SPRING GROVE AREA SCHOOL DISTRICT

PLANNED INSTRUCTION

Course Title:	**AP Chemistry**	**Length of Course:**	**30 cycles**
Grade Level(s):	**11, 12**	**Periods Per Cycle:**	**9**
Units of Credit:	**1.5**	**Length of Period:**	**43 minutes**
		Total Instructional Time:	**193.5 hours**

Course Description:

This rigorous college-level chemistry course is designed to prepare the student to succeed on the Advanced Placement Chemistry Examination. Course content will deal with intermediate to advanced concepts in chemistry. Analysis skills and higher order thinking are required for success in this class. ***Prerequisite: Successful completion of Chemistry I or Chemistry I Honors is required. 80 % in Chemistry I or 75% in Chemistry I Honors is recommended for success in the class.***

Materials/Resources:

Textbook: Chang Chemistry, 9th edition, ©2006

Adopted: 2010
Revised: 5/21/12

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Teacher: Core AP Chemistry
Year: 2011-2012
Course: AP Chemistry

AUGUST

Chemistry Basics - Chemistry I/IH Review/ Summer Assignment

Essential Questions	Content	Skills	Vocabulary	Standards
How does the modern theory of atomic structure help us to understand the formation of ionic and covalent compounds?	Atomic Theory	Identify characteristics of the modern atomic theory. Explain the relationship among atomic number, mass number, and isotopes of an element. Discuss evidence for the modern atomic theory.	atomic Theory mass number isotope molecule ion	3.1.10.B ~ Describe concepts of models as a way to predict and understand science and technology. 3.1.10.C ~ Apply patterns as repeated processes or recurring elements in science and technology. 3.1.10.E ~ Describe patterns of change in nature, physical and man made systems. 3.1.11.B ~ Apply concepts of models as a method to predict and understand science and technology. 3.1.11.C ~ Assess and apply patterns in science and technology. 3.1.11.E ~ Evaluate change in nature, physical systems and man-made systems. 3.2.10.A ~ Apply knowledge and understanding about the nature of scientific and technological knowledge. 3.2.10.C ~ Apply the elements of scientific inquiry to solve problems. 3.2.11.C ~ Apply the elements of scientific inquiry to solve multi-step problems. 3.4.10.A ~ Explain concepts about the structure and properties of matter. 3.4.10.D ~ Explain essential ideas about the composition and structure of the universe. 3.4.11.A ~ Apply concepts about the structure and properties of matter.

				3.4.11.B ~ Analyze energy sources and transfers of heat. 3.4.11.D ~ Explain essential ideas about the composition and structure of the universe. 3.8.11.C ~ Evaluate the consequences and impacts of scientific and technological solutions.
How is the periodic table used to analyze properties of matter in the study of Chemistry?	Periodic Table	Distinguish between groups and periods on the Periodic Table. List the names of the different groups on the Periodic Table. List various types of information that the Periodic Table may provide.	period group (family) metal nonmetal metalloid	
	Chemical Formulas	Distinguish among empirical, molecular, and structural formulas.	empirical formula molecular formula structural formula	
	Molecular and Ionic Compounds	Distinguish between molecular and ionic compounds.		
	Nomenclature	Name molecular and ionic compounds including acids. Name and write formulas for the first 10 straight	oxyacid binary acid alkane	

		chain alkanes.	molecular compound ionic compound polyatomic ion	

Matter and Measurement - Review from first year Chemistry course

Essential Questions	Content	Skills	Vocabulary	Standards
What are the properties of matter that are used to characterize and identify different types of matter and how are they measured?	Classification and Properties of Matter	Distinguish between elements, compounds, and mixtures. Distinguish between physical and chemical properties of a substance. Use physical properties to determine the identity of a substance.	physical property melting point chemical property freezing point heat of vaporization	3.1.10.D ~ Apply scale as a way of relating concepts and ideas to one another by some measure. 3.1.10.E ~ Describe patterns of change in nature, physical and man made systems. 3.1.11.C ~ Assess and apply patterns in science and technology. 3.1.11.E ~ Evaluate change in nature, physical systems and man-made systems. 3.2.10.A ~ Apply knowledge and understanding about the nature of scientific and technological knowledge. 3.2.10.B ~ Apply process knowledge and organize scientific and technological phenomena in varied ways. 3.2.10.C ~ Apply the elements of scientific inquiry to solve problems. 3.2.10.D ~ Identify and apply the technological design process to solve problems. 3.2.11.A ~ Evaluate the nature of scientific and technological knowledge. 3.2.11.C ~ Apply the elements of scientific inquiry to solve multi-step problems. 3.2.11.D ~ Analyze and use the technological design process to solve problems.

				3.4.11.A ~ Apply concepts about the structure and properties of matter. 3.4.11.B ~ Analyze energy sources and transfers of heat.
How are SI units used in measurement of chemical data?	Units of Measurement	Use the SI system (metric) base units and prefixes and other common chemistry units in solving problems. Differentiate between precision and accuracy. Apply rules for using significant figures in measurement and calculations.	accuracy significant figures instrumental precision	
How is dimensional analysis used in chemistry calculations?	Dimensional Analysis	Solve chemistry problems using dimensional analysis.	dimensional analysis	

Stoichiometry: Calculations with Chemical Formulas and Equations - Review from first-year Chemistry

Essential Questions	Content	Skills	Vocabulary	Standards
What information can be obtained from a chemical equation?	Chemical reactions and patterns of reactivity	Balance equations and identify reactions types.	synthesis reaction decomposition reaction metathesis reaction single displacement reaction combustion reaction neutralization reaction	3.1.10.C ~ Apply patterns as repeated processes or recurring elements in science and technology. 3.1.10.E ~ Describe patterns of change in nature, physical and man made systems. 3.1.12.B ~ Apply concepts of models as a method to predict and understand science and technology. 3.1.12.C ~ Assess and apply patterns in science and technology. 3.1.12.D ~ Analyze scale as a way of relating concepts

				and ideas to one another by some measure. 3.1.12.E ~ Evaluate change in nature, physical systems and man made systems. 3.2.10.A ~ Apply knowledge and understanding about the nature of scientific and technological knowledge. 3.4.10.A ~ Explain concepts about the structure and properties of matter. 3.4.12.A ~ Apply concepts about the structure and properties of matter. 3.4.12.B ~ Apply and analyze energy sources and conversions and their relationship to heat and temperature.
What information can be obtained from a chemical formula?	Mass mole atom calculations	Solve problems involving the mole concept.	Avogadro's number	
	Empirical and Molecular Formulas	Solve problems involving molecular and empirical formulas.	empirical formula molecular formula	
What quantitative information can we determine about a chemical reaction?	Reaction Stoichiometry Chemical reactions in sequence Limiting Reactants	Solve reaction stoichiometry problems involving limiting and excess reactants, reactions in sequence, and percent yield.	Stoichiometry limiting reactant excess reactant percent yield	
How do we collect and analyze data in the	Laboratory Experiments	Students will be able to follow appropriate laboratory procedures to	filtration	

chemistry laboratory? How can physical properties be utilized to accomplish separation of the components of a mixture?	Methods of separation of mixtures.	complete selected experiments. Describe the appropriate method for the separation of a mixture.	extraction chromatography crystallization distillation	

