BIG IDEAS

Atoms and molecules are building blocks of matter.	**Organic chemistry** and its applications have significant implications for human health, society, and the environment.	The **mole** is a quantity used to make atoms and molecules measurable.	Matter and energy are conserved in **chemical reactions**.	**Solubility** within a solution is determined by the nature of the solute and the solvent.

Learning Standards

Curricular Competencies	Content
Students are expected to be able to do the following: **Questioning and predicting** • Demonstrate a sustained intellectual curiosity about a scientific topic or problem of personal, local, or global interest • Make observations aimed at identifying their own questions, including increasingly abstract ones, about the natural world • Formulate multiple hypotheses and predict multiple outcomes **Planning and conducting** • Collaboratively and individually plan, select, and use appropriate investigation methods, including field work and lab experiments, to collect reliable data (qualitative and quantitative) • Assess risks and address ethical, cultural, and/or environmental issues associated with their proposed methods • Use appropriate SI units and appropriate equipment, including digital technologies, to systematically and accurately collect and record data • Apply the concepts of accuracy and precision to experimental procedures and data: – significant figures – uncertainty – scientific notation **Processing and analyzing data and information** • Experience and interpret the local environment • Apply First Peoples perspectives and knowledge, other ways of knowing, and local knowledge as sources of information	*Students are expected to know the following:* • quantum mechanical model and **electron configuration** • valence electrons and Lewis structures • **chemical bonding** based on electronegativity • **bonds/forces** • **organic compounds** • **applications of organic chemistry** • the mole • **dimensional analysis** • **reactions** • **stoichiometric calculations** using significant figures • local and other **chemical processes** • **green chemistry** • **solubility** of molecular and ionic compounds • **stoichiometric calculations in aqueous solutions** • **analysis techniques**

Learning Standards (continued)

Curricular Competencies	Content
• Seek and analyze patterns, trends, and connections in data, including describing relationships between variables, performing calculations, and identifying inconsistencies • Construct, analyze, and interpret graphs, models, and/or diagrams • Use knowledge of scientific concepts to draw conclusions that are consistent with evidence • Analyze cause-and-effect relationships **Evaluating** • Evaluate their methods and experimental conditions, including identifying sources of error or uncertainty, confounding variables, and possible alternative explanations and conclusions • Describe specific ways to improve their investigation methods and the quality of their data • Evaluate the validity and limitations of a model or analogy in relation to the phenomenon modelled • Demonstrate an awareness of assumptions, question information given, and identify bias in their own work and in primary and secondary sources • Consider the changes in knowledge over time as tools and technologies have developed • Connect scientific explorations to careers in science • Exercise a healthy, informed skepticism and use scientific knowledge and findings to form their own investigations to evaluate claims in primary and secondary sources • Consider social, ethical, and environmental implications of the findings from their own and others' investigations • Critically analyze the validity of information in primary and secondary sources and evaluate the approaches used to solve problems • Assess risks in the context of personal safety and social responsibility	

Learning Standards (continued)

Curricular Competencies	Content
Applying and innovating • Contribute to care for self, others, community, and world through individual or collaborative approaches • Cooperatively design projects with local and/or global connections and applications • Contribute to finding solutions to problems at a local and/or global level through inquiry • Implement multiple strategies to solve problems in real-life, applied, and conceptual situations • Consider the role of scientists in innovation **Communicating** • Formulate physical or mental theoretical models to describe a phenomenon • Communicate scientific ideas and information, and perhaps a suggested course of action, for a specific purpose and audience, constructing evidence-based arguments and using appropriate scientific language, conventions, and representations • Express and reflect on a variety of experiences, perspectives, and worldviews through **place**	

Big Ideas – Elaborations

- **Atoms and molecules:**
  Sample questions to support inquiry with students:
  - How does the quantum mechanical model extend our understanding of the atom?
  - Why is fluorine the most electronegative element?
- **Organic chemistry:**
  Sample questions to support inquiry with students:
  - How do organic compounds differ in structure and properties?
  - How is carbon the basis for all living things?
  - How do the structure and geometry of organic compounds contribute to their usefulness in medicine?
- **mole:**
  Sample questions to support inquiry with students:
  - How could you demonstrate Avogadro's hypothesis?
  - How does a mole compare to other units of measure?
- **chemical reactions:**
  Sample questions to support inquiry with students:
  - How could you measure negative and/or positive impacts of chemical reactions on human health, society, and the environment in your local community?
  - How can you observe the conservation of mass and energy in chemical reactions you encounter in your everyday life?
  - How do lab techniques contribute to safety?
- **Solubility:**
  Sample questions to support inquiry with students:
  - How does the bent shape of the water molecule cause polarity?
  - Why do some materials dissolve in water or other liquids, but others do not?

