Chemistry Curriculum Guide
Lunenburg County Public Schools
June 2014

Marking Period: 1
Days: 13
Reporting Category/Strand: Lab Techniques, Safety, Chemistry Math, Structure and Properties of Matter

SOL CH.1 a-j* ***Reinforced throughout the course** **SOL CH.2 h**	**The student will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts include:** **a) designated laboratory techniques;** **b) safe use of chemicals and equipment;** **c) proper response to emergency situations;** **d) manipulation of multiple variables, using repeated trials;** **e) accurate recording, organization, and analysis of data through repeated trials;** **f) mathematical and procedural error analysis;** **g) mathematical manipulations including SI units, scientific notation, linear equations, graphing, ratio and proportion, significant digits, and dimensional analysis;** **h) use of appropriate technology including computers, graphing calculators, and probeware, for gathering data, communicating results, and using simulations to model concepts;** **i) construction and defense of a scientific viewpoint; and** **j) the use of current applications to reinforce chemistry concepts.** **The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of** **h) chemical and physical properties and changes**
Essential Knowledge/Skills/Understandings	Essential Understandings a) the natural world is understandable; b) science is based on evidence - both observational and experimental; c) science is a blend of logic and innovation; d) scientific ideas are durable yet subject to change as new data are collected; e) science is a complex social endeavor; and f) scientists try to remain objective and engage in peer review to help avoid bias. ● Techniques for experimentation involve the identification and the proper use of chemicals, the description of equipment, and the recommended statewide framework for high school laboratory safety. ● Measurements are useful in gathering data about chemicals and how they behave. ● Repeated trials during experimentation ensure verifiable data. ● Data tables are used to record and organize measurements. ● Mathematical procedures are used to validate data, including percent error to evaluate accuracy.

	● Measurements of quantity include length, volume, mass, temperature, time, and pressure to the correct number of significant digits. Measurements must be expressed in International System of Units ● Scientific notation is used to write very small and very large numbers. ● Algebraic equations represent relationships between dependent and independent variables. ● Graphs are used to summarize the relationship between the independent and dependent variable. ● Graphed data give a picture of a relationship. ● Ratios and proportions are used in calculations. ● Significant digits of a measurement are the number of known digits together with one estimated digit. ● The last digit of any valid measurement must be estimated and is therefore uncertain. ● Dimensional analysis is a way of translating a measurement from one unit to another unit. ● Graphing calculators can be used to manage the mathematics of chemistry. ● Scientific questions drive new technologies that allow discovery of additional data and generate better questions. New tools and instruments provide an increased understanding of matter at the atomic, nano, and molecular scale. ● Constant reevaluation in the light of new data is essential to keeping scientific knowledge current. In this fashion, all forms of scientific knowledge remain flexible and may be revised as new data and new ways of looking at existing data become available. ● Matter occurs as elements (pure), compounds (pure), and mixtures, which may be homogeneous (solutions) or heterogeneous. Some elements, such as oxygen, hydrogen, fluorine, chlorine, bromine, iodine, and nitrogen, naturally occur as diatomic molecules. ● Matter is classified by its chemical and physical properties. ● Physical properties refer to the condition or quality of a substance that can be observed or measured without changing the substance's composition. Important physical properties are density, conductivity, melting point, boiling point, malleability, and ductility. ● Chemical properties refer to the ability of a substance to undergo a chemical reaction and form a new substance. <u>Essential Knowledge and Skills</u> ● Identify the following basic lab equipment: beaker, Erlenmeyer flask, graduated cylinder, test tube, test tube rack, test tube holder, ring stand, wire gauze, clay triangle, crucible with lid, evaporating dish, watch glass, wash bottle, and dropping pipette. ● make connections between components of the nature of science, investigations and the greater body of scientific knowledge and research. ● demonstrate safe laboratory practices, procedures, and techniques. ● demonstrate the following basic lab techniques: filtering, chromatography, and lighting a gas burner. ● understand Material Safety Data Sheet (MSDS) warnings, including handling chemicals, lethal dose (LD), hazards, disposal, and chemical spill cleanup. ● make the following measurements, using the specified equipment: - volume: graduated cylinder, volumetric flask, buret