SEPTEMBER

Types of Chemical Reactions and Solution Stoichiom

Essential Questions	Content	Skills	Vocabulary	Standards
How does the nature of substances dissolved in water affect the various types of chemical reactions that occur in solution?	General Properties of Aqueous Solutions	Classify dissolved substances as strong electrolytes, weak electrolytes, or non-electrolytes.	strong electrolyte weak electrolyte nonelectrolyte	3.1.10.D ~ Apply scale as a way of relating concepts and ideas to one another by some measure. 3.1.10.E ~ Describe patterns of change in nature, physical and man made systems. 3.1.12.B ~ Apply concepts of models as a method to predict and understand science and technology. 3.1.12.C ~ Assess and apply patterns in science and technology. 3.1.12.E ~ Evaluate change in nature, physical systems and man made systems. 3.4.10.A ~ Explain concepts about the structure and properties of matter. 3.4.11.A ~ Apply concepts about the structure and properties of matter. 3.4.12.A ~ Apply concepts about the structure and properties of matter. 3.4.12.B ~ Apply and analyze energy sources and conversions and their relationship to heat and temperature.
	Precipitation Reactions	Classify common ionic compounds as soluble or	soluble	

		insoluble. Predict the insoluble product of two ionic reactants. Write net ionic equations for metathesis reactions.	precipitate spectator ion metathesis reaction net ionic equation insoluble	
	Acid-Base Reactions	Identify common strong acids and bases. Write the balanced chemical and net ionic equation for neutralization reactions. Predict products of an acid-base reaction with gas formation.	strong acid neutralization reaction weak acid strong base weak base	
	Single Replacement Reactions	Use the activity series to predict the products of a single replacement reaction.	activity series single replacement reaction	
How do we quantify the concentration of solute in a solution?	Concentrations of Solutions	Calculate the concentration of solutions in terms of molarity. Describe solution preparation using a solid solute.	solute solvent molarity stock solution	

		Describe solution preparation by diluting a concentrated stock solution. Prepare solutions of specified concentrations by dissolving a solid and diluting a concentrated stock solution.	volumetric flask quantitative transfer	
How do we apply concepts of stoichiometry and solution concentration to reactions in aqueous solution?	Solution Stoichiometry	Solve solution stoichiometry problems using the concept of molarity. Apply solution stoichiometry concepts and calculations to the process of titration. Explain the difference between equivalence point and end point of a titration. Standardize a solution by performing acid base titration. Determine the percent purity of an acid salt using acid base titration.	titration end point equivalence point visual indicator solution standardization	
	Oxidation-Reduction Reactions	Assign oxidation numbers to elements in a compound or ion. Identify an oxidation-	oxidation reduction	

		reduction reaction. Identify the oxidizing and reducing agents in a redox reaction. Balance redox equations in acid and base and write molecular and net ionic equations for these reactions. Predict the products of common redox reactions. Determine the percent of iron in an unknown sample using redox titration.	oxidizing agent disproportionation reaction reducing agent	

Stoichiometry

Essential Questions	Content	Skills	Vocabulary	Standards
What information can be obtained from a chemical equation?	Chemical reactions and patterns of reactivity	Balance equations and identify reactions types.	synthesis reaction decomposition reaction combustion reaction	3.1.10.C ~ Apply patterns as repeated processes or recurring elements in science and technology. 3.1.10.E ~ Describe patterns of change in nature, physical and man made systems. 3.1.12.B ~ Apply concepts of models as a method to predict and understand science and technology. 3.1.12.C ~ Assess and apply patterns in science and technology. 3.1.12.D ~ Analyze scale as a way of relating concepts and ideas to one another by some measure. 3.1.12.E ~ Evaluate change in nature, physical systems and man made systems. 3.2.10.A ~ Apply knowledge and understanding about the

					nature of scientific and technological knowledge. 3.4.10.A ~ Explain concepts about the structure and properties of matter. 3.4.12.A ~ Apply concepts about the structure and properties of matter. 3.4.12.B ~ Apply and analyze energy sources and conversions and their relationship to heat and temperature.
OCTOBER	**Gases**				
	Essential Questions	**Content**	**Skills**	**Vocabulary**	**Standards**
	How does the kinetic molecular theory describe the behavior of gases?	Characteristics of Gases	Compare physical properties of gases to liquid and solid states. Describe how pressure can be measured with a manometer and a barometer. Convert between various units of pressure.	kinetic molecular theory of gases	3.1.10.B ~ Describe concepts of models as a way to predict and understand science and technology. 3.1.11.B ~ Apply concepts of models as a method to predict and understand science and technology. 3.1.11.E ~ Evaluate change in nature, physical systems and man-made systems. 3.1.12.A ~ Apply concepts of systems, subsystems, feedback and control to solve complex technological problems. 3.1.12.B ~ Apply concepts of models as a method to predict and understand science and technology. 3.1.12.C ~ Assess and apply patterns in science and technology. 3.1.12.E ~ Evaluate change in nature, physical systems and man made systems. 3.2.10.A ~ Apply knowledge and understanding about the nature of scientific and technological knowledge. 3.2.12.A ~ Evaluate the nature of scientific and technological knowledge.

