MONTGOMERY COUNTY PUBLIC SCHOOLS

Chemistry Curriculum Pacing Guide

1st 9 Weeks	SOL Objectives	Vocabulary
90 Minute Class: 8 Days **45 Minute Class:** 15 Days	**CH.1 The student will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts include:** 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; d) manipulation of multiple variables, using repeated trials; c) proper response to emergency situations; j) the use of current applications to reinforce chemistry concepts; f) mathematical and procedural error analysis; e) accurate recording, organization, and analysis of data through repeated trials; b) safe use of chemicals and equipment; i) construction and defense of a scientific viewpoint; and **LI: ● I can make connections between components of the nature of science and their investigations and the greater body of scientific knowledge and research.** **● I can demonstrate safe laboratory practices, procedures, and techniques by not causing injury to myself or others.** **● I can demonstrate the following basic lab techniques: filtering to separate a solid from a liquid, using chromatography to separate liquid mixtures, and lighting a gas burner without blowing up the school.** **● I can understand Material Safety Data Sheet (MSDS) warnings, including handling chemicals, lethal dose (LD), hazards, disposal, and chemical spill cleanup.** **● I will 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 by correctly matching the equipment to the name.** **● I can measure volume using graduated cylinders, volumetric flasks, and burets by reading the bottom of the meniscus.** **● I can measure mass using electronic balance to the nearest 0.01 gram.** **● I can measure temperature using a thermometer and/or temperature probe to the nearest 0.1 °C.** **● I can measure pressure using a barometer and/or pressure probe using appropriate**	filtering, chromatography, material data safety sheet, erlenmeyer flask, crucible, clay triangle, evaporating dish, pipette, buret, volumetric flask, barameter, fume hood, significant digit, accuracy, precision, mean, percent error, SI measurement, milli-, centi-, kilo-, independent variable, dependent variable

pressure units.

● I will 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 by walking through the room.

● I will design and perform controlled experiments to test predictions, including the following key components: hypotheses, independent and dependent variables, constants, controls, and repeated trials.

● I can predict outcome(s) when a variable is changed by creating a reasonable hypothesis.

● I will read measurements and record data, reporting the significant digits of the measuring equipment within 20% of the measure.

● I will demonstrate precision (reproducibility) in measurement by drawing a bullseye.

● I can recognize accuracy in terms of closeness to the true value of a measurement by drawing a bullseye.

● I will determine the mean of a set of measurements, for example density, with no more than 5% error.

● I can use data collected to calculate percent error, for example with repeated mass measurements, within 5% error.

● I will discover and eliminate procedural errors by performing multiple trials with percent error less than 20%.

● I can use common SI prefixes and their values (milli-,centi-,kilo-)in measurements and calculations by relating them to foreign languages and using them correctly 80% of the time.

● I will demonstrate the use of scientific notation, using the correct number of significant digits with powers of ten notation for the decimal place, for example 102 = 1.02×10^2, at least 80 % of the time.

● I will graph data utilizing the following: independent variable (horizontal axis) dependent variable (vertical axis) scale and units of a graph regression line (best fit curve) for experimental results obtained in lab.

● I will calculate mole ratios for reactions such as $2H_2 + O_2 > 2H_2O$, percent composition of elements in a compound such as CH_4, conversions between units such as grams and milligrams, and average atomic mass using isotopic masses and relative abundances.

● I can perform calculations according to significant digits rules for things with leading and trailing zeroes.

● I can convert measurements using dimensional analysis such as converting kilometers to meters.

● I can use graphing calculators to solve chemistry problems such as solving for the

	equilibrium concentrations of products in an equilibrium reaction. ● I can read a measurement from a graduated scale, stating measured digits plus the estimated digit such as using a buret to read to the nearest 0.01 mL. ● I will use appropriate technology for data collection and analysis, including probeware interfaced to a graphing calculator and/or computer and computer simulations such as the Vernier labquest 2 to collect temperature data. ● I can summarize knowledge gained through gathering and appropriate processing of data in a report that documents background, objective(s), data collection, data analysis and conclusions to write a lab report. ● I will explain the emergence of modern theories based on historical development. For example, I am able to explain the origin of the atomic theory beginning with the Greek atomists and continuing through the most modern quantum models. **CH.2 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 **CH.1 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;	
90 Minute Class: 5 Days **45 Minute Class:** 10 Days	**CH.2 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; i) historical and quantum models	mixture element compound alkali metal alkaline earth metal halogen noble gas transition metal principle energy level Hund's rule Aufbau Principle Pauli Exclusion Principle oxidation number
90 Minute Class: 4 Days **45 Minute**	**CH.2 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:** d) families or groups; e) periods; f) trends including atomic radii, electronegativity, shielding effect, and ionization energy;	

