BIG IDEAS

Reactants must collide to react, and the **reaction rate** is dependent on the surrounding conditions.	**Dynamic equilibrium** can be shifted by changes to the surrounding conditions.	**Saturated solutions** are systems in equilibrium.	**Acid or base strength** depends on the degree of ion dissociation.	**Oxidation and reduction** are complementary processes that involve the gain or loss of electrons.

Learning Standards

Curricular Competencies

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
- 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 diagrams
- Use knowledge of scientific concepts to draw conclusions that are consistent with evidence
- Analyze cause-and-effect relationships

Curricular Competencies continued	Content
Students are expected to be able to do the following: **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 **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**	*Students are expected to know the following:* • **reaction rate** • **collision theory** • **energy change** during a chemical reaction • **reaction mechanism** • **catalysts** • **dynamic nature of chemical equilibrium** • **Le Châtelier's principle and equilibrium shift** • **equilibrium constant (K_{eq})** • saturated solutions and **solubility product (K_{sp})** • **relative strength** of acids and bases in solution • water as an equilibrium system • **weak acids and weak bases** • **titration** • **hydrolysis of ions in salt solutions** • **applications of acid-base reactions** • **the oxidation-reduction process** • **electrochemical cells** • **electrolytic cells** • **quantitative relationships**

- **reaction rate:**
  - heterogeneous and homogeneous reactions
  - factors that affect reaction rate
  - controlling reaction rate
- **collision theory:**
  - collision geometry
  - relationship between successful collisions and reaction rate
  - relationship of activated complex, reaction intermediates, and activation energy to PE diagrams
- **energy change:** relationship between PE, KE, enthalpy (ΔH), and catalysis
- **reaction mechanism:**
  - relationship of the overall reaction to a series of steps (collisions)
  - rate-determining step
- **catalysts:** applications (e.g., platinum in automobile catalytic converters, catalysis in the body, chlorine from CFCs in ozone depletion)

- **dynamic nature of chemical equilibrium:** reversible nature of reactions, relationship to PE diagram
- **Le Châtelier's principle and equilibrium shift:**
  - concentrations of reactants and products
  - enthalpy and entropy
  - presence of a catalyst
  - applications (e.g., Haber process, hemoglobin and oxygen in the blood)
- **equilibrium constant (K_{eq}):**
  - homogeneous and heterogeneous systems
  - pure solids and liquids
  - effect of changes in temperature, pressure, concentration, surface area, and a catalyst

- **solubility product (K_{sp}):** K_{sp} as a specialized K_{eq} expression
- **relative strength:**
  - electrical conductivity
  - table of relative acid strength
  - equations of strong and weak acids and bases in water

- **weak acids and weak bases:** equilibrium systems
- **titration:** the method to find an equivalence point: strong acid–strong base titration, weak acid–strong base titration, strong acid–weak base titration
- **hydrolysis of ions in salt solutions:**
  - acidic, basic, or neutral salt solutions
  - amphiprotic ions
- **applications of acid-base reactions:**
  - non-metal and metal oxides in water and associated environmental impacts
  - buffers

- **the oxidation-reduction process:**
  - oxidation number
  - balancing redox reactions
- **electrochemical cells:** half-reactions, cell voltage (E^0), applications (e.g., lead-acid storage batteries, alkali cells, hydrogen-oxygen fuel cells)
- **electrolytic cells:** half-reactions, minimum voltage to operate, applications including metal refining (e.g. zinc, aluminum), preventing metal corrosion (cathodic protection)
- **quantitative relationships:** quantitative problems using relationships between variables such as:
  - in equilibrium systems (e.g., K_{eq}, initial concentrations, equilibrium concentrations)
  - in solutions (e.g., K_{sp}, prediction of precipitate formation, calculating the maximum allowable concentration)
  - in water as an equilibrium system (e.g., K_w, $[H_3O^+]$ or $[OH^-]$, pH and pOH)
  - in acid-base systems (e.g., K_a, K_b, $[H_3O^+]$, $[OH^-]$, pH and pOH)
  - in a titration (e.g., pH of a solution, K_a of an indicator)
  - pH in hydrolysis of ions in salt solutions
  - in a redox titration (e.g., grams, moles, molarity)
  - in an electrochemical cell (e.g., E^0)

To achieve an "A", student will/can...

Produce high-quality, frequently innovative work. Communicate comprehensive, nuanced understanding of concepts and contexts. Consistently demonstrate sophisticated critical thinking. Frequently transfer knowledge and skills with independence and expertise in a variety of complex classroom and real-world situations. Evaluate a topic and develop a well-structured argument that demonstrates different perspectives on an issue.

To achieve a "B", student will/can...

Consistently produce high-quality work. Communicate comprehensive understanding of concepts and contexts. Consistently demonstrate critical thinking. With some support transfer knowledge with skill in a variety of classroom and real-world situations. Assess a topic and develop a well-structured argument on an issue.

To achieve a "C", student will/can...

Produce work of an acceptable quality. Communicate basic understanding of many concepts and contexts, with occasionally significant misunderstandings or gaps. Begin to demonstrate some basic critical thinking. Be fixed in the use and application of knowledge and skills, requiring support even in familiar classroom situations. In certain circumstances, lack the ability to identify the issues involved with a topic and have challenges with developing a response.

FINAL SUMMATIVE ASSESSMENT

The final exam will assess the student's proficiency in the following content:

• **reaction rate** • **collision theory** • **energy change** during a chemical reaction • **reaction mechanism** • **catalysts** • **dynamic nature of chemical equilibrium** • **Le Châtelier's principle and equilibrium shift** • **equilibrium constant (K_{eq})**	• saturated solutions and **solubility product (K_{sp})** • **relative strength** of acids and bases in solution • water as an equilibrium system • **weak acids and weak bases** • **titration** • **hydrolysis of ions in salt solutions** • **applications of acid-base reactions** • **quantitative relationships**

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