LEE ACADEMY

Lee, Maine USA

Official Curriculum

Chemistry

Rev. August 2011

Course description:

Chemistry is the study of matter, including its composition, structure, and behavior. Chemistry is an inquiry-based laboratory course that prepares students for further studies in the sciences and develops their problem solving skills.

Primary text(s) and other major resources

Chemistry in the Community, W.H. Freeman and Company, American Chemical Society, 2002
ISBN 0716735512

Chemistry: The Science in Context W.H. Norton and Company, 2004, Thomas R. Gilbert, Rein V. Kirss, Geoffrey Davies
ISBN 0393975312

FLINN ChemTopic Lab series:
http://www.flinnsci.com/Sections/Chemistry/chemTopicLabs.asp

Because of their universal applicability in chemistry, learning of the following Maine Learning Results (http://www.maine.gov/education/lres/pei/index.html) is ongoing in each unit:

Student will:

A1a *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.*
A1b *explain and provide examples that illustrate how it may not always be possible to predict the impact of changing some part of a manmade or natural system.*
A2 *evaluate the effectiveness of a model by comparing its predictions to actual observations from the physical setting, the living environment, and the technological world.*
A3 *identify and analyze examples of constancy and change that result from varying types and rates of change in physical, biological, and technological systems with and without counterbalances.*
A4a *describe how large changes of scale may change how physical and biological systems work and provide examples.*
A4b *mathematically represent large magnitudes of scale.*

B1a *identify questions, concepts, and testable hypotheses that guide scientific investigations.*
B1b *design and safely conduct methodical scientific investigations, including experiments with controls.*
B1c *use statistics to summarize, describe, analyze, and interpret results.*
B1d *formulate and revise scientific investigations and models using logic and evidence.*
B1e *use a variety of tools and technologies to improve investigations and communications.*
B1f *recognize and analyze alternative explanations and models using scientific criteria.*
B1g *communicate and defend scientific ideas.*

B2a *identify new problems or a current design in need of improvement.*
B2b *generate alternative design solutions.*
B2c *select the design that best meets established criteria.*
B2d *use models and simulations as prototypes in the design planning process.*
B2e *implement the proposed design solution.*
B2f *evaluate the solution to a design problem and the consequences of that solution.*
B2g *present the problem, design process, and solution to a design problem including models, diagrams, and demonstrations.*

C2a *provide an example that shows how science advances with the introduction of new technologies and how solving technological problems often impacts new scientific knowledge.*
C2b *provide examples of how creativity, imagination, and a good knowledge base are required to advance scientific ideas and technological design.*
C2c *provide examples that illustrate how technological solutions to problems sometimes lead to new problems or new fields of inquiry.*

MLR content standards for Science and Technology:

1. **UNIFYING THEMES -** Students apply the principles of *systems*, *models*, constancy and change, and scale in science and technology.

2. **THE SKILLS AND TRAITS OF SCIENTIFIC INQUIRY AND TECHNOLOGICAL DESIGN** – Students plan, conduct, analyze data from and communicate results of in-depth scientific investigations; and they use a systematic process, tools, equipment, and a variety of materials to create a *technological design* and produce a solution or product to meet a specified need.

3. **THE SCIENTIFIC AND TECHNOLOGICAL ENTERPRISE** – Students understand the history and nature of scientific knowledge and technology, the processes of inquiry and *technological design*, and the impacts science and technology have on society and the environment.

4. **THE PHYSICAL SETTING -** Students understand the universal nature of matter, energy, force, and motion and identify how these relationships are exhibited in earth systems, in the solar system, and throughout the universe.

5. ***THE LIVING ENVIRONMENT -*** Students understand that cells are the basic unit of life, that all life as we know it has evolved through genetic transfer and natural selection to create a great diversity of organisms, and that these organisms create interdependent webs through which matter and energy flow. Students understand similarities and differences between humans and other organisms and the interconnections of these interdependent webs.

