Science
Chemistry
Unit 5: Industry: Applying Chemical Reactions

Essential Understandings	▪ The physical world contains basic elements whose structure can be studied. ▪ Matter is transformed in accordance with various chemical laws and principles. ▪ Energy is a fundamental part of physical and chemical changes. ▪ Heat is one of the fundamental forms of energy affecting changes and order or matter in our universe.
Essential Questions	▪ How do chemical industries convert substances into other useful materials by large-scale manufacturing? ▪ What chemical principles are involved in converting nitrogen gas to useful nitrogen-based compounds? ▪ How does electrical energy cause chemical changes?
Essential Knowledge	▪ Complete fertilizers contain the three main elements growing plants need: nitrogen, phosphorous, and potassium as well as trace ions and filler material. ▪ Nitrogen recycles among plants and animals (i.e., nitrogen cycle). ▪ Oxidation-reduction reactions fix nitrogen using hydrogen gas (Haber-Bosch process). ▪ The higher (more positive) the oxidation state becomes, the more an atom has become oxidized. The lower (less positive) the atom's oxidation state becomes, the more the atom has become reduced. ▪ Reaction rates (chemical kinetics) express how fast a particular chemical change occurs. ▪ All reversible reactions in closed containers eventually reach dynamic equilibrium if conditions such as temperature remain constant and LeChatelier's principle is applied. ▪ Electrochemistry involves chemical changes that produce or are caused by electrical energy, specifically known as the process of electrolysis.
Vocabulary	▪ <u>Terms</u>: ○ nitrogen cycle, phosphates, colorimetry, colorimeter, oxidation-reduction reaction, oxidation state, reaction rates, kinetics, dynamic equilibrium, LeChatelier's Principle, electrochemistry, electrolysis, electrolyte, voltaic cell, half-cell, electrodes, electric current, salt bridge, dry cell and alkaline batteries.
Essential Skills	▪ Determine oxidation states. ▪ Perform chemical systems at equilibrium. ▪ Describe explosive nitrogen chemistry. ▪ Investigate getting charged by electrochemistry.

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Related Maine Learning Results	Science and Technology A. Unifying Themes A1. Systems Students apply an understanding of systems to explain and analyze man-made and natural phenomena. a. Analyze a system using the principles of boundaries, subsystems, inputs, outputs, feedback, or the system's relation to other systems and design solutions to a system problem. b. Explain and provide examples that illustrate how it may not always be possible to predict the impact of changing some part of a man-made or natural system. A2.Models Students evaluate the effectiveness of a model by comparing its predications to actual observations from the physical setting, the living environment, and the technological world. A3.Constancy and Change Students identify and analyze examples of constancy and change that result from varying types and rates of change in physical, biological, and technical systems with and without counterbalances. B. The Skills and Traits of Scientific Inquiry and Technological Design B1.The Skills and Traits of Scientific Inquiry Students methodically plan, conduct, analyze data from, and communicate results of in-depth scientific investigations, including experiments guided by a testable hypothesis. a. Identify questions, concepts, and testable hypotheses that guide scientific investigations. b. Design and safely conduct methodical scientific investigations, including experiments with controls. c. Use statistics to summarize, describe, analyze, and interpret results. d. Formulate and revise scientific investigations using logic and evidence. e. Use a variety of tools and technologies to improve investigations and communications. f. Recognize and analyze alternative explanations and models using scientific criteria. g. Communicate and defend scientific ideas.

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Related Maine Learning Results	C. The Scientific and Technological Enterprise C1. Understandings of Inquiry Students describe key aspects of scientific investigations: that they are guided by scientific principles and knowledge, and that they are performed to test ideas, and that they are communicated and defended publicly. a. Describe how hypotheses and past and present knowledge guide and influence scientific investigations. b. Describe how scientists defend their evidence and explanations using logical arguments and verifiable results.

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Related Maine Learning Results	D. The Physical Setting D3.Matter and Energy Students describe the structure, behavior, and interactions of matter at the atomic level and the relationships between matter and energy. a. Describe the structure of atoms in terms of neutrons, protons, and electrons and the role of the atomic structure in determining chemical properties. b. Describe how the number and arrangement of atoms in a molecule determine a molecule's properties, including the types of bonds it makes with other molecules and its mass, and apply this to predictions about chemical reactions. c. Explain the essential roles of carbon and water in life processes. d. Describe how light is emitted and absorbed by atoms' changing energy levels, and how the results can be used to identify a substance. e. Describe factors that affect the rate of chemical reactions (including concentration, pressure, temperature, and the presence of molecules that encourage interaction with other molecules. f. Apply an understanding of the factors that affect the rate of chemical reaction to predictions about the rate of chemical reactions. g. Describe nuclear reactions, including fusion and fission, and the energy they release. h. Describe the radioactive decay and half-life. i. Explain the relationship between kinetic and potential energy and apply the knowledge to solve problems. j. Describe how in energy transformations the total amount of energy remains the same, but because of inefficiencies (heat, sound, and vibration) useful energy is often lost through radiation or conduction. k. Apply an understanding of energy transformations to solve problems. l. Describe the relationship among heat, temperature, and pressure in terms of the actions of atoms, molecules, and ions.

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Related Maine Learning Results	E. The Living Environment E2.Ecosystems Students describe and analyze the interactions, cycles, and factors that affect short-term and long-term ecosystem stability and change. a. Explain why ecosystems can be reasonably stable over hundreds or thousands of years, even though populations may fluctuate. b. Describe dynamic equilibrium in ecosystems and factors that can, in the long run, lead to change in the normal pattern of cyclic fluctuations and apply that knowledge to actual situations. c. Explain the concept of carrying capacity and list factors that determine the amount of life that any environment can support. d. Describe the critical role of photosynthesis and how energy and the chemical elements that make up molecules are transformed in ecosystems and obey basic conversation laws.
Sample Lessons And Activities	▪ Lab Investigation A.3: Testing for Fertilizer Components ▪ Identifying the steps of the Nitrogen Cycle ▪ Lab Investigation A.7: Analysis of Fertilizer for Percent Phosphate. ▪ Application of Oxidation-Reduction to determine Oxidation State of Chemical Equations (A.9) ▪ Determination of Plant Nutrients (A.5)
Sample Classroom Assessment Methods	▪ Section and unit quizzes and tests ▪ Laboratory investigations and reports ▪ "Developing Skills" classroom activities ▪ "Making Decisions" classroom activities
Sample Resources	▪ Publications: o Chemistry in the Community – Chemcom, 5th edition ▪ Videos: o World of Chemistry series o Planet Earth series