				3.2.12.B ~ Evaluate experimental information for appropriateness and adherence to relevant science processes. 3.2.12.C ~ Apply the elements of scientific inquiry to solve multi-step problems. 3.4.10.A ~ Explain concepts about the structure and properties of matter. 3.4.12.A ~ Apply concepts about the structure and properties of matter. 3.4.12.B ~ Apply and analyze energy sources and conversions and their relationship to heat and temperature. 3.7.11.B ~ Evaluate appropriate instruments and apparatus to accurately measure materials and processes.
	The Gas Laws	Solve problems using Boyle's Law, Charles' Law, and Avogadro's Law.	Boyle's Law Charles' Law Avogadro's Law	
	The Ideal Gas Equation	Solve problems using the ideal gas equation. Calculate gas densities and the standard molar mass volume using the ideal gas equation.	Ideal Gas Law	
	Gas Mixtures and Partial Pressures	Describe the behavior of gases in a mixture and apply Dalton's Law of Partial Pressures to	Dalton's Law	

		solve problems. Calculate mole fractions in a mixture of gases and describe the relationship between mole fractions and partial pressures of gases. Use Dalton's Law of Partial Pressure to determine the pressure of a gas collected over water.		
	Kinetic-Molecular Theory	Summarize the basic concepts of the kinetic-molecular theory.		
	Effusion and Diffusion	Explain the effect of molar mass on molecular speeds. Calculate the rms (root mean square speed) of a molecule at a specified temperature. Use Graham's Law to relate relative velocity and effusion/ diffusion rates to molar mass of gases.	Effusion Diffusion Graham's Law	
	Real Gases: Deviations from Ideal Behavior	Explain the conditions in which the behavior of a real gas approaches ideal behavior. List two reasons why real gases deviate from ideal behavior.	van Der Waals equation ideal gas real gas	

		Apply the van Der Waals equation.		

Electrochemistry

Essential Questions	Content	Skills	Vocabulary	Standards
How is chemical potential related to electrical energy?	Voltaic Cells	Utilize common terms used in the study of electrochemistry. Examine voltaic cells using the zinc/copper cell and other simple salt bridge cells. Determine cell voltages using standard potentials. Use standard reduction potentials to determine the spontaneity of chemical reactions and the relative strengths of oxidizing and reducing agents.	voltaic cell electrochemical cell galvanic cell electrolytic cell anode cathode salt bridge table of standard reduction potential	3.1.12.B ~ Apply concepts of models as a method to predict and understand science and technology. 3.1.12.C ~ Assess and apply patterns in science and technology. 3.1.12.D ~ Analyze scale as a way of relating concepts and ideas to one another by some measure. 3.1.12.E ~ Evaluate change in nature, physical systems and man made systems. 3.4.12.A ~ Apply concepts about the structure and properties of matter. 3.4.12.B ~ Apply and analyze energy sources and conversions and their relationship to heat and temperature. 3.4.12.D ~ Analyze the essential ideas about the composition and structure of the universe.
What causes an electrochemical reaction to occur spontaneously?	Free Energy and Redox Reactions	Use the Nernst equation to solve problems in electrochemical spontaneity.	Gibbs free energy	
	Cell EMF Under Nonstandard Conditions	Calculate the EMF of a voltaic cell under nonstandard conditions.	Electromotive Force	

	Electrolysis	Using periodic trends in ionization energy and electron affinity, and a table of standard reduction potentials, predict the products of electrolysis of molten or aqueous salts. Define Faraday's constant and use it in stoichiometry of electrolysis calculations.	overvoltage Faraday's Constant Coulomb Ampere Watt Kilowatt-hour	

NOVEMBER

Chemical Periodicity - This content will be reviewed by the student independently over the Thanksgiving Vacation.

Essential Questions	Content	Skills	Vocabulary	Standards
How is the chemical periodicity of the elements reflected in the organization of the Periodic Table?	Development of the Periodic Table	Summarize the development of the Periodic Table.	Periodic Table	3.1.10.B ~ Describe concepts of models as a way to predict and understand science and technology. 3.1.10.C ~ Apply patterns as repeated processes or recurring elements in science and technology. 3.1.10.E ~ Describe patterns of change in nature, physical and man made systems. 3.1.11.C ~ Assess and apply patterns in science and technology. 3.1.11.E ~ Evaluate change in nature, physical systems and man-made systems. 3.1.12.B ~ Apply concepts of models as a method to predict and understand science and technology. 3.1.12.C ~ Assess and apply patterns in science and technology. 3.1.12.E ~ Evaluate change in nature, physical systems and man made systems.

				3.2.10.A ~ Apply knowledge and understanding about the nature of scientific and technological knowledge. 3.3.12.A ~ Explain the relationship between structure and function at all levels of organization. 3.4.10.A ~ Explain concepts about the structure and properties of matter. 3.4.10.D ~ Explain essential ideas about the composition and structure of the universe. 3.4.11.A ~ Apply concepts about the structure and properties of matter. 3.4.11.D ~ Explain essential ideas about the composition and structure of the universe. 3.4.12.D ~ Analyze the essential ideas about the composition and structure of the universe.
	Periodic Trends in atomic and ionic radii	Explain the meaning of effective nuclear charge. Describe the trends in atomic radii for the representative elements for vertical groups and horizontal periods. Describe the periodic trends in ionic radii for the representative elements.	effective nuclear charge atomic and ionic radius isoelectronic	
	Periodic Trends in Ionization Energies and Electron Affinities	Explain the variations in successive ionization energies for sodium through argon. Describe and explain the	ionization energy electronegativity	

		periodic trends in first ionization energies. Explain the meaning of electron affinity. Describe the periodic trends in electron affinities.	electron affinity	
	Group Trends for Selected Families on the Periodic Table	Describe the characteristic properties of the alkali metals, the alkaline earth metals, the halogens, and the noble gases.	active metal chemical reactivity solubility	

Concepts of Chemical Bonding - This content will be reviewed by the student independently over the Thanksgiving Vacation.

Essential Questions	Content	Skills	Vocabulary	Standards
What determines the type of bonding in each substance and how do the characteristics of these bonds give rise to different physical and chemical properties?	Chemical Bonds, Lewis Symbols and the Octet Rule	Distinguish between ionic and covalent bonds and describe metallic bonds. Draw Lewis symbols for any element. Describe the octet rule.	polar covalent rule of octet ionic bond covalent bond coordinate covalent bond nonpolar covalent bond	3.1.12.C ~ Assess and apply patterns in science and technology. 3.3.12.A ~ Explain the relationship between structure and function at all levels of organization. 3.4.12.A ~ Apply concepts about the structure and properties of matter.