~Unit length & MLRs	Objectives	Essential Questions	Assessment	Labs
Unit 1 2 weeks Lab Introduction ***Application of the skills and ideas in the following MLR is ongoing in each unit: **B1** 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 controlled experiments. c. Use a variety of tools and technologies to improve investigations and communications.	Students will review concepts of : ✓ Measuring - S.I. units, metrics ✓ Numeric accounting and calculators - scientific notation, significant figures ✓ Conversion factors ✓ Approaching a Problem - Steps to problem solving, Scientific Method ✓ Lab Report - Problem, background, hypothesis, procedure, results, conclusion	✓ How can I represent quantitatively (measure) the phenomena I see? ✓ What number systems should I use to measure and quantify? ✓ What tools can I use to measure and quantify? ✓ How do I formally present the information I see into a written report?	**Quiz:** Lab safety quiz **Lab:** Observation of Reaction--Flinn ChemTopic™ Labs vol. 1--"Observation and Experiment--Introduction of the Scientific Method" **Description:** In this lab, the students can see and feel the reaction It is an inquiry based lab, used to reinforce and asses students in Observation, Scientific Method, and Lab Report Format. This lab will be revisited later to help asses future concepts.	**Lab:** Think Tube--Flinn ChemTopic™ Labs vol. 3 "The Think Tube--A Black Box Demonstration" **Description:** This apparatus is used to introduce the Scientific Method, Problem Solving, and Lab Report Format **Lab:** Measurement Lab--Flinn ChemTopic™ Labs vol. 1 "Introduction to Measurement--Mass, Length, and Volume" **Description:** This lab is used to introduce lab procedures and equipment. It also helps reinforce topics such as Units, Significant Figures, Accuracy and Precision.

d. Use a variety of tools and techniques to improve investigations and communications. e. Formulate and revise scientific explanations and models using logic and evidence. f. Recognize and analyze alternative explanations and models using scientific criteria. g. Communicate and defend scientific ideas. ****Understanding periodic trends and the organization of the periodic table is ongoing, in all units.*				
Unit 2 4 weeks Atomic Structure and Periodic Properties **D3a** Describe the structure of atoms in terms of neutrons, protons, and electrons and the role of the atomic structure in determining chemical properties. **D3b** Describe how the number and arrangement of atoms in a molecule	✓ Student will: ✓ distinguish between elements, pure substances, compounds, homogeneous mixtures, and heterogeneous mixtures. ✓ represent elements and compounds using symbols and formulas. ✓ Identify and state the location of subatomic particles. ✓ predict the number of each type of subatomic particle for a given element. ✓ represent elements and compounds using symbols and formulas ✓ distinguish between atoms and molecules ✓ Identify trends in the atomic structure of elements ✓ Identify and predict trends in properties of elements.	✓ What is a chemical substance and what makes each chemical substance unique? ✓ How are chemical substances represented with symbols and formulas? ✓ How do we represent subatomic particles? ✓ How is the Periodic Table organized and why is it organized that way? ✓ How are electrons organized inside an atom? ✓ How do we know where electrons are located? ✓ How do we determine how many protons,	Tests (constructed response) **Project:** Atom model--construct a 3-D model of an atom of a given element which clearly depicts sub-atomic structure **Lab:** Atomic Coatings--Flinn ChemTopic™ Labs vol. 3 "Atomic Coatings--The Size of the Atom" **Description:** This lab is used to asses knowledge of Stoichiometric calculations. **Lab:**	**Lab:** Metal or Non-metal?--ChemCom Unit 2 section A.3 **Description:** This lab shows the periodic differences in metals and non-metals. **Lab:** Bean Bag Isotopes--Flinn ChemTopic™ Labs vol. 3 "Bean Bag Isotopes--Relative Abundance and Atomic Mass" **Description:** This lab is used to describe how an