	- mass: triple beam and electronic balances - temperature: thermometer and/or temperature probe - pressure: barometer and/or pressure probe. ● identify, locate, and know how to use laboratory safety equipment, including aprons, goggles, gloves, fire extinguishers, fire blanket, safety shower, eye wash, broken glass container, and fume hood. ● design and perform controlled experiments to test predictions, including the following key components: hypotheses, independent and dependent variables, constants, controls, and repeated trials. ● predict outcome(s) when a variable is changed. ● read measurements and record data, reporting the significant digits of the measuring equipment. ● demonstrate precision (reproducibility) in measurement. ● recognize accuracy in terms of closeness to the true value of a measurement. ● determine the mean of a set of measurements. ● use data collected to calculate percent error. ● discover and eliminate procedural errors. ● use common SI prefixes and their values (milli-, centi-, kilo-) in measurements and calculations. ● demonstrate the use of scientific notation, using the correct number of significant digits with powers of ten notation for the decimal place. ● graph data utilizing the following: - independent variable (horizontal axis) - dependent variable (vertical axis) - scale and units of a graph - regression line (best fit curve). ● calculate mole ratios, percent composition, conversions, and average atomic mass. ● perform calculations according to significant digits rules. ● convert measurements using dimensional analysis. ● use graphing calculators to solve chemistry problems. ● read a measurement from a graduated scale, stating measured digits plus the estimated digit. ● use appropriate technology for data collection and analysis, including probeware interfaced to a graphing calculator and/or computer and computer simulations. ● summarize knowledge gained through gathering and appropriate processing of data in a report that documents background, objective(s), data collection, data analysis and conclusions. ● explain the emergence of modern theories based on historical development. For example, students should be able to explain the origin of the atomic theory beginning with the Greek atomists and continuing through the most modern quantum models. ● distinguish between physical and chemical properties of metals and nonmetals. ● differentiate between pure substances and mixtures and between homogeneous and heterogeneous mixtures.

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Essential Questions	Describe matter, its components, and classifications. What is a good measurement and how can it be manipulated?
Primary Resources	Text: World of Chemistry, Brooks/Cole, 2013. Chapters 2, 5. PowerPoint to accompany World of Chemistry Laboratory Experiments, World of Chemistry, 2013. Activities at cavalcadepublishing.net Chemistry Tutorials yeahchemistry.com https://www.khanacademy.org/science/chemistry
Essential Vocabulary	matter, states of matter, atom, pure substance, compound, element, hypothesis, conclusion, trial, significant digits, accuracy, precision, error, chemical property, physical property, chemical change, physical change, variables, international system or measurement, conversion factor

Marking Period: 1
Days: 14
Reporting Category/Strand: Atomic Structure, History, Periodic Table, Radioactivity, Quantum Mechanics

SOL CH.2 a- i	**The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of** **a) average atomic mass, mass number, and atomic number;** **b) isotopes, half lives, and radioactive decay;** **c) mass and charge characteristics of subatomic particles;** **d) families or groups;** **e) periods;** **f) trends including atomic radii, electronegativity, shielding effect, and ionization energy;** **g) electron configurations, valence electrons, and oxidation numbers;** **h) chemical and physical properties; and** **i) historical and quantum models.**
Essential Knowledge/Skills/Understanding	Essential Understandings ● The periodic table is arranged in order of increasing atomic numbers. ● The atomic number of an element is the same as the number of protons. In a neutral atom, the number of electrons is the same as the number of protons. All atoms of an element have the same number of protons. ● The average atomic mass for each element is the weighted average of that element's naturally occurring isotopes. ● The mass number of an element is the sum of the number of protons and neutrons. It is different for each element's isotopes.