	Ionic and Covalent Bonding	Describe the electron transfers that occur in the formation of an ionic bond. Describe lattice energy and the factors that affect its magnitude. Arrange ionic compounds in order of increasing or decreasing lattice energy. Calculate the lattice energy of an ionic compound using the Born-Haber cycle. Describe covalent bonding in terms of the attractive and repulsive forces among electrons and nuclei of two hydrogen atoms to form hydrogen gas. Draw Lewis structures for simple covalent compounds including those with double and triple bonds.	lattice energy Born Haber cycle	
	Bond Polarity and Electronegativity	Based on electronegativity trends, predict whether bonding between two specific elements will be primarily ionic, covalent or polar covalent.		

	Drawing Lewis Structures including Resonance	Draw Lewis structures for compounds and polyatomic ions with single or multiple bonds. Calculate formal charge on any atom in a Lewis structure. Based on formal charge, decide which of several possible Lewis structures for a substance would be the preferred one. Describe the concept of resonance and draw appropriate resonance structures.	formal charge resonance sigma bonds pi bonds	
	Exceptions to the Octet Rule	Name, describe, and give examples of the three main types of exceptions to the octet rule. Draw Lewis structures for substances that are exceptions to the octet rule.	electron deficient compounds expanded valence shell odd number of valence electrons	

Electronic Structure of Atoms - This content will be reviewed by the students over the Thanksgiving Vacation.

Essential Questions	Content	Skills	Vocabulary	Standards
How are the interactions of light and matter related to electron arrangement in atoms?	The Wave Nature of Light	Describe the wave properties of light and how wavelength, frequency and speed of light are related.	electromagnetic Spectrum frequency	3.1.10.C ~ Apply patterns as repeated processes or recurring elements in science and technology. 3.1.10.D ~ Apply scale as a way of relating concepts and ideas to one another by some measure.

		Describe the regions of the electromagnetic spectrum.	wavelength amplitude velocity of electromagnetic radiation electromagnetic radiation	3.1.12.B ~ Apply concepts of models as a method to predict and understand science and technology. 3.1.12.C ~ Assess and apply patterns in science and technology. 3.1.12.E ~ Evaluate change in nature, physical systems and man made systems. 3.4.12.A ~ Apply concepts about the structure and properties of matter. 3.4.12.B ~ Apply and analyze energy sources and conversions and their relationship to heat and temperature.
	Quantized Energy and Photons	Explain the photoelectric effect and the dual nature of light. Calculate the energy of a photon of light knowing its wavelength and vice versa.	quanta quantized energy photons	
	Line Spectra and the Bohr Model	Relate the line spectra of elements to the energy states of an atom. Recognize the Rydberg equation and explain its use.	line spectra excited states	
	Wave Behavior of Matter	Explain the meaning of the Heisenberg Uncertainty Principle.	dual wave-particle nature of the electron	

	Quantum Mechanics and Atomic Orbitals	Describe the main features of the quantum mechanical model of the atom. Describe the four quantum numbers of an electron and the possible combinations of their values for specific atomic orbitals. Describe the three dimensional shape of the s and p orbitals and the maximum number of orbitals in each of the four subshells. Describe the Pauli Exclusion Principle and how it relates to atomic orbitals.	orbitals principle quantum number Aufbau Principle Pauli exclusion principle Hund's rule	
How do we notate the arrangement of electrons in an atom?	Electron Configurations and the Periodic Table	Write electron configurations for the elements and ions using the Aufbau Principle, Hund's Rule, and the Pauli Exclusion Principle. Draw orbital diagrams for electron configurations. Write electron configurations using the short-hand noble gas method. State the characteristic valence electron configuration of the eight representative element groups on the periodic	orbital diagram notation valence electron core electron	

		table.		
How do the electron arrangements in atoms cause the magnetic properties of the element?	Electron configuration and magnetic properties	Predict the magnetism of ions (paramagnetic or diamagnetic) using electron configurations.	paramagnetic diamagnetic ferromagnetic	

Molecular Geometries and Bonding Theories

Essential Questions	Content	Skills	Vocabulary	Standards
How does the VSEPR theory predict the geometry of a molecule?	Molecular Shapes and the VSEPR Theory	Describe the VSEPR Theory. Use the VSEPR model to predict the electronic and molecular geometries of molecules and ions. Use the VSEPR model to predict the molecular geometry of molecules with expanded valence shells.	VSEPR Theory molecular shape: linear molecular shape: trigonal bipyramidal electron Group molecular shape: trigonal planar molecular shape: tetrahedral molecular shape: bent Molecular shapes: trigonal pyramidal molecular shape: square planar molecular shape: square planar molecular shape:	3.1.10.B ~ Describe concepts of models as a way to predict and understand science and technology. 3.1.10.C ~ Apply patterns as repeated processes or recurring elements in science and technology. 3.1.10.D ~ Apply scale as a way of relating concepts and ideas to one another by some measure. 3.1.12.C ~ Assess and apply patterns in science and technology. 3.1.12.D ~ Analyze scale as a way of relating concepts and ideas to one another by some measure. 3.4.10.A ~ Explain concepts about the structure and properties of matter. 3.4.12.A ~ Apply concepts about the structure and properties of matter.

			octahedral molecular shape:square planar ideal bond angle actual bond angle	
	Molecular Shape and Molecular Polarity	Predict whether a molecule is polar or nonpolar based upon its overall dipole moment.	dipole moment polarity	
	Covalent Bonding and Hybrid Orbitals	Describe the hybridization of the s, p, and d, orbitals and predict when hybridization will occur.	hybridization	
	Multiple Bonds	Describe and distinguish between sigma and pi bonds. Describe how the bonds in selected molecules are formed in terms of overlaps of appropriate hybridized and unhybridized orbitals.	sigma bonding pi bonding	

Thermochemistry

Essential Questions	Content	Skills	Vocabulary	Standards
What are the energy transformations that occur in chemical and physical processes?	The Nature of Energy	Use appropriate units for energy and differentiate between system and surroundings.	energy	3.1.12.B ~ Apply concepts of models as a method to predict and understand science and technology. 3.1.12.D ~ Analyze scale as a way of relating concepts