determine a molecule's proper, including the types of bonds it makes with other molecules and its mass, and apply this to predictions about chemical reactions. **D3c** Describe how light is emitted and absorbed by atoms changing energy levels, the results of which can be used to identify a substance. **D3d** Describe how light is emitted and absorbed by atoms' changing energy levels, and how the results can be used to identify a substance.	✓ explain that electrons move around in energy fields. ✓ describe Rutherford's experiments. ✓ use periodic table to determine number of each type of sub-atomic particle.	electrons, and neutrons are in an atom?	Density is Periodic--Flinn ChemTopic™ Labs vol. 4 "Density is a Periodic Property--Discovering an Element" **Description:** This lab is used to asses knowledge of periodic properties.	elements atomic mass is calculated. **Lab:** Atomic Target-- Flinn ChemTopic™ Labs vol. 3 "Atomic Target Practice--Rutherford Scattering and the Nuclear Atom" **Description:** This lab helps establish the connection between energy levels and electron scatter. **Lab:** Flame Test-- Flinn ChemTopic™ vol. 3 "Flame Tests--Atomic Emission and Electron Energy Levels **Description:** This lab shows the visible difference between elements and their energy levels.
Unit 3 3 weeks Ions **D3a** Describe the structure of atoms in terms of neutrons, protons, and electrons and the role of the atomic structure in determining chemical properties. **D3b** Describe how	Student will: ✓ predict which elements will become ions. ✓ calculate ionic charge. ✓ predict how ions will combine to form neutral compounds. ✓ describe properties of ionic compounds ✓ explain how spectroscopy works ✓ list common organic molecules ✓ explain how molecules form ✓ describe different types of bonds ✓ explain the importance of electronegativity	✓ What is an ion and how do we know which elements will become ions? ✓ How do we determine an ion's charge? ✓ How do ions react with each other? ✓ What are the properties of ionic compounds? ✓ Why do elements give off certain colors?	Test (constructed response): ✓ describe ions & properties of ions ✓ predict ionic charges ✓ write formulas for ionic compounds	**Lab:** Ion puzzle game--students will use ion puzzle pieces to make compounds **Description:** This activity is used to help reinforce how ionic compounds are formed. **Lab:** Formula of Ionic Compound-- Flinn ChemTopic™ vol. 5 "Formula of an Ionic

the number and arrangement of atoms in a molecule determine a molecule's proper, including the types of bonds it makes with other molecules and its mass, and apply this to predictions about chemical reactions. **D3d** Describe how light is emitted and absorbed by atoms' changing energy levels, and how the results can be used to identify a substance.				Compound--Balancing Charges on Ions" **Description:** This lab investigates how a formula for an ionic compound can be determined. **Lab:** Lewis Structures--Flinn ChemTopic™ vol. 5 "Lewis Structures and Molecular Geometry--Models of Covalent Bonding" **Description:** This lab enforces molecule notation and molecular geometry.
Unit 4 4 weeks Covalent Bonding and Organic Chemistry **D3b** Describe how the configuration of an atom in a molecule determines a molecule's properties including the types of bonds it makes, its energy level and its mass.	Student will: ✓ explain how covalent bonds are formed. ✓ describe some examples of covalent molecules and their properties. ✓ explain the structure of different covalent molecules. ✓ explain that organic molecules are a type of covalent molecule and give examples. ✓ describe the properties of organic molecules. ✓ explain what happens during a combustion reaction.	✓ What is a covalent bond? ✓ What compounds have covalent bonds? ✓ How are covalent molecules "put together"? ✓ What are organic molecules, where are they found and how are they useful? ✓ Why do some elements form molecules? ✓ What shapes do molecules take and why? ✓ How are ionic compounds different from molecules?	✓ molecule models	**Lab:** "Modeling Alkanes"--ChemCom Unit 3 Section A.6 **Description:** This lab is used to build models of simple hydrocarbons. **Lab:** Properties of Solids--Flinn ChemTopic™ vol. 5 "Properties of Solids--Structure and Bonding" **Description:** This lab helps answer the question "Does the nature of forces on an atom influence the properties of a material?"