	• An isotope is an atom that has the same number of protons as another atom of the same element but has a different number of neutrons. Some isotopes are radioactive; many are not. • Half-life is the length of time required for half of a given sample of a radioactive isotope to decay. • Electrons have little mass and a negative (–) charge. They are located in electron clouds or probability clouds outside the nucleus. • Protons have a positive (+) charge. Neutrons have no charge. Protons and neutrons are located in the nucleus of the atom and comprise most of its mass. Quarks are also located in the nucleus of the atom. • The names of groups and periods on the periodic chart are alkali metals, alkaline earth metals, transition metals, halogens, and noble gases. • Metalloids have properties of metals and nonmetals. They are located between metals and nonmetals on the periodic table. Some are used in semiconductors. • Periods and groups are named by numbering columns and rows. Horizontal rows called periods have predictable properties based on an increasing number of electrons in the outer energy levels. Vertical columns called groups or families have similar properties because of their similar valence electron configurations. • The Periodic Law states that when elements are arranged in order of increasing atomic numbers, their physical and chemical properties show a periodic pattern. • Periodicity is regularly repeating patterns or trends in the chemical and physical properties of the elements arranged in the periodic table. • Atomic radius is the measure of the distance between radii of two identical atoms of an element. Atomic radius decreases from left to right and increases from top to bottom within given groups. • Electronegativity is the measure of the attraction of an atom for electrons in a bond. Electronegativity increases from left to right within a period and decreases from top to bottom within a group. • Shielding effect is constant within a given period and increases within given groups from top to bottom. • Ionization energy is the energy required to remove the most loosely held electron from a neutral atom. Ionization energies generally increase from left to right and decrease from top to bottom of a given group. • Electron configuration is the arrangement of electrons around the nucleus of an atom based on their energy level. • Electrons are added one at a time to the lowest energy levels first (Aufbau Principle). Electrons occupy equal-energy orbitals so that a maximum number of unpaired electrons results (Hund's Rule). • Energy levels are designated 1–7. Orbitals are designated s, p, d, and f according to their shapes and relate to the regions of the Periodic Table. An orbital can hold a maximum of two electrons (Pauli Exclusion Principle). • Atoms can gain, lose, or share electrons within the outer energy level. • Loss of electrons from neutral atoms results in the formation of an ion with a positive charge (cation). Gain of electrons by a neutral atom results in the formation of an ion with a negative charge (anion). • Transition metals can have multiple oxidation states. • Reactivity is the tendency of an element to enter into a chemical reaction. • Discoveries and insights related to the atom's structure have changed the model of the atom over time. Historical

	models have included solid sphere, plum pudding, nuclear, and planetary models. The modern atomic theory is called the quantum mechanical model. Essential Knowledge and Skills ● determine the number of neutrons in an isotope given its mass number. ● perform calculations to determine the "weighted" average atomic mass. ● perform calculations involving the half-life of a radioactive substance. ● differentiate between alpha, beta, and gamma radiation with respect to penetrating power, shielding, and composition. ● differentiate between the major atom components (proton, neutron and electron) in terms of location, size, and charge. ● distinguish between a group and a period. ● identify key groups, periods, and regions of elements on the periodic table. ● identify and explain trends in the periodic table as they relate to ionization energy, electronegativity, shielding effect, and relative sizes. ● compare an element's reactivity to the reactivity of other elements in the table. ● relate the position of an element on the periodic table to its electron configuration. ● determine the number of valence electrons and possible oxidation numbers from an element's electron configuration. ● write the electron configuration for the first 20 elements of the periodic table. ● distinguish between physical and chemical properties of metals and nonmetals. ● differentiate between pure substances and mixtures and between homogeneous and heterogeneous mixtures. ● identify key contributions of principal scientists including: - atomos, initial idea of atom – Democritus - first atomic theory of matter, solid sphere model – John Dalton - discovery of the electron using the cathode ray tube experiment, plum pudding model – J. J. Thomson - discovery of the nucleus using the gold foil experiment, nuclear model – Ernest Rutherford - discovery of charge of electron using the oil drop experiment –Robert Millikan - energy levels, planetary model – Niels Bohr - periodic table arranged by atomic mass – Dmitri Mendeleev - periodic table arranged by atomic number – Henry Moseley - quantum nature of energy – Max Planck - uncertainty principle, quantum mechanical model – Werner Heisenberg - wave theory, quantum mechanical model – Louis de Broglie. ● differentiate between the historical and quantum models of the atom.
Essential Questions	How has our understanding of the atom changed over time? What knowledge can be obtained from a periodic table? Describe radioactivity, its uses and its dangers.
Primary Resources	Text: World of Chemistry, Brooks/Cole, 2013. Chapters 3, 11, 19.