		Differentiate between heat and work.	system surroundings heat work	and ideas to one another by some measure. 3.4.12.B ~ Apply and analyze energy sources and conversions and their relationship to heat and temperature.
	First Law of Thermodynamics	Relate changes in energy to heat and work. Explain and use the concept of state functions. Explain the difference between endothermic and exothermic reactions.	state function endothermic exothermic	
	Enthalpy	Define Enthalpy and use it to calculate the heat transfer in a process.	enthalpy internal energy	
	Enthalpies of Reaction	Write thermochemical equations and draw or interpret enthalpy diagrams.	thermochemical equation enthalpy diagram	
	Calorimetry	Solve calorimetry problems relating heat, temperature change, and heat capacity or specific heat. Calculate ΔH using	calorimetry heat capacity	

		coffee-cup calorimeter data. Calculate heat of reaction (q_{rxn}) using bomb calorimeter data.	specific heat coffee cup calorimetry bomb calorimetry	
	Hess's Law	Use Hess's Law to calculate ΔH for a reaction by indirect method.	Hess's Law of heat summation	
	Enthalpies of Formation	Explain the meaning of standard enthalpy of formation, and write formation reactions. Calculate the standard enthalpy of a reaction using a table of standard enthalpies of formation. Use a coffee-cup calorimeter to measure the heat change in a chemical reaction.	standard molar enthalpy of formation formation reaction	
	Expansion Work Bond Enthalpy	Calculate the expansion work of a chemical reaction involving gases. Use bond enthalpies to estimate the enthalpy of a reaction.	expansion expansion work bond enthalpy contraction	

DECEMBER

Chemical Thermodynamics

Essential Questions	Content	Skills	Vocabulary	Standards
What is the relationship between energy and the extent of a chemical reaction?	Spontaneous Processes	Predict whether a chemical process will be spontaneous given appropriate data. Describe the difference between a reactant-favored (nonspontaneous) reaction and a product-favored (spontaneous) reaction. Describe the difference between a reversible and a nonreversible process. Relate ΔG to a phase change at equilibrium. Calculate free energy change under non-standard conditions.	spontaneous nonspontaneous reversible nonreversible	3.1.12.B ~ Apply concepts of models as a method to predict and understand science and technology. 3.1.12.C ~ Assess and apply patterns in science and technology. 3.1.12.D ~ Analyze scale as a way of relating concepts and ideas to one another by some measure. 3.1.12.E ~ Evaluate change in nature, physical systems and man made systems. 3.4.12.A ~ Apply concepts about the structure and properties of matter. 3.4.12.B ~ Apply and analyze energy sources and conversions and their relationship to heat and temperature. 3.4.12.D ~ Analyze the essential ideas about the composition and structure of the universe.
	Entropy and the Second and Third Law of Thermodynamics	Understand the relationship of entropy to the dispersal of energy and dispersal of matter (disorder) in a system. Distinguish between a state function and a path function. Calculate ΔS for a phase change given appropriate data.	entropy standard molar entropy of formation disorder randomness	

		Explain the second law of thermodynamics. Predict the sign of ΔS for chemical reactions at constant temperature given appropriate data.		
	Gibbs Free Energy	Describe the terms in the Gibbs Helmholtz equation. Explain the meaning of the sign of ΔG in terms of spontaneity of a chemical reaction. Calculate the standard free energy change for a reaction from tabulated values of free energies of formation.	Gibbs free energy Gibbs - Helmholtz equation free energy of formation	
	Gibbs Free Energy, Temperature, and the Equilibrium Constant	Describe how temperature changes can affect the spontaneity of a reaction.		

Molecular Geometries and Bonding Theories - This content will be reviewed by the individual student over the December holiday vacation.

Essential Questions	Content	Skills	Vocabulary	Standards
How does the VSEPR theory predict the geometry of a molecule?	Molecular Shapes and the VSEPR Theory	Describe the VSEPR Theory. Use the VSEPR model	VSEPR Theory molecular shape: linear	3.1.10.B ~ Describe concepts of models as a way to predict and understand science and technology. 3.1.10.C ~ Apply patterns as repeated processes or recurring elements in science and technology.

			to predict the electronic and molecular geometries of molecules and ions. Use the VSEPR model to predict the molecular geometry of molecules with expanded valence shells.	molecular shape: trigonal bipyramidal electron Group	3.1.10.D ~ Apply scale as a way of relating concepts and ideas to one another by some measure. 3.1.12.C ~ Assess and apply patterns in science and technology. 3.1.12.D ~ Analyze scale as a way of relating concepts and ideas to one another by some measure. 3.4.10.A ~ Explain concepts about the structure and properties of matter. 3.4.12.A ~ Apply concepts about the structure and properties of matter.

JANUARY

Chemical Equilibrium

Essential Questions	Content	Skills	Vocabulary	Standards
How does an understanding of the concept of equilibrium enable chemical reactions to be controlled?	The Concept of Equilibrium	Explain the concept of dynamic equilibrium as it applies to a chemical or physical reaction.	dynamic equilibrium homogeneous equilibria heterogeneous equilibria	3.1.10.A ~ Discriminate among the concepts of systems, subsystems, feedback and control in solving technological problems. 3.1.10.B ~ Describe concepts of models as a way to predict and understand science and technology. 3.1.10.C ~ Apply patterns as repeated processes or recurring elements in science and technology. 3.1.10.D ~ Apply scale as a way of relating concepts and ideas to one another by some measure. 3.1.10.E ~ Describe patterns of change in nature, physical and man made systems. 3.2.10.A ~ Apply knowledge and understanding about the nature of scientific and technological knowledge. 3.2.10.B ~ Apply process knowledge and organize scientific and technological phenomena in varied ways. 3.2.10.C ~ Apply the elements of scientific inquiry to solve problems.

				3.2.10.D ~ Identify and apply the technological design process to solve problems. 3.7.10.C ~ Apply basic computer operations and concepts. 3.7.10.D ~ Utilize computer software to solve specific problems.
	The Equilibrium Constant	Explain what the equilibrium constant expression is and what information the equilibrium constant provides. Write an equilibrium constant expression for any reaction at equilibrium.(K_c) Write an equilibrium constant expression in terms of pressure. (K_p) Convert between K_c and K_p. Interpret the magnitude of an equilibrium constant. Evaluate an equilibrium constant when an equation is reversed. Determine the value of the equilibrium constant given appropriate data. Distinguish between heterogeneous and homogeneous equilibria. Distinguish between an equilibrium constant (K)	equilibrium constant, Kp law of mass action reaction Quotient, Q equilibrium constant, Kc	

		and a reaction quotient (Q). Calculate K when all equilibrium concentrations are known. Calculate K from initial and equilibrium concentrations. Predict the direction of approach to equilibrium by comparing K and Q. Calculate equilibrium concentrations given appropriate data. Calculate equilibrium concentrations from initial concentrations.		
	Le Châtelier's Principle	Apply Le Châtlier's Principle when reactant or product concentrations change in a system at equilibrium. Apply Le Chatelier's Principle when volume and pressure changes occur to a system at equilibrium. Determine the effect of temperature changes on endothermic and exothermic reactions at equilibrium by applying Le Châtelier's Principle. Predict the effect of	LeChâtlier's Principle catalyst	

		temperature on K. Explain why adding a catalyst does not change the composition of an equilibrium mixture.		