				Lab: Graphite Disks-- Flinn ChemTopic™ vol. 5 "Graphite Disk Demonstration-- Face-up or Face-down? **Description:** This lab helps illustrate the difference between polar and non-polar substances.
Unit 5 4 weeks Conservation of Matter and Reactions **D3b** Describe how the number and arrangement of atoms in a molecule determine a molecule's proper, including the types of bonds it makes with other molecules and its mass, and apply this to predictions about chemical reactions. **D3e** Describe factors that affect the rate of chemical reactions (including concentration, pressure, temperature, and the presence of molecules that encourage interaction with other molecules)	Student will: ✓ state the LCM (Law of Conservation of Matter) ✓ balance chemical equations. ✓ explain why equations must be balanced. ✓ demonstrate the LCM through experimentation. ✓ calculate percent composition. ✓ explain what a mole is and why we use it. ✓ calculate percent yield through experimentation. ✓ explain what a chemical reaction is and represent a reaction with an equation. ✓ identify different types of chemical reactions. ✓ perform mole to mole and mass to mole calculations ✓ determine oxidation numbers ✓ examine effects of electrochemical reactions	✓ What does the Law of Conservation of Matter state? ✓ How can we show that matter is conserved? ✓ What is a mole? ✓ Why must equations be balanced? ✓ What can balanced chemical equations tell us? ✓ What is a chemical reaction and how do we represent it? ✓ What are the different types of chemical reactions? ✓ How can reactions be classified? ✓ What is an oxidation number? ✓ Why do reactions occur?	✓ Test (constructed response) ✓ explain why equations must be balanced ✓ balance equations ✓ calculate % composition ✓ complete stoichiometry problems ✓ calculate % yield	**Lab:** Conservation of Mass Lab (penny and silver nitrate) **Lab:** "Copper Plating"-- ChemCom Unit 2 Section D.6 **Description:** This lab is used to enforce the Conservation of Matter. **Lab:** "Voltaic Cells"-- ChemCom Unit 5 Section C.2 **Description:** This lab looks at a different style of reaction dealing with electrochemistry.

Unit 6 4 weeks Gases **D3l** Describe the relationship among heat, temperature, and pressure in terms of the actions of atoms, molecules, and ions.	Student will: ✓ describe the basic properties of gases. ✓ explain and apply the kinetic molecular theory. ✓ apply Boyle's Law. ✓ apply Charles' Law. ✓ apply the Ideal Gas Law. ✓ describe the electromagnetic spectrum. ✓ explain the effects of radiation in our atmosphere. ✓ explain why CO2 is a greenhouse gas.	✓ What are the properties of gases? ✓ How do the volume, pressure and temperature of a gas change, with respect to each other? ✓ How does radiation affect our atmosphere? ✓ What are greenhouse gasses and why are they "greenhouse gasses"?	✓ Gas Laws Test ✓ Develop a solubility curve for dissolved oxygen ✓ Global warming project ??	**Lab:** Hydrogen-- Flinn ChemTopic™ vol. 8 "Preparing and Testing Hydrogen Gas--A Microscale Approach" **Description:** This lab isolates then test various properties of hydrogen. **Lab:** Oxygen--Flinn ChemTopic™ vol. 8 "Oxygen, What a Flame--Microscale Gas Chemistry" **Description:** This lab isolates then test various properties of oxygen. **Lab:** Boyle's Law--Flinn ChemTopic™ vol. 9 "Boyle's Law in a Bottle--Pressure versus Volume" **Description:** This lab analyzes the correlation between pressure and volume. **Lab:** Molar Volume of Hydrogen--Flinn ChemTopic™ vol. 9 "Molar Volume of Hydrogen--