	PowerPoint to accompany World of Chemistry Laboratory Experiments, World of Chemistry, 2013. Activities at cavalcadepublishing.net Chemistry Tutorials yeahchemistry.com https://www.khanacademy.org/science/chemistry
Essential Vocabulary	atom, proton, neutron, electron, average atomic mass, isotope, energy level, sublevel, orbital, periodic table, group, family, half-life, radioactivity, atomic theory, periodic trend, atomic radius, electronegativity, ionization energy, series, period, valence electrons, octet, electron configuration, orbital notation

Marking Period: 1, 2
Days: 3, 6 days into 2
Reporting Category/Strand: Writing Formulas, Nomenclature, Bonding, Electrolytes

SOL CH.3 a, c, d **SOL CH.4 d**	**The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:** **a) nomenclature;** **c) writing chemical formulas;** **d) bonding types;** **The student will investigate and understand that chemical quantities are based on molar relationships. Key concepts include:** **d) strong electrolytes, weak electrolytes, and nonelectrolytes**
Essential Knowledge/Skills/Understanding	Essential Understandings ● Chemical formulas are used to represent compounds. Subscripts represent the relative number of each type of atom in a molecule or formula unit. The International Union of Pure and Applied Chemistry (IUPAC) system is used for naming compounds. ● When pairs of elements form two or more compounds, the masses of one element that combine with a fixed mass of the other element form simple, whole-number ratios (Law of Multiple Proportions). ● Compounds have different properties than the elements from which they are composed. ● The empirical formula shows the simplest whole-number ratio in which the atoms of the elements are present in the compound. The molecular formula shows the actual number of atoms of each element in one molecule of the substance. ● Lewis dot diagrams are used to represent valence electrons in an element. Structural formulas show the arrangements of atoms and bonds in a molecule and are represented by Lewis dot structures. ● Bonds form between atoms to achieve stability. Covalent bonds involve the sharing of electrons between atoms. Ionic

	bonds involve the transfer of electrons between ions. Elements with low ionization energy form positive ions (cations) easily. Elements with high ionization energy form negative ions (anions) easily. Polar bonds form between elements with very different electronegativities. Non-polar bonds form between elements with similar electronegativities. ● Polar molecules result when electrons are distributed unequally. ● Strong electrolytes dissociate completely. Weak electrolytes dissociate partially. Non-electrolytes do not dissociate. Essential Knowledge and Skills ● name binary covalent/molecular compounds. ● name binary ionic compounds (using the Roman numeral system where appropriate). ● predict, draw, and name molecular shapes (bent, linear, trigonal planar, tetrahedral, and trigonal pyramidal). ● write the chemical formulas for certain common substances, such as ammonia, water, carbon monoxide, carbon dioxide, sulfur dioxide, and carbon tetrafluoride. ● use polyatomic ions for naming and writing formulas of ionic compounds, including carbonate, sulfate, nitrate, hydroxide, phosphate, and ammonium. ● draw Lewis dot diagrams to represent valence electrons in elements and draw Lewis dot structures to show covalent bonding, recognize polar molecules and non-polar molecules. ● use valence shell electron pair repulsion (VSEPR) model to draw and name molecular shapes (bent, linear, trigonal planar, tetrahedral, and trigonal pyramidal).
Essential Questions	Describe the types of chemical bonding that occurs in nature and how it determines the properties of a substance. What can you determine about a compound from its name? How do you write the formula for the different types of compounds?
Primary Resources	Text: World of Chemistry, Brooks/Cole, 2013. Chapters 4, 12. PowerPoint to accompany World of Chemistry Laboratory Experiments, World of Chemistry, 2013. Activities at cavalcadepublishing.net Chemistry Tutorials yeahchemistry.com https://www.khanacademy.org/science/chemistry
Essential Vocabulary	chemical bond, covalent, ionic, polarity, salt, electrolyte, non-electrolyte, binary compound, molecule, dissociation, acid, base, Lewis dot, molecular shape

Marking Period: 2
Days: 9
Reporting Category/Strand: Stoichiometric and Mole Relationships

