Lenoir County Public Schools
Curriculum Pacing Guide
Revision (August 2008)

Subject: **Chemistry I** **Grade Level:** **10-12** **2nd/4th** **9 weeks**

Time (approx teaching days)	**Major Concepts**	**Objective / Pacing**	**Text / Support Materials**
5	Chemical equation Skeleton equation Reactants Products Catalyst Synthesis reaction Decomposition reaction Single replacement reaction Double replacement reaction Combustion reaction Activity series of metals Complete ionic equation Net ionic equation Spectator ion Precipitate Collision theory Reaction rate Activation energy Activated complex Transition state Inhibitor Reversible reaction	**Objectives** 5.01 Evaluate various types of chemical reactions. • Analyze reactions by types: Single replacement, double replacement, decomposition, synthesis, and combustion, including simple hydrocarbons. • Predict products. 5.02 Evaluate the Law of Conservation of Matter. • Write and balance formulas and equations. • Write net ionic equations 4.02 Analyze the law of conservation of energy, energy transformations, and various forms of energy involved in chemical and physical processes. • Diagrams (energy vs. reaction pathway), enthalpy, and activation energy 4.02-1H Summarize energy changes within a reaction to determine heats of reaction. (**HONORS**) 4.03 Analyze the relationship between entropy and disorder in the universe. 4.03-1H Predict spontaneity by the use of Gibbs Free Energy. (**HONORS**) 5.06 Assess the factors that affect the rates of chemical reaction. • The nature of the reactants • Temperature • Concentration • Surface area • Catalyst **Questions addressed** • What is the correct procedure for writing a chemical equation? • What is a skeleton equation? • What role does a catalyst play in a chemical reaction? • Why must a chemical equation be balanced? • What are the steps in balancing a chemical equation?	Chapter 11 – **Prentice Hall Chemistry** (Sections 11.2 – 11.3) Text (pp. 330-344) Chapter 18 – **Prentice-Hall Chemistry** (Sections 18.1, 18.2, & 18.4 only!) Text (pp.541-559, 566-573) NCDPI Chemistry Curriculum Unit 8 *"Chemical Reactions"* Video: **The World of Chemistry** *Molecules in Action* Video: **Chemical Demonstrations** *Rates of Reaction* Virtual Labs – **PH Chemistry** *#20: Enthalpy and Entropy*

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	Chemical equilibrium Le Chatelier's principle Equilibrium constant (K_{eq}) Free energy Spontaneous reaction Nonspontaneous reaction Entropy	• What are the five general types of chemical reactions? • What is the distinguishing feature of a synthesis reaction? • How can a decomposition reaction be recognized? • What occurs during a single replacement reaction? How does the activity series of metals play a role in this category of chemical reaction? How can a single-replacement reaction be recognized? • How is a double-replacement reaction identified? • What element is always present as a reactant in a combustion reaction? • In complete combustion, what products are always formed? • What are several guidelines to follow in predicting the products of a chemical reaction? • What is a complete ionic equation? • What is a spectator ion? What roles does it play in a chemical reaction? • What is shown in a net ionic equation? How is the net ionic equation derived from a complete ionic equation? • What is the reaction rate for a chemical change? • What are the key points of collision theory? • What is the activation energy for a reaction? • What is an activated complex? What is another name for this particle? • What are the four main factors that determine the rate of a chemical reaction? Describe the effects of each on reaction rate. • What is an inhibitor? How does its mechanism of action differ from that of a catalyst? • What is a reversible reaction? • What is true when a system attains a state of chemical equilibrium? • What does Le Chatelier's principle state? • What are some stresses to a system that could upset the equilibrium of that system? Describe the effects of each stress, and how a system could adjust to compensate for it and reachieve equilibrium. • What is the equilibrium constant (K_{eq}) for a system at equilibrium?	