				Combining the Gas Laws" **Description:** This lab takes a look at the combined gas laws.
Unit 7 3 weeks Solutions **D3c** Explain the essential roles of carbon and water in life processes. **D3f** Apply an understanding of the factors that affect the rate of chemical reaction to predictions about the rate of chemical reactions.	Student will: ✓ describe the factors that affect solubility. ✓ predict how solubility will change under changing conditions. ✓ measure and calculate concentrations of solutions (including molarity). ✓ construct a solubility curve. ✓ explain that ph is a measure of the hydrogen ion concentration. ✓ measure and compare the ph of different substances.	✓ What is solubility and what factors affect it? ✓ How does solubility change under different conditions? ✓ How is a solubility curve constructed? ✓ How are concentrations of solutions measured and calculated? ✓ What is a ph and what does it tell us? ✓ Can I predict whether or not a substance will dissolve?	✓ Solubility curve: develop a solubility curve (and write lab report) for ionic compound.	**Lab:** "Solubility Curve"--ChemCom Unit 1 Section C.3 *Measuring concentration *water testing for ions *comparing properties that effect solubility *comparing solubility of different substances *conductivity of solutions
Unit 8 4 weeks Acids, Bases and Equilibrium **D3b** Describe how the configuration of an atom in a molecule determines a molecule's properties including the types of bonds it makes, its energy level and its mass. **D3e** Describe factors that affect the rate of chemical reactions (including	Student will: ✓ explain what acids and bases are describe their properties. ✓ measure the ph of various substances and determine if they are acidic or basic. ✓ perform a titration on a strong acid. ✓ explain the concept of chemical equilibrium. ✓ explain what ph is a measure of ✓ describe Le Chatelier's Principle	✓ What are acids and bases and what are their properties? ✓ How do we measure acids and bases? ✓ What are strong acids and bases? ✓ What is equilibrium and what affects it? ✓ What is Le Chatelier's Principle?	Titration *** Water Testing IV	**Lab:** compare ph of various solutions **Lab:** practice titrations **Lab:** "Buffers"--ChemCom Unit 4 Section C.8 **Description:** This lab will compare the results of adding an acid or a base to a buffered solution. **Lab:** "Le Chatelier's Principle"--ChemCom Unit 5

concentration, pressure, temperature, and the presence of molecules that encourage interaction with other molecules)				Section B.2 **Description:** This lab is used to investigate a system at equilibrium.
Unit 9 Kinetics and Thermochemistry **D3e** Describe factors that affect the rate of chemical reactions (including concentration, pressure, temperature, and the presence of molecules that encourage interaction with other molecules) **D3i** Explain the relationship between kinetic and potential energy and apply the knowledge to solve problems. **D3j** 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.	Student will: ✓ state the law of conservation of energy ✓ compare endo and exothermic processes ✓ use a basic calorimeter ✓ explain what determines the rate of reaction.		✓ Energy test	**Lab:** "Carbon Dioxide Levels"--ChemCom Unit 4 Section B.6 **Description:** This lab will estimate and compare the CO_2 levels found in different air samples. **Lab:** "Specific Heat Capacity"--ChemCom Unit 4 Section B.4 **Lab:** "Energy Contained in a Snack"--ChemCom Unit 7 Section A.3 **Description:** This lab will determine the amount of energy in various snacks, using the specific heat capacity of water.

D3k Apply an understanding of energy transformations to solve problems.				
Unit 10 *(If time allows)* 2 weeks Nuclear Chemistry **D3g** Describe nuclear reactions, including fusion and fission, and the energy they release. **D3h** Describe radioactive decay and half-life	Student will: ✓ explain what an isotope is and provide examples. ✓ write chemical reactions to show how isotopes change and energy is released. ✓ describe how half-life is determined and give examples. ✓ explain how fusion occurs in stars	✓ What is an isotope? ✓ How do isotopes change over time? ✓ How is energy produced by radioactive decay? ✓ What is half-life and how is it determined? ✓ How do stars produce energy?	✓ Nuclear Energy Project ✓ National Laboratories project ✓ Isotope quiz ✓ Radioactive decay quiz ✓ Half-life quiz ✓ Nuclear Chemistry Test	**Activity:** Nuclear chemistry—modeling reaction; radioactive decay