Chemical Kinetics

Essential Questions	Content	Skills	Vocabulary	Standards
How are the rates of chemical reactions affected by various factors and why is this important to the overall understanding of these reactions?	Reaction Rates and the Factors That Affect Them	Describe the four main variables that affect reaction rates. Calculate an average rate of reaction over a time interval given concentration changes over that time interval. Calculate an instantaneous rate of reaction given appropriate data. Relate the rates at which products appear and reactants disappear given appropriate data. Determine the order of a reaction from the rate law and determine the units for the rate constant. Determine the rate law for a reaction given initial rates.	kinetics average rate rate constant rate law method of initial rates reaction rate instantaneous rate initial rate reaction order	3.1.10.A ~ Discriminate among the concepts of systems, subsystems, feedback and control in solving technological problems. 3.1.10.B ~ Describe concepts of models as a way to predict and understand science and technology. 3.1.10.C ~ Apply patterns as repeated processes or recurring elements in science and technology. 3.1.10.D ~ Apply scale as a way of relating concepts and ideas to one another by some measure. 3.1.10.E ~ Describe patterns of change in nature, physical and man made systems. 3.2.10.A ~ Apply knowledge and understanding about the nature of scientific and technological knowledge. 3.2.10.B ~ Apply process knowledge and organize scientific and technological phenomena in varied ways. 3.2.10.C ~ Apply the elements of scientific inquiry to solve problems. 3.2.10.D ~ Identify and apply the technological design process to solve problems. 3.4.10.A ~ Explain concepts about the structure and properties of matter. 3.4.10.B ~ Analyze energy sources and transfers of heat.

				3.4.10.D ~ Explain essential ideas about the composition and structure of the universe. 3.7.10.B ~ Apply appropriate instruments and apparatus to examine a variety of objects and processes.
	The Change of Concentration with Time	Analyze concentration vs time data to determine the order of a reaction. Compare and contrast zero, first, and second order reactions. Use the integrated first-order rate law to solve kinetics problems. Determine reaction order from the integrated rate law. Determine half-life from first order reaction data. Calculate appropriate units for the rate constant for different reaction orders.	First order integrated rate law half life Second order integrated rate law Zeroth order integrated rate law	
	Temperature and Rate of Reaction	Describe the effect that temperature generally has on reaction rate. Describe the collision model of reaction rates and describe how this accounts for both temperature and concentration factors effecting reaction rates. Explain what is meant by the orientation factor in	Arrhenius Equation activation Energy frequency factor collision orientation factor	

		the collision model of reaction rates. Interpret energy profiles in the form of diagrams to activation energy and speeds of reactions. Explain the three factors affecting reaction rate included in the Arrhenius equation. Determine activation energy and the value of the rate constant at a particular temperature given appropriate data. Describe the main aspects of transition state theory and the role of activation energy in determining the rate of a reaction.	transition State reaction energy diagram	
	Reaction Mechanisms	Given a mechanism, describe the molecularity of each elementary reaction in the mechanism, write the equation for the overall reaction, and identify the intermediates. Predict the rate law for an elementary reaction. Determine the rate law for a multistep reaction.	molecularity Reaction intermediate reaction mechanism	
	Catalysis	Explain the difference between homogeneous	heterogeneous catalyst	

		and heterogeneous catalysts. Interpret a graphical summary of the energy profiles for uncatalyzed and catalyzed reactions. Explain how a catalyst works.	homogeneous catalyst	

FEBRUARY

Acid Base Equilibrium

Essential Questions	Content	Skills	Vocabulary	Standards
How do aspects of equilibrium apply to solutions with acidic or basic characteristics?	Arrhenius and Bronsted-Lowry Acid Base Theories Strong and Weak Acid and Base pH scale and autoionization of water Weak acid, weak base, and polyprotic acid equilibria calculations Molecular properties and acid strength Acid Base properties of salt solutions	Analyze the Arrhenius, Bronsted-Lowry and Lewis models of acids and bases. Identify and describe the behavior of strong and weak acids and bases. Use Kw, the ion product constant for water, to determine the hydrogen and hydroxide ion concentrations in strong acids and bases. Use the Ka, and Kw to calculate the hydrogen and Hydroxide ion concentration in weak acids and bases.	Arrhenius Acid and Base autoionization of water conjugate acid strong acid Bronsted-Lowry Acid and Base Lewis Acid and Base pH scale conjugate base strong base weak acid weak base	3.1.12.B ~ Apply concepts of models as a method to predict and understand science and technology. 3.1.12.C ~ Assess and apply patterns in science and technology. 3.1.12.D ~ Analyze scale as a way of relating concepts and ideas to one another by some measure. 3.1.12.E ~ Evaluate change in nature, physical systems and man made systems. 3.4.12.A ~ Apply concepts about the structure and properties of matter. 3.4.12.B ~ Apply and analyze energy sources and conversions and their relationship to heat and temperature.

		Calculate the Ka of a weak acid given concentration data or vice versa. Deduce the expression for the base dissociation constant, Kb, for various bases. Calculate the Kb given concentration data or vice versa. Utilize Ka and Kb to determine the percent dissociation of weak acids and bases. Examine the relationships between Kw, Ka, Kb, pH, pOH and equilibrium concentrations. Create and analyze a titration curve.	ion product constant, Kw pH pOH Ka Kb	

Additional Aspects of Aqueous Equilibria

Essential Questions	Content	Skills	Vocabulary	Standards
How do concepts of equilibrium apply to aqueous ionic systems?	The Common-Ion Effect	Describe the common ion effect.	common ion effect	3.1.12.A ~ Apply concepts of systems, subsystems, feedback and control to solve complex technological problems. 3.1.12.B ~ Apply concepts of models as a method to predict and understand science and technology.

