure.**

*Investigate the relationship between temperature, pressure and volume for a fixed mass of an ideal gas and analyse graphs relating these variables.*

- The names of specific gas laws will not be assessed.
- The value for the molar volume of an ideal gas under standard temperature and pressure (STP) is given in the data booklet.

#### **Structure 1.5.4**

**The relationship between the pressure, volume, temperature and amount of an ideal gas is shown in the ideal gas equation  $PV = nRT$  and the combined gas law  $P_1V_1/T_1 = P_2V_2/T_2$ .**

- Inquiry 2—In the study of emission spectra from gaseous elements and of light, what qualitative and quantitative data can be collected from instruments such as gas discharge tubes and prisms?

#### **Structure 1.4.4**

- Tool 1—How can experimental data on mass changes in combustion reactions be used to derive empirical formulas?
- Tool 3 —What is the importance of approximation in the determination of an empirical formula?

#### **Structure 1.4.5**

- Tool 1—What are the considerations in the choice of glassware used in preparing a standard solution and a serial dilution?
- Tool 1, Inquiry 2—How can a calibration curve be used to determine the concentration of a solution?

#### **Structure 1.5.3**

- Tools 2 and 3 — Graphs can be presented as sketches or as accurately plotted data points. What are the advantages and limitations of each representation?

#### **Structure 1.5.4**

- Tool 1, Inquiry 2—How can the ideal gas law be used to calculate the molar mass of a gas from experimental data?

<p><i>Solve problems relating to the ideal gas equation.</i></p> <ul style="list-style-type: none"> <li>• Units of volume and pressure should be SI only. The value of the gas constant R, the ideal gas equation, and the combined gas law, are given in the data booklet.</li> </ul>	
<p><b>Approaches to Learning (ATL)</b></p> <p><i>Check the boxes for any explicit approaches to learning connections made during the unit. For more information on ATL, please see <a href="#">the guide</a>.</i></p>	
<p><input checked="" type="checkbox"/> Thinking</p> <p><input checked="" type="checkbox"/> Social</p> <p><input checked="" type="checkbox"/> Communication</p> <p><input checked="" type="checkbox"/> Self-management</p> <p><input checked="" type="checkbox"/> Research</p> <p>Details:</p> <p><i>Students will be continuously challenged to develop higher-order thinking skills as they take prior knowledge, combine it with new content, and synthesize new understandings and connections.</i></p> <p><i>Students will build social groups through group work and intentional reflection activities.</i></p> <p><i>Students will communicate their findings to their peers in the form of small-group presentations.</i></p> <p><i>Students will continue to work on self-management and organization skills.</i></p> <p><i>Students will complete background research to develop and extend their learning.</i></p>	

<b>Language and Learning</b> <i>Check the boxes for any explicit language and learning connections made during the unit. For more information on the IB's approach to language and learning, please see <a href="#">the guide</a>.</i>	<b>TOK Connections</b> <i>Check the boxes for any explicit TOK connections made during the unit</i>	<b>CAS Connections</b> <i>Check the boxes for any explicit CAS connections. If you check any of the boxes, provide a brief note in the “details” section explaining how students engaged in CAS for this unit.</i>
<div> <input checked="" type="checkbox"/> Activating background knowledge           <input checked="" type="checkbox"/> Scaffolding for new learning           <input checked="" type="checkbox"/> Acquisition of new learning through practice           <input checked="" type="checkbox"/> Demonstrating proficiency         </div> <p>Details:</p> <p><i>Content and vocabulary introduced in previous science courses will be used in this unit.</i></p> <p><i>Students will use many of the concepts from this unit in future units throughout the two-year course.</i></p> <p><i>Students will acquire new vocabulary.</i></p> <p><i>Students will continually demonstrate proficiency with chemistry vocabulary in class discussions and group work.</i></p>	<div> <input type="checkbox"/> Personal and shared knowledge           <input checked="" type="checkbox"/> Ways of knowing           <input type="checkbox"/> Areas of knowledge           <input type="checkbox"/> The knowledge framework         </div> <p>Details:</p> <p><i>TOK knowledge questions will be included as discussion options for each lesson.</i></p>	<div> <input checked="" type="checkbox"/> Creativity           <input type="checkbox"/> Activity           <input type="checkbox"/> Service         </div> <p>Details:</p> <p><i>Students will be encouraged to consider the creativity involved in scientific experimentation. Students can explore alternative ways (visual, for example) to express and explain this creativity to others.</i></p>

## Resources

*List and attach (if applicable) any resources used in this unit*

Resources for 2025 “New” Syllabus

- Textbook TBD – pending evaluation of resources
- [IB Chemistry Guide First Assessment 2025](#)
- InThinking IB subject site for Chemistry
- IB Chemistry Schoology Course

Resources for 2016 “Old” Syllabus

- Murphy et al. *Oxford IB Diploma Programme: Chemistry Course Companion*, 2014 edition.
- Brown and Ford. *Pearson Baccalaureate Standard Level Chemistry*, 2nd edition.
- Hodder Study and Revision Guide for the IB Diploma
- Hodder IA Internal Assessment for Chemistry

## ***REFLECTION: considering the planning, process, and impact of the inquiry***

What worked well	What didn't work well	Notes / Changes / Suggestions
<i>List the portions of the unit (content, assessment, planning) that were successful</i>	<i>List the portions of the unit (content, assessment, planning) that were not as successful as hoped</i>	<i>List any notes, suggestions, or considerations for the future teaching of this unit</i>