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		How is it calculated? • What is the significance of the values of K_{eq}? • What is free energy? • What is the difference between a spontaneous reaction and a nonspontaneous reaction? • What is entropy? • What roles do enthalpy and entropy play in determining whether or not a reaction will be spontaneous or nonspontaneous? • What is Gibbs free energy change? How is it calculated? • What is the significance of the sign of the Gibbs free energy change?	
5	Stoichiometry Conservation of mass Mole ratio Mass-mass calculations Mass-mole calculations Volume-volume calculations Limiting reactant Excess reactant Percent yield Theoretical yield Actual yield	**Objectives** 3.03 Calculate quantitative relationships in chemical reactions (Stoichiometry). • Moles of each species in a reaction • Mass of each species in a reaction • Volumes of gaseous species in a reaction 3.03-1H Evaluate reactions to determine limiting reactant and percent yield. (**HONORS**) 5.02 Evaluate the Law of Conservation of Matter. • Write and balance formulas and equations. **Questions addressed** • What useful information can be obtained from a balanced chemical equation? • What is stoichiometry? • What are several different ways that a balanced chemical equation can be interpreted? • What two things are always conserved in every chemical reaction? • What ratio is found in all stoichiometric calculations?	Chapter 12 – **Prentice Hall Chemistry** Text (pp. 353-375) NCDPI Chemistry Curriculum Unit 9 *"Stoichiometry"*

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		• What is the basis for all stoichiometry problems? • What is the procedure for calculating stoichiometry problems in general? • Why can a volume-volume stoichiometry problem be reduced to a single step under STP conditions? • What is meant by the limiting reactant and the excess reactant in a chemical reaction? • What is the significance of the limiting reactant in a chemical reaction? • How is the limiting reactant determined in a stoichiometry problem? • What is the difference between the theoretical yield and the actual yield in a chemical reaction? • How is percent yield calculated? • Why is the percent yield for a reaction generally less than 100%?	
6	Kinetic theory Gas pressure Atmospheric pressure Barometer Pascal STP Kinetic energy Temperature Evaporation Vapor pressure Boiling point Normal boiling point Melting point Crystal	**Objectives** 2.05 Analyze the basic assumptions of kinetic molecular theory and its applications. • Ideal Gas Equation • Combined Gas Law • Dalton's Law of Partial Pressures 2.08 Assess the dynamics of physical equilibria, • Interpretation of phase diagrams • Factors that affect phase changes **Questions addressed** • What are the three basic assumptions of the kinetic theory? • How is gas pressure defined? In what units is it measured? • How does a barometer work? • How does the Kelvin temperature of a substance relate to the kinetic energy contained in that substance? • How are liquids and gases similar? How are they different? Why does evaporation occur? Where in a liquid does evaporation	Chapter 13 – **Prentice Hall Chemistry** Text (pp. 385-404) Chapter 14 – **Prentice Hall Chemistry** Text (pp. 413-436) Video: **The World of Chemistry** *A Matter of State* Video: **Chemical Demonstrations** *Reactions of Gases* Virtual Labs – **PH Chemistry** *#11: Pressure-Volume Relationship for Gases* Virtual Labs – **PH Chemistry** *#12: Temperature-Volume*

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Time (approx teaching days)	Major Concepts	Objective / Pacing	Text / Support Materials
	Unit cell Allotrope Amorphous solid Sublimation Phase diagram Triple point Compressibility Boyle's law Charles's law Gay-Lussac's law Combined gas law Ideal gas law Ideal gas constant Real gas Ideal gas Dalton's law of partial pressures Diffusion Effusion Graham's law of effusion	occur? • What is the vapor pressure of a liquid? • How does vapor pressure vary with temperature for most substances? • What is the boiling point of a substance? What is meant by normal boiling point? • How are solids different from liquids and gases? • What are some general characteristic of crystals? What are the seven groups of crystal systems? • What are allotropes? Give examples. • What are amorphous solids? How do they differ from crystalline solids? • What is sublimation? How does it occur? • What information can be obtained from a phase diagram? • Why is a gas compressible, while solids and liquids are incompressible? • What factors affect the gas pressure in a container? How does each factor impact gas pressure in that container? • What is the formula for the combined gas law? What does each variable represent? • What three gas laws are derived from the combined gas law? What are the formulas for each of three gas laws? What factor, or factors, is kept constant in each of these laws? • What gas law makes use of the number of moles of a gas? • What is the ideal gas constant? Why is there more than one value for the ideal gas constant listed on the North Carolina Chemistry reference tables? • What are the differences between an ideal gas and a real gas? • Under what conditions does the behavior of real gases deviate the most from that of ideal gases? • What does Dalton's law of partial pressures state? • What is gas effusion? How does it relate to gas diffusion? • What does Graham's law of effusion state?	*Relationship for Gases* Virtual Labs – **PH Chemistry** *#13: Derivation of the Ideal Gas Law* Virtual Labs – **PH Chemistry** *#14: Ideal vs. Real Gases* Virtual Labs – **PH Chemistry** *#15 – Investigation of Gas Pressure and Mass* NCDPI Chemistry Curriculum Unit 10 *"Kinetic Molecular Theory and Gas Laws"*