				3.1.12.C ~ Assess and apply patterns in science and technology. 3.1.12.E ~ Evaluate change in nature, physical systems and man made systems. 3.2.12.A ~ Evaluate the nature of scientific and technological knowledge. 3.2.12.B ~ Evaluate experimental information for appropriateness and adherence to relevant science processes. 3.4.12.A ~ Apply concepts about the structure and properties of matter. 3.4.12.D ~ Analyze the essential ideas about the composition and structure of the universe.
	Buffers	Describe using chemical reactions, how a buffer works to control the pH of a solution within a narrow range. Calculate pH changes in buffers when acids or bases are added. Describe the preparation of a buffer solution.	buffer buffer capacity buffer component ratio	
	Acid-Base Titrations	Identify the graphical representation of pH titration curves: strong acid/strong base, weak acid/strong base, or strong acid/weak base. Calculate the pH at the equivalence point for an acid-base titration of any	equivalence point half equivalence point acid base visual indicator acid base titration	

		type given the appropriate data. Identify the equivalence point and the half equivalence point on any acid-base titration curve. Calculate the pH of solution during any point in an acid base titration.		
	Solubility Equilibria	Write solubility product (Ksp) expressions for ionic solids. Calculate solubility from K_{sp} and K_{sp} from solubility data. Use the Ksp to calculate the molar solubility of an insoluble salt.	soluble solubility product constant, Ksp molar solubility insoluble partly soluble	
	Factors That Affect Solubility	Calculate the effect of a common ion on solubility. Predict the effect of acid on solubility. Describe the formation of a complex ion. Describe amphoterism.	common ion formation reaction amphoteric complex ion formation constant, Kf	
	Precipitation and Separation of Ions	Predict whether a precipitate will form when two salt solutions	selective precipitation qualitative analysis	

		are combined. Explain what is meant by selective precipitation of ions. Calculate the ion concentrations necessary for precipitation, given appropriate data.		
	Qualitative Analysis for Cations and Anions	Interpret a flowchart showing the separation of cations into groups as part of a common scheme for identifying cations.		

MARCH

Properties of Solutions

Essential Questions	Content	Skills	Vocabulary	Standards
Why do solutions play such an important role in the study of chemical reactions?	The Solution Process	Describe the dissolution of an ionic solid in water. Describe the energy changes in solution formation. Explain the relationship between spontaneity and disorder in solution formation.	solute solvent dissolution solution	3.1.12.A ~ Apply concepts of systems, subsystems, feedback and control to solve complex technological problems. 3.1.12.B ~ Apply concepts of models as a method to predict and understand science and technology. 3.1.12.C ~ Assess and apply patterns in science and technology. 3.1.12.E ~ Evaluate change in nature, physical systems and man made systems. 3.2.12.A ~ Evaluate the nature of scientific and technological knowledge. 3.2.12.C ~ Apply the elements of scientific inquiry to solve multi-step problems.

				3.2.12.D ~ Analyze and use the technological design process to solve problems. 3.4.12.A ~ Apply concepts about the structure and properties of matter. 3.4.12.D ~ Analyze the essential ideas about the composition and structure of the universe.
What are the factors that affect the dissolving process of a solute in a solvent?	Factors Affecting Solubility	Describe solute-solvent interactions that lead to the "like dissolves like" generalization. Describe the relationship between solubility and pressure as expressed by Henry's Law. Describe the effect of temperature changes on solubility of substances. Know the basic solubility rules and the major exceptions to each.	Henry's Law	
	Expressing Concentration	Define each concentration unit and describe the relationship among molarity, molality, per cent composition, and mole fraction. Interconvert among the different concentration units given appropriate data. Solve problems involving each of the major concentration units.	molarity molality % solute by mass mole fraction	

	Colligative Properties Beer's Law	Describe the relationship between vapor pressure and concentration of a nonvolatile solute as expressed by Raoult's Law. Calculate vapor pressure of a solution according to Raoult's Law given appropriate data. Calculate boiling point elevation and freezing point lowering using molal boiling point elevation and freezing point depression constants. Calculate osmotic pressure of a solution given appropriate data. Calculate molar mass of a compound based on its osmotic pressure and other appropriate data. Use Beer's Law and spectrophometry to determine the concentration of a colored solution by measuring its absorbance.	vapor pressure volatile solute colligative properties spectrophotometry Raoult's Law nonvolatile solute boiling point elevation freezing point depression osmotic pressure absorbance transmittance molar absorptivity Beer's Law	

Additional Aspects of Aqueous Equilibria

Essential Questions	Content	Skills	Vocabulary	Standards
How do concepts of equilibrium apply to aqueous ionic	The Common-Ion Effect	Describe the common ion effect.	common ion effect	3.1.12.A ~ Apply concepts of systems, subsystems, feedback and control to solve complex technological problems.

systems?		Calculate the pH of a solution when a common ion is involved given appropriate data. Calculate ion concentrations when a common ion is involved.		3.1.12.B ~ Apply concepts of models as a method to predict and understand science and technology. 3.1.12.C ~ Assess and apply patterns in science and technology. 3.1.12.E ~ Evaluate change in nature, physical systems and man made systems. 3.2.12.A ~ Evaluate the nature of scientific and technological knowledge. 3.2.12.B ~ Evaluate experimental information for appropriateness and adherence to relevant science processes. 3.4.12.A ~ Apply concepts about the structure and properties of matter. 3.4.12.D ~ Analyze the essential ideas about the composition and structure of the universe.

APRIL

Intermolecular Forces, Liquids and Solids

Essential Questions	Content	Skills	Vocabulary	Standards
What role do intermolecular forces play in the composition and structure of molecules?	A Molecular Comparison of Gases, Liquids, and Solids Based Upon Intermolecular Forces	Describe on a molecular level as well as a macroscopic level the differences among the three states of matter. Describe and compare the strength of the various types of intermolecular forces including ion-dipole, dipole-dipole, London dispersion, and hydrogen bonding. List substances in order of increasing or decreasing strength of	intermolecular forces dispersion force dipole force induced dipole hydrogen Bond	3.1.12.A ~ Apply concepts of systems, subsystems, feedback and control to solve complex technological problems. 3.1.12.B ~ Apply concepts of models as a method to predict and understand science and technology. 3.1.12.C ~ Assess and apply patterns in science and technology. 3.1.12.D ~ Analyze scale as a way of relating concepts and ideas to one another by some measure. 3.1.12.E ~ Evaluate change in nature, physical systems and man made systems. 3.2.12.A ~ Evaluate the nature of scientific and

		intermolecular forces. Identify substances that can form hydrogen bonds. Predict the types and relative strengths of intermolecular forces for various substances.		technological knowledge. 3.4.12.A ~ Apply concepts about the structure and properties of matter. 3.4.12.B ~ Apply and analyze energy sources and conversions and their relationship to heat and temperature. 3.4.12.D ~ Analyze the essential ideas about the composition and structure of the universe.
	Liquid Properties	Define and describe the properties of viscosity and surface tension. Explain how the type and strength of intermolecular forces affect viscosity and surface tension.	viscosity surface tension equilibrium vapor pressure boiling point	
	Phase Changes and Vapor Pressure	Calculate the heat transfer involved in phase changes. Interpret heating curves as to specific heat and identify melting and boiling points. Calculate Delta H for temperature and phase changes. Define and describe critical temperature and pressure. Describe the effect of temperature on the distribution of kinetic energies in a liquid.	vapor pressure critical temperature phase changes heat of fusion heat of condensation heat of sublimation	