Chemistry Curriculum Guide
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SOL CH.4 a, b	**The student will investigate and understand that chemical quantities are based on molar relationships. Key concepts include:** **a) Avogadro's principle and molar volume;** **b) stoichiometric relationships;**
Essential Knowledge/Skills/Understanding	Essential Understandings ● Atoms and molecules are too small to count by usual means. A mole is a way of counting any type of particle (atoms, molecules, and formula units). ● Avogadro's number = 6.02×10^{23} particles per mole. ● Molar mass of a substance is its average atomic mass in grams from the Periodic Table. ● Molar volume = 22.4 L/mole for any gas at standard temperature and pressure (STP). ● Stoichiometry involves quantitative relationships. Essential Knowledge and Skills ● perform conversions between mass, volume, particles, and moles of a substance. ● perform stoichiometric calculations involving the following relationships: - mole-mole; - mass-mass; - mole-mass; - mass-volume; - mole-volume; - volume-volume; - mole-particle; - mass-particle; and - volume-particle.
Essential Questions	What is the mole concept and why is it vital to chemists? By knowing the mass of a substance how can you convert that information into something useful to a chemist? How can you determine the formula of a substance if you know its percent composition? Distinguish between the empirical and molecular formulas of a compound and why it is important to know the difference.
Primary Resources	Text: World of Chemistry, Brooks/Cole, 2013. Chapter 6. PowerPoint to accompany World of Chemistry Laboratory Experiments, World of Chemistry, 2013. Activities at cavalcadepublishing.net Chemistry Tutorials yeahchemistry.com https://www.khanacademy.org/science/chemistry

Essential Vocabulary	mole, molar mass, molecular mass, formula mass, Avogadro's number, empirical formula, particle, percent composition

Marking Period: 2
Days: 12
Reporting Category/Strand: Balancing Equations, Identifying Types of Equations, Stoichiometry, Limiting Reactants, Percent Yield

SOL CH.3 b, e	**The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:** **b) balancing chemical equations** **e) reaction types**
SOL CH.4 a, b	**The student will investigate and understand that chemical quantities are based on molar relationships. Key concepts include:** **a) Avogadro's principle and molar volume;** **b) stoichiometric relationships;**
Essential Knowledge/Skills/Understanding	Essential Understandings ● Conservation of matter is represented in balanced chemical equations. A coefficient is a quantity that precedes a reactant or product formula in a chemical equation and indicates the relative number of particles involved in the reaction. ● Major types of chemical reactions are - synthesis ($A + B \rightarrow AB$) - decomposition ($BC \rightarrow B + C$) - single replacement ($A + BC \rightarrow B + AC$) - double replacement ($AC + BD \rightarrow AD + BC$) - neutralization ($HX + MOH \rightarrow H_2O + MX$) - combustion ($CxHy + O_2 \rightarrow CO_2 + H_2O$). ● Stoichiometry involves quantitative relationships. Stoichiometric relationships are based on mole quantities in a balanced equation. ● Total grams of reactant(s) = total grams of product(s). Essential Knowledge and Skills ● classify types of chemical reactions as synthesis, decomposition, single replacement, double replacement, neutralization, and/or combustion. ● perform stoichiometric calculations from balanced equations involving the following relationships: - mole-mole;

	- mass-mass; - mole-mass; - mass-volume; - mole-volume; - volume-volume; - mole-particle; - mass-particle; and - volume-particle. ● identify the limiting reactant (reagent) in a reaction. ● calculate percent yield of a reaction.
Essential Questions	How do you know if a chemical reaction has occurred? Distinguish between the types of chemical reactions. What is the Law of Conservation of Mass and Energy and why must it be obeyed during a chemical reaction? How does one carry out a stoichiometric calculation and why is this knowledge vital to medicine, science, business and industry?
Primary Resources	Text: World of Chemistry, Brooks/Cole, 2013. Chapters 7, 8, 9. PowerPoint to accompany World of Chemistry Laboratory Experiments, World of Chemistry, 2013. Activities at cavalcadepublishing.net Chemistry Tutorials yeahchemistry.com https://www.khanacademy.org/science/chemistry
Essential Vocabulary	chemical equation, reactants, products, percent yield, single replacement, double replacement, combustion, synthesis, decomposition, stoichiometry, molar volume

Marking Period: 2, 3
Days: 3, 7 days into 3
Reporting Category/Strand: Kinetics and Equilibrium, Thermochemistry, Phase Changes