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4	Surface tension Surfactant Aqueous solution Solute Solvent Solvation Electrolyte Nonelectrolyte Hydrate Efflorescence Hygroscopic Deliquescent Suspension Colloid Emulsion Tyndall effect Brownian motion Solubility Saturated solution Unsaturated solution Supersaturated solution Miscible Immiscible Henry's law Dilute solution Concentrated solution	**Objectives** 3.02 Apply the mole concept, Avogadro's number, and conversion factors to chemical calculations. • Molarity of solutions **Questions addressed** • What phenomenon is responsible for water's many unique properties? • What is surface tension? What is one consequence of water's high surface tension? How can it be reduced? • How does hydrogen bonding impact the vapor pressure of water? • What is unique about the relative densities of water and ice? What biological consequence has resulted from this phenomenon? • What is an aqueous solution? What are the two components of all solutions? • What occurs in the process of solvation? • What is the difference between electrolytes and nonelectrolytes? • How are ionic compounds classified? • What is the difference between a strong electrolyte and a weak electrolyte? • What is a hydrate? How is the formula for a hydrate written? • What is the difference between a hygroscopic compound, efflorescent compound, and a deliquescent compound? Name at least one use for each of these. • What are the differences among suspensions, colloids, and solutions? • What is the Tyndall effect? How can it be used to distinguish between heterogeneous aqueous systems and aqueous solutions? • What are some examples of colloidal systems? What is an emulsion? • What are three factors that determine how fast a solute dissolves in a solvent? • What is solubility? What is the most common unit for expressing solubility?	Chapter 15 – **Prentice Hall Chemistry** Text (pp. 445-462) Chapter 16 – **Prentice Hall Chemistry** (Sections 16.1-16.2 only!) Text (pp. 471-486) Video: **The World of Chemistry** *Water* Video: **The World of Chemistry** *On The Surface* Video: **Chemical Demonstrations** *Selected Properties of Liquids and Solutions* Virtual Labs – **PH Chemistry** *#21: Electrolytes* Virtual Labs – **PH Chemistry** *#22: Precipitation Reactions – Formation of Solids* Virtual Labs – **PH Chemistry** *#23: Identification of Cations in Solution*

Subject: Chemistry I **Grade Level:** 10-12 $2^{nd}/4^{th}$ **9 weeks**

Time (approx teaching days)	Major Concepts	Objective / Pacing	Text / Support Materials
	Molarity Percent solution (***m/m***) Percent solution (***v/v***)	• What are the differences among unsaturated, saturated, and supersaturated solutions? • What is the difference between miscible and immiscible liquids? • What factor affects the solubility of a solution? What are some significant exceptions to the general trend? • How does a dilute solution differ from a concentrated solution? • What is molarity? How is the molarity of a solution calculated? • What are the two ways that a solute's concentration can be expressed as percent? How is each calculated?	
6	Thermochemistry Chemical potential energy Heat Law of conservation of energy Endothermic Exothermic Calorie Joule Specific heat Heat capacity Calorimetry Enthalpy Thermochemical equation Heat of reaction Heat of combustion Heat of fusion	**Objectives** 4.02 Analyze the law of conservation of energy, energy transformations, and various forms of energy involved in chemical and physical processes. • Differentiate between heat and temperature. • Analyze heating and cooling curves. • Calorimetry, heat of fusion, and heat of vaporization calculations • Endothermic and exothermic processes including interpretation of potential energy • Diagrams (energy vs. reaction pathway), enthalpy, and activation energy **Questions addressed** • What is thermochemistry? • Where is chemical potential energy stored? • How is heat defined? • In what direction does heat always flow? • What is the difference between a system and its surroundings? • What does the law of conservation of energy state? • What is the difference between an endothermic process and an exothermic process? • In what two units is heat energy commonly measured?	Chapter 17 – **Prentice Hall Chemistry** Text (pp. 505-532) Video: **The World of Chemistry** *The Driving Forces* Video: **Chemical Demonstrations** *Exothermic Reactions* Video: **Conceptual Physics** *Heat, Temperature, and Expansion* Video: **Conceptual Physics** *Heat: Change of Phase* Virtual Labs – **PH Chemistry** *#16: The Specific Heat of a Metal* Virtual Labs – **PH Chemistry** *#17 – Heat of Fusion of Water*