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Curricular Competencies – Elaborations

- **Questioning and predicting:**
  Sample opportunities to support student inquiry:
  - How does organic chemistry apply to your life (e.g., plastics, medicine, nutrition, cosmetics, transportation)?
  - What are some applications of chemical reactions within your local community (e.g., smelting, pulp and paper industry, food chemistry, petrochemical smog)?
  - How does the solubility of carbon dioxide in the oceans contribute to climate change?

Curricular Competencies – Elaborations

- **Planning and conducting:**
  Sample opportunities to support student inquiry:
  - How do spectral lines relate to the quantum mechanical model?
  - How would you measure negative and positive impacts of chemical reactions on human health, society or the environment in your local community?
  - How would you safely prepare and collect a gas (e.g., collection of hydrogen from the single displacement reaction of Zn and HCl displacing water from a tube)?
  - How could you use solution chemistry analysis techniques to investigate local water or soil samples?
  - Demonstrate Avogadro's hypothesis (e.g., Zn and HCl to produce a mole of H_2 gas).
  - Use a solubility chart to predict whether ions can be separated from a solution through precipitation and outline an experimental procedure that includes the compound added, precipitate formed, and method of separation.
  - How would you estimate the uncertainty in a measurement, and how does using significant figures communicate uncertainty?
- **Processing and analyzing data and information:**
  Sample opportunities to support student inquiry:
  - How is the solubility of ions related to their position on the periodic table?
  - What variables affect solubility, concentration (molarity), and conductivity?
  - Construct, analyze, and interpret graphs of electronegativity, atomic radii, and ionic radii.
- **Evaluating:**
  Sample opportunities to support student inquiry:
  - Calculate uncertainty in derived values.
  - How has technology played a role in the evolution of the model of the atom?
- **Applying and innovating:**
  Sample opportunities to support student inquiry:
  - What solutions would you propose to address concerns about carbon dioxide in the environment?
  - Using knowledge shared by First Peoples, explore the uses of traditional medicines. What medicines have been used? Which particular health conditions are/were they used for?
  - Having been hired by the local government in your community to consult on the chemistry of fireworks, what suggestions would you provide for a spectacular yet safe show?
- **Communicating:**
  Sample opportunity to support student inquiry:
  - During a meeting of various stakeholders, how would you best present your solutions to a local, chemistry-related problem?
- **place:** Place is any environment, locality, or context with which people interact to learn, create memory, reflect on history, connect with culture, and establish identity. The connection between people and place is foundational to First Peoples perspectives.

Content – Elaborations

- **electron configuration:** molecular geometry, valence shell electron pair repulsion (VSEPR) theory
- **chemical bonding:** Lewis structures of compounds, polarity
- **bonds/forces:**
  - covalent bond
  - hydrogen bond
  - intra- and intermolecular forces
  - impact on properties
- **organic compounds:** names, structures, geometry
- **applications of organic chemistry:** First Peoples traditional practices (e.g., medicines), pharmaceuticals, petrochemicals, polymers, cosmetics, metabolism, agriculture, food, biotechnology
- **dimensional analysis:**
  - factor-label method (unit-analysis method)
  - calculation of mass and molar quantities (using significant figures)
- **reactions:** predicting products, reactants and energy changes (ΔH)
- **stoichiometric calculations:**
  - mass
  - number of molecules
  - gas volumes
  - molar quantities
  - excess and limiting reactants
- **chemical processes:** First Peoples traditional practices (e.g., tanning hides; preparation of food, soap, and natural bleach), smelting, pulp and paper production, food chemistry, photosynthesis and cellular respiration, development of petrochemical smog
- **green chemistry:** development of sustainable processes and technologies that reduce negative impacts on the environment (e.g., reducing toxicity, designing benign solvents, increasing energy efficiency)
- **solubility:** dissociation of ions, dissociation equation
- **stoichiometric calculations in aqueous solutions:**
  - molarity
  - dilution effect
  - concentration of ions in solution when two solutions are mixed
- **analysis techniques:** e.g., dissolved oxygen, pH, nitrates, phosphorus