SOL CH.3 f	**The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include:** **f) reaction rates, kinetics, and equilibrium**.
SOL CH.5 c, d, e, f	**The student will investigate and understand that the phases of matter are explained by kinetic theory and forces of attraction between particles. Key concepts include:**

	c) vapor pressure; **d) phase changes;** **e) molar heats of fusion and vaporization;** **f) specific heat capacity**
Essential Knowledge/Skills/Understanding	Essential Understandings ● Kinetics is the study of reaction rates. Several factors affect reaction rates, including temperature, concentration, surface area, and the presence of a catalyst. ● Reaction rates/kinetics are affected by activation energy, catalysis, and the degree of randomness (entropy). Catalysts decrease the amount of activation energy needed. ● Chemical reactions are exothermic reactions (heat producing) and endothermic reactions (heat absorbing). ● Reactions occurring in both forward and reverse directions are reversible. Reversible reactions can reach a state of equilibrium, where the reaction rates of both the forward and reverse reactions are constant. Le Chatelier's Principle indicates the qualitative prediction of direction of change with temperature, pressure, and concentration. ● Forces of attraction (intermolecular forces) between molecules determine their state of matter at a given temperature. Forces of attraction include hydrogen bonding, dipole-dipole attraction, and London dispersion (van der Waals) forces. ● Vapor pressure is the pressure of the vapor found directly above a liquid in a closed container. When the vapor pressure equals the atmospheric pressure, a liquid boils. Volatile liquids have high vapor pressures, weak intermolecular forces, and low boiling points. Nonvolatile liquids have low vapor pressures, strong intermolecular forces, and high boiling points. ● Solid, liquid, and gas phases of a substance have different energy content. Pressure, temperature, and volume changes can cause a change in physical state. Specific amounts of energy are absorbed or released during phase changes. ● A fourth phase of matter is plasma. Plasma is formed when a gas is heated to a temperature at which its electrons dissociate from the nuclei. ● A heating curve graphically describes the relationship between temperature and energy (heat). It can be used to identify a substance's phase of matter at a given temperature as well as the temperature(s) at ● which it changes phase. It also shows the strength of the intermolecular forces present in a substance. ● Molar heat of fusion is a property that describes the amount of energy needed to convert one mole of a substance between its solid and liquid states. Molar heat of vaporization is a property that describes the amount of energy needed to convert one mole of a substance between its liquid and gas states. Specific heat capacity is a property of a substance that tells the amount of energy needed to raise one gram of a substance by one degree Celsius. The values of these properties are related to the strength of their intermolecular forces. Essential Knowledge and Skills ● recognize that there is a natural tendency for systems to move in a direction of randomness (entropy). ● distinguish between an endothermic and exothermic process. ● interpret reaction rate diagrams. ● identify and explain the effect the following factors have on the rate of a chemical reaction: catalyst, temperature,

	concentration, size of particles. • distinguish between irreversible reactions and those at equilibrium. • predict the shift in equilibrium when a system is subjected to a stress (Le Chatelier's Principle) and identify the factors that can cause a shift in equilibrium (temperature, pressure, and concentration.) • identify how hydrogen bonding in water plays an important role in many physical, chemical, and biological phenomena. • interpret vapor pressure graphs. • graph and interpret a heating curve (temperature vs. time). • interpret a phase diagram of water. • calculate energy changes, using molar heat of fusion and molar heat of vaporization. • calculate energy changes, using specific heat capacity.
Essential Questions	What is the correlation between energy flow and chemical and physical changes? How do intermolecular forces affect energy changes? How is knowledge of Le Chatelier's Principle applied in industry?
Primary Resources	Text: World of Chemistry, Brooks/Cole, 2013. Chapters 10, 14, 17. PowerPoint to accompany World of Chemistry Laboratory Experiments, World of Chemistry, 2013. Activities at cavalcadepublishing.net Chemistry Tutorials yeahchemistry.com https://www.khanacademy.org/science/chemistry
Essential Vocabulary	intermolecular forces, energy changes, entropy, endothermic, exothermic, vapor pressure, phase change, heat of fusion, heat of vaporization, equilibrium, reversible reaction, hydrogen bonding, temperature, kinetic energy, vapor pressure curve, heating/cooling curve, phase diagram, specific heat