Subject: Chemistry I **Grade Level:** 10-12 2nd/4th 9 weeks

Time (approx teaching days)	Major Concepts	Objective / Pacing	Text / Support Materials
	Heat of vaporization Heat of solution Hess's law Standard heat of formation	• What is the difference between the heat capacity of an object and the specific heat of the substance that makes up that object? • What formula is used to calculate the specific heat of a substance? • What is calorimetry? • What is meant by the enthalpy of a system? • How does a thermochemical equation differ from a standard chemical equation? • What is the heat of reaction? What is the significance of the sign of this value? • What is the heat of combustion? • What is the heat of fusion of a substance? • What is the heat of vaporization of a substance? • What does the sign of the heat of solution indicate about what occurs during the dissolving process? • What does Hess's law of heat formation state? • How can the heat of reaction be determined using Hess's Law? • What is the standard heat of formation for a compound? What value is given to the heat of formation for a free element in its standard state? • How can standard heats of formation be used to calculate the heat of reaction?	Virtual Labs – **PH Chemistry** *#18 – Heats of Reaction* Virtual Labs – **PH Chemistry** *#19 – Heat of Combustion* NCDPI Chemistry Curriculum Unit 11 *"Thermochemistry"*
6	Arrhenius acid Arrhenius base Brönsted-Lowry acid Brönsted-Lowry base Conjugate acid Conjugate base Amphoteric Lewis acid	**Objectives** 5.04 Identify the physical and chemical behaviors of acids and bases. • General properties of acids and bases • Concentration and dilution of acids and bases • Ionization and the degree of dissociation (strength) of acids and bases • Indicators • Acid-base titration • pH and pOH **Questions addressed** • What are some characteristic properties of acids?	Chapter 19 – **Prentice Hall Chemistry** (Sections 19.1-19.4 only!) Text (pp. 587-617) Video: **The World of Chemistry** *The Proton in Chemistry* Video: **Chemical Demonstrations** *Acids and Bases Demonstrations*

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	Lewis base Ionization constant for water (K_w) pH pOH Acid-base indicator Strong acid Weak acid Acid dissociation constant (K_a) Strong base Weak base Base dissociation constant (K_b) Neutralization reaction Titration Standard solution Equivalence point End point	• What are some characteristic properties of bases? • What is the Arrhenius definition of an acid? • What is the Arrhenius definition of a base? • How do the Brönsted-Lowry definitions of acids and bases differ from the Arrhenius definitions? • What is the difference between a conjugate acid and a conjugate base? • Why is water known as an amphoteric substance? • What is the difference between a Lewis acid and a Lewis base? • What is the ion-product constant for water? How is it calculated? • What is the difference between an acidic solution and a basic solution, in terms of the hydrogen-ion and hydroxide-ion concentrations? • How is pH defined? • What is the pH of a neutral solution? Acidic solution? Basic solution? • What is pOH? How does pOH relate to pH? • What is the function of acid-base indicators? How do they work? • What is the difference between a strong acid or base and a weak acid or base? • What is the acid dissociation constant (Ka) for a weak acid? How is it calculated? • What is the base dissociation constant (Kb) for a weak base? How is it calculated? • What is the distinction between a strong acid or base and a concentrated acid or base? • What is the distinction between a weak acid or base and a dilute acid or base? • What are the products in an acid-base neutralization reaction? • What is the procedure for conducting an acid-base titration? Where is the standard solution placed? When does the titration end?	Virtual Labs – **PH Chemistry** *#25: Study of Acid-Base Titrations* Virtual Labs – **PH Chemistry** *#26: Acid-Base Titrations* Virtual Labs – **PH Chemistry** *#27: Ionization Constants of Weak Acids* Virtual Labs – **PH Chemistry** *#28: Analysis of Baking Soda* Virtual Labs – **PH Chemistry** *#29: Molecular Weight Determination by Acid-Base Titration* NCDPI Chemistry Curriculum Unit 13 *"Acids and Bases"*