		Define dynamic equilibrium. Predict relative vapor pressures of different substances. Explain the relationship between vapor pressure and boiling point and describe how boiling point changes with external pressure changes.		
	Phase Diagrams	Interpret phase diagrams for three-phase systems.	phase diagram	
	Structures of Solids	Describe the two types of structures of solids: crystalline and amorphous. Describe the three types of cubic unit cells found in crystalline lattices. Calculate density using the contents and dimensions of a unit cell. Describe the two different types of close packing of spheres.	unit cell face centered cubic body centered cubic simple cubic	
	Bonding in Solids	Calculate ionic radii from unit cell information. Compare properties among molecular solids, covalent-network solids, ionic solids, and metallic	amorphous solids crystalline solid metallic solid	

		solids based upon the different types of bonding in each.	molecular solid network covalent solid	

MAY

Nuclear Chemistry

Essential Questions	Content	Skills	Vocabulary	Standards
Why is the study of nuclear chemistry relevant to modern day society?	Radioactivity	Name the three most common types of radioactive decay and describe their properties in terms of charge, mass, and penetrating power. Explain what is meant by the belt of stability in terms of the neutron-proton ratio. Write nuclear equations representing the three most common types of radioactive decay using the appropriate symbols. Describe electron-capture. Describe nuclear transmutations. Perform calculations based on half-life. Perform calculations involving radioactive decay given appropriate data.	radioactivity half life alpha barticle beta particle gamma radiation transmutation belt of stability	3.1.12.C ~ Assess and apply patterns in science and technology. 3.1.12.E ~ Evaluate change in nature, physical systems and man made systems. 3.4.12.A ~ Apply concepts about the structure and properties of matter. 3.4.12.B ~ Apply and analyze energy sources and conversions and their relationship to heat and temperature. 3.4.12.D ~ Analyze the essential ideas about the composition and structure of the universe. 3.8.12.A ~ Synthesize and evaluate the interactions and constraints of science and technology on society. 3.8.12.C ~ Evaluate the consequences and impacts of scientific and technological solutions.

	Energy Changes in Nuclear Reactions	Calculate mass change in a nuclear reaction given appropriate data.	mass defect binding energy	
	Nuclear Fission and Nuclear Fusion	Explain critical mass, supercritical mass, and chain reaction when describing the process of nuclear fission. Be able to describe the difference between a fossil fuel power plant and a nuclear power plant. Write nuclear equations representing nuclear fission. Describe the difference between nuclear fission and nuclear fusion. Write nuclear equations for the fusion process.	fission reaction chain reaction nuclear reactor fusion reaction critical mass supercritical mass	
	Biological Effects of Radiation	List several sources, both natural and man-made, of exposure to radiation. Describe the difference and give examples of both ionizing and nonionizing radiation.	ionizing radiation nonionizing radiation	

Organic Chemistry

Essential Questions	Content	Skills	Vocabulary	Standards

	Why is organic chemistry called the Chemistry of Life?	Hydrocarbons Nomenclature of Organic compounds Functional Groups	Describe the four main types of hydrocarbons and give examples of each. Apply the rules for naming the alkanes, including the branched chain alkanes. Know the molecular formula, condensed structural formula, and name for the ten straight-chain alkanes. Know the common names for the most common alkyl groups. Write condensed structural formulas given the systematic name of the alkane. Know the general formula for straight chain alkanes and the general formula for cycloalkanes.	hydrocarbon aromatic compound systematic nomenclature alkane alkene alkyne saturated unsaturated structural isomer geometric isomer ortho isomers meta isomers para isomers common nomenclature	3.1.12.B ~ Apply concepts of models as a method to predict and understand science and technology. 3.1.12.C ~ Assess and apply patterns in science and technology. 3.1.12.E ~ Evaluate change in nature, physical systems and man made systems. 3.2.12.A ~ Evaluate the nature of scientific and technological knowledge. 3.3.12.A ~ Explain the relationship between structure and function at all levels of organization. 3.4.12.A ~ Apply concepts about the structure and properties of matter. 3.8.12.C ~ Evaluate the consequences and impacts of scientific and technological solutions.
		Unsaturated Hydrocarbons: Alkenes and Alkynes Functional Groups	Know and apply the rules for naming alkanes, alkenes, and alkynes. Identify the functional groups in an organic molecule. Use systematic nomenclature to name compounds containing	addition reactions functional group substitution reactions alcohol aldehyde	

		functional groups. Describe characteristic reactions of the various functional groups. Draw structural isomers for hydrocarbons. Know the products of addition reactions of halogens, hydrogen, and hydrogen halides to simple alkenes and alkynes.	carboxylic acid ester ether amine amide ketone	

JUNE

Chemistry of Coordination Compounds

Essential Questions	Content	Skills	Vocabulary	Standards
Why are coordination compounds associated with color?	Metal Complexes	Describe vocabulary related to coordination compounds. Determine the oxidation number of a metal in a complex metal. Determine the formula of a complex ion.	coordination compound ligand metal complex complex ion donor atom	3.1.12.B ~ Apply concepts of models as a method to predict and understand science and technology. 3.1.12.C ~ Assess and apply patterns in science and technology. 3.1.12.E ~ Evaluate change in nature, physical systems and man made systems. 3.2.12.A ~ Evaluate the nature of scientific and technological knowledge. 3.3.12.A ~ Explain the relationship between structure and function at all levels of organization. 3.4.12.A ~ Apply concepts about the structure and properties of matter. 3.4.12.D ~ Analyze the essential ideas about the composition and structure of the universe.