Marking Period: 3
Days: 16
Reporting Category/Strand: Solutions, Acids/Bases, Electrolytes, Gas Laws

SOL CH.4 c, d	**The student will investigate and understand that chemical quantities are based on molar relationships. Key concepts include:** **c) solution concentrations** **d) acid/base theory; strong electrolytes, weak electrolytes, and nonelectrolytes; dissociation and ionization; pH and pOH; and the titration process.**

SOL CH.5 a, b, g	**The student will investigate and understand that the phases of matter are explained by kinetic theory and forces of attraction between particles. Key concepts include:** **a) pressure, temperature, and volume;** **b) partial pressure and gas laws;** **c) vapor pressure;** **d) phase changes;** **e) molar heats of fusion and vaporization;** **f) specific heat capacity; and** **g) colligative properties.**
Essential Knowledge/Skills/Understanding	Essential Understandings ● Molarity = moles of solute/L of solution. ● [ ] refers to molar concentration. ● When solutions are diluted, the moles of solute present initially remain. ● The saturation of a solution is dependent on the amount of solute present in the solution. ● Solutions can be a variety of solute/solvent combinations: gas/gas, gas/liquid, liquid/liquid, solid/liquid, gas/solid, liquid/solid, or solid/solid. ● Polar substances dissolve ionic or polar substances; nonpolar substances dissolve nonpolar substances. The number of solute particles changes the freezing point and boiling point of a pure substance. ● A liquid's boiling point and freezing point are affected by changes in atmospheric pressure. A liquid's boiling point and freezing point are affected by the presence of certain solutes. ● Two important classes of compounds are acids and bases. Acids and bases are defined by several theories. According to the Arrhenius theory, acids are characterized by their sour taste, low pH, and the fact that they turn litmus paper red. According to the Arrhenius theory, bases are characterized by their bitter taste, slippery feel, high pH, and the fact that they turn litmus paper blue. According to the Bronsted-Lowry theory, acids are proton donors, whereas bases are proton acceptors. Acids and bases dissociate in varying degrees. ● Strong electrolytes dissociate completely. Weak electrolytes dissociate partially. Non-electrolytes do not dissociate. ● pH is a number scale ranging from 0 to 14 that represents the acidity of a solution. The pH number denotes hydrogen (hydronium) ion concentration. The pOH number denotes hydroxide ion concentration. The higher the hydronium [H_3O+] concentration, the lower the pH. ● pH + pOH = 14 ● Strong acid-strong base titration is the process that measures [H+] and [OH-]. ● Indicators show color changes at certain pH levels. ● The concepts developed in this standard include the following: ● Atoms and molecules are in constant motion.

	● The phase of a substance depends on temperature and pressure. ● Temperature is a measurement of the average kinetic energy in a sample. There is a direct relationship between temperature and average kinetic energy. ● The kinetic molecular theory is a model for predicting and explaining gas behavior. ● Gases have mass and occupy space. Gas particles are in constant, rapid, random motion and exert pressure as they collide with the walls of their containers. Gas molecules with the lightest mass travel fastest. Relatively large distances separate gas particles from each other. ● Equal volumes of gases at the same temperature and pressure contain an equal number of particles. Pressure units include atm, kPa, and mm Hg. ● An ideal gas does not exist, but this concept is used to model gas behavior. A real gas exists, has intermolecular forces and particle volume, and can change states. The Ideal Gas Law states that PV = nRT. ● The pressure and volume of a sample of a gas at constant temperature are inversely proportional to each other (Boyle's Law: $P_1V_1 = P_2V_2$). ● At constant pressure, the volume of a fixed amount of gas is directly proportional to its absolute temperature (Charles' Law: $V_1/T_1 = V_2/T_2$). ● The Combined Gas Law ($P_1V_1/ T_1=P_2V_2/T_2$) relates pressure, volume, and temperature of a gas. ● The sum of the partial pressures of all the components in a gas mixture is equal to the total pressure of a gas mixture (Dalton's law of partial pressures). <u>Essential Knowledge and Skills</u> ● perform calculations involving the molarity of a solution, including dilutions. ● interpret solubility curves. ● differentiate between the defining characteristics of the Arrhenius theory of acids and bases and the Bronsted-Lowry theory of acids and bases. ● identify common examples of acids and bases, including vinegar and ammonia. ● compare and contrast the differences between strong, weak, and non-electrolytes. ● relate the hydronium ion concentration to the pH scale. ● perform titrations in a laboratory setting using indicators. ● explain the behavior of gases and the relationship between pressure and volume (Boyle's Law), and volume and temperature (Charles' Law). ● solve problems and interpret graphs involving the gas laws.
Essential Questions	How does the mole concept apply to a solution? Distinguish between acids and bases, their strength, and concentration. What is Kinetic Molecular Theory and how does it apply to a gas? Explain the interrelationships, both numerically and graphically, of pressure, temperature, volume, and the number of moles of a gas.