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4	Oxidation Reduction Redox reactions Oxidizing agent Reducing agent Corrosion Oxidation number Oxidation-number change method Half-reaction Half-reaction method	**Objectives** 5.05 Analyze oxidation/reduction reactions with regard to the transfer of electrons. • Assign oxidation numbers to elements in redox reactions. • Identify the elements oxidized and reduced. • Write simple half-reactions. • Assess the practical applications of oxidation and reduction reactions. 5.05-1H Analyze redox reactions by balancing via half reaction method or electron transfer method. (**HONORS**) **Questions addressed** • How did early chemists define oxidation? • What is the current definition of oxidation? • What is reduction? • Can oxidation occur without reduction? Can reduction occur without oxidation? • What is a redox reaction? • What is an oxidizing agent in a redox reaction? • What is a reducing agent in a redox reaction? • What is corrosion? How can knowledge of redox reactions be useful in controlling corrosion? Give one example. • What is the oxidation number of an atom? • What are the rules for assigning oxidation numbers? • How can changes in oxidation number in a reaction be used to identify the elements undergoing oxidation and reduction? • What types of reactions, in general, are redox reactions? • What types of reactions, in general, are not redox reactions? • What are the two methods for balancing redox reactions? • What is a half-reaction? How can a redox reaction be balanced by the half-reaction method?	Chapter 20 – **Prentice Hall Chemistry** Text (pp. 631-654) Video: **The World of Chemistry** *The Busy Electron* Virtual Labs – **PH Chemistry** *#30: Redox Titrations – Determination of Iron* NCDPI Chemistry Curriculum Unit 12 *"Redox"*

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4	Radioactivity Radiation Radioisotopes Alpha particle Beta particle Gamma ray Band of stability Positron Half-life Transmutation Nuclear fission Nuclear fusion Neutron moderation Neutron absorption Control rods Nuclear reactor Ionizing radiation Geiger counter Scintillation counter Film badge	**Objectives** 4.04 Analyze nuclear energy. • Radioactivity: Characteristics of alpha, beta, and gamma radiation • Decay equations for alpha and beta emission • Half-life • Fission and fusion **Questions addressed** • What is radiation and radioactivity? Which French chemists are credited with developing the field of nuclear chemistry? • How did the discovery of radioactivity impact Dalton's atomic theory? • Howe does an unstable atomic nucleus become stable? • What are the three most common types of nuclear radiation? Describe each in terms of mass, velocity, and penetrating power. • What is the band of stability? What is the general rule for the proton: neutron ratio for a stable nucleus? • What is a positron? How is it formed and emitted? • Under what conditions could a nucleus undergo positron emission versus beta decay? • What is half-life? • What is meant by transmutation? How and when does it occur? • What is nuclear fission? What occurs during nuclear fission? • What is a chain reaction? What is needed to sustain a chain reaction? • What is the difference between neutron moderation and neutron absorption? • What roles does a moderator play in a fission reaction? What are some materials suitable for use as moderators? • What role do control rods play in a fission reaction? What materials are suitable for use in this capacity? • What is nuclear fusion? What provides the fuel for a nuclear fusion reaction?	Chapter 25 – **Prentice Hall Chemistry** Text (pp. 799-819) Video: **Chemical Demonstrations** *Simulation of a Nuclear Chain Reaction* Video: **Conceptual Physics** *Radioactivity* Video: **Conceptual Physics** *Fission and Fusion* Video: **PH Field Trips Volume 2** *Fusion and Fission* NCDPI Chemistry Curriculum Unit 14 *"Nuclear Chemistry"*

Subject: Chemistry I **Grade Level:** 10-12 $2^{nd}/4^{th}$ **9 weeks**

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		• Why are nuclear fusion reactors not in use on Earth at this time? • What is ionizing radiation? • What are three devices that are commonly used to detect radiation? Describe how each works. • What are some applications for radioisotopes in medicine, agriculture, and industry?	
5	All concepts covered in course (**except** for those objectives labeled as **HONORS**)	**North Carolina End-of-Course Test in Chemistry (Review and Test Administration)**	Test review materials (to include previous New York State Regents examinations , NCDPI sample test questions, and other sources)
NOTE		**Chemistry I Honors students will also study two additional topics in-depth. Examples include environmental chemistry and organic chemistry. Student research and classroom presentations will be the primary delivery method for these enrichment topics, in several after-school sessions.**	