Chemistry Curriculum Guide
Lunenburg County Public Schools
June 2014

Primary Resources	Text: World of Chemistry, Brooks/Cole, 2013. Chapters 13, 15, 16. PowerPoint to accompany World of Chemistry Laboratory Experiments, World of Chemistry, 2013. Activities at cavalcadepublishing.net Chemistry Tutorials yeahchemistry.com , https://www.khanacademy.org/science/chemistry
Essential Vocabulary	concentration, molarity, liter, pH, pOH, acid, base, titration, end point, equivalence point, gas, kinetic molecular theory, pressure, volume, molar volume, standard temperature and pressure, Boyle's Law, Charles' Law, Gay-Lussac's Law, Avogadro's Law, Combined Gas Law, Dalton's Law

Marking Period: 3
Days: 2
Reporting Category/Strand: Organic Chemistry

SOL CH.6 a, b	**The student will investigate and understand how basic chemical properties relate to organic chemistry and biochemistry. Key concepts include:** **a) unique properties of carbon that allow multi-carbon compounds; and** **b) uses in pharmaceuticals and genetics, petrochemicals, plastics and food.**
Essential Knowledge/Skills/Understanding	Essential Understandings ● It is expected that the content of this SOL is incorporated into the appropriate SOL as that content is being taught (i.e., bonding types, shapes, etc.) and not isolated as a discrete unit. ● The concepts developed in this standard include the following: ● The bonding characteristics of carbon contribute to its stability and allow it to be the foundation of organic molecules. These characteristics result in the formation of a large variety of structures such as DNA, RNA and amino acids. ● Carbon-based compounds include simple hydrocarbons, small carbon-containing molecules with functional groups, complex polymers, and biological molecules. ● Petrochemicals contain hydrocarbons, including propane, butane, and octane. ● There is a close relationship between the properties and structure of organic molecules. ● Common pharmaceuticals that are organic compounds include aspirin, vitamins, and insulin. ● Small molecules link to make large molecules called polymers that have combinations with repetitive subunits. Natural polymers include proteins and nucleic acids. Human-made (synthetic) polymers include polythene, nylon and Kevlar. Essential Knowledge and Skills ● describe how saturation affects shape and reactivity of carbon compounds. ● draw Lewis dot structures, identify geometries, and describe polarities of the following molecules: CH_4, C_2H_6, C_2H_4,

	C_2H_2, CH_3CH_2OH, CH_2O, C_6H_6, CH_3COOH. ● recognize that organic compounds play a role in natural and synthetic pharmaceuticals. ● recognize that nucleic acids and proteins are important natural polymers. ● recognize that plastics formed from petrochemicals are organic compounds that consist of long chains of carbons. ● conduct a lab that exemplifies the versatility and importance of organic compounds (e.g. aspirin, an ester, a polymer).
Essential Questions	Why are both natural and synthetic organic compounds important? How does saturation apply to organic compounds? How does the nomenclature for organic compounds differ from inorganic compounds?
Primary Resources	Text: World of Chemistry, Brooks/Cole, 2013. Chapters 20, 21. PowerPoint to accompany World of Chemistry Laboratory Experiments, World of Chemistry, 2013. Activities at cavalcadepublishing.net Chemistry Tutorials yeahchemistry.com , https://www.khanacademy.org/science/chemistry
Essential Vocabulary	organic, natural polymer, synthetic polymer, single bond, double bond, triple bond