Class: 8 Days	g) electron configurations, valence electrons, and oxidation numbers; **LI: ● I will be able to use the periodic table to determine the atomic number, atomic mass, the number of protons, and the number of electrons for elements number 1-20** **● I will be able to determine the number of neutrons in an isotope given its mass number; for example, C-14 has a mass number of 14, contains 6 protons, 6 electrons and 8 neutrons** **● I will be able to determine the "weighted" average atomic mass: for example, if 20% of a sample of carbon have a mass of 14, and 80% have a mass number of 12, the weighted average atomic mass is (.20 x 14) + (.8 x 12) = 12.4** **● I will be able to perform calculations involving the half-life of a radioactive substance.** **● I will be able to differentiate between alpha, beta, and gamma radiation with respect to penetrating power, shielding, and composition.** **● I will be able to differentiate between the major atom components (proton, neutron and electron) in terms of location, size, and charge by definition and through the use of Bohr models and Lewis structures** **● I will be able to distinguish between a group and a period on the periodic table for example the first column represents the alkaline metals group and the second horizontal row or period contains elements filling electrons into the second principle energy level** **● I will be able to identify the following key groups, periods, and regions of elements on the periodic table: alkali metals, alkaline earth metals, halogens, Nobel gases, transition metals and inner transition metals.** **● I will be able to identify and explain trends in the periodic table as they relate to ionization energy, electronegativity, shielding effect, and relative sizes** **● I will be able to use its location on the periodic table to compare an element's reactivity to the reactivity of other elements in the table.** **● I will be able to relate the position of an element on the periodic table to its electron configuration: for example all elements in the 2nd column are filling electrons into the s2 orbitals of a their energy level.** **● I will be able to determine the number of valence electrons and possible oxidation numbers from an element's electron configuration: for example all elements in group 6A have 6 valence electrons and an oxidation number of -2** **● I will be able to use the periodic table to write the electron configuration for the first 20 elements of the periodic table.** **● I will be able to list at least 3 distinguishing characteristics between physical and chemical properties of metals and nonmetals.** **● I will be able to provide w methods to use to differentiate between pure substances and mixtures and between homogeneous and heterogeneous mixtures.** **● I will be able to match the key contributions of principal scientists to their theories**	

	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	
90 Minute Class: 8 Days **45 Minute Class:** 17 Days	**CH.3 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; **I understand that completion reactions form only products while reversible reactions reform reactants; I recognize that single-headed arrows indicate completion reactions and double-headed arrows indicate reversible reactions; I understand that reactions at equilibrium reactions have equal rates for the forward and reverse reactions; I know that LeChatlier's Principle states that a system in equilibrium will respond to changes in concentration, temperature, or pressure to restore equilibrium; I understand that only reaction systems with gases respond to changes in pressure.** **I will draw the correct arrow indicating completion & reversible reactions; I can determine if a reaction is at equilibrium by comparing the rates of the forward and reverse reactions; I can write the expression for K_{eq} that has product concentrations divided by reaction concentrations and assign appropriate exponents from the balanced equation; I will predict equilibrium shifts due to changes in concentration, temperature & pressure using LeChatlier's Principle.** **I can identify 5 reaction types based on characteristics of each reaction type including typical products and reactants.** **I will demonstrate my ability to write double displacement reactions and identify states of matter using solubility rules.** **Separate compounds into ions** **Select spectator ions from an equation** **Write a total and net ionic equation.** **Definition of net ionic equations** **Differences in net and total ionic equations** **Definition of spectator ions**	cation, anion, subscript, law of multiple proportions, Lewis dot diagram, valence electron, oxidation number, octet rule, ionic bond, covalent bond, binary compound, formula unit, molecule, molecular formula, structural formula, polyatomic ion, nomenclature, VSEPR model, polar bond, nonpolar bond, polar molecule, nonpolar molecule, ionization energy, electronegativity.

2nd 9 Weeks	SOL Objectives	Vocabulary
90 Minute Class: 5 Days **45 Minute Class:** 9 Days	**CH.3 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	cation, anion, subscript, law of multiple proportions, Lewis dot diagram, valence electron, oxidation number, octet rule, ionic bond, covalent bond, binary compound, formula unit, molecule, molecular formula, structural formula, polyatomic ion, nomenclature, VSEPR model, polar bond, nonpolar bond, polar molecule, nonpolar molecule, ionization energy, electronegativity.
90 Minute Class: 10 Days **45 Minute Class:** 20 Days	**CH.4 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	mole Avagadro's number molar mass empirical formula molecular formula percentage composition molar volume stoichiometry dimensional analysis formula unit molecule limiting reactant actual yield theoretical yield percent yield factor - label method

3rd 9 Weeks	SOL Objectives	Vocabulary
90 Minute Class: 7 Days **45 Minute**	**CH.5 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:** e) molar heats of fusion and vaporization; f) specific heat capacity; and	kinetic molecular theory, kilopascal, atmosphere (atm), mm Hg, Ideal Gas Law, Charles Law, Combined Gas Law,

Class: 13 Days		Dalton's Law of Partial Press, intermolecular force, vapor pressure, heating curve, molar heat of fusion, molar heat of vaporization, specific heat capacity, plasma, colligative property, Gay Lussac's Gas Law
90 Minute Class: 3 Days **45 Minute Class:** 7 Days	**CH.5 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;	
90 Minute Class: 6 Days **45 Minute Class:** 12 Days	**CH.5 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:** b) partial pressure and gas laws; a) pressure, temperature, and volume;	
90 Minute Class: 4 Days **45 Minute Class:** 8 Days	**CH.4 The student will investigate and understand that chemical quantities are based on on molar relationships. Key concepts include:** c) **solution concentrations;** **CH.5 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:** g) **colligative properties.** **LI: In order to meet this standard** **● I will be able explain the behavior of gases and the relationship between pressure and volume (Boyle's Law), and volume and temperature (Charles' Law).** **● I will be able to solve problems and interpret graphs involving the gas laws. ·** **● I will be able to make sketches that identify how hydrogen bonding in water plays an important role in many physical, chemical, and biological phenomena.** **● I will be able to draw and interpret vapor pressure graphs from data collected in the laboratory** **● I will carry out laboratory exercises and collect, graph and interpret a heating curve (temperature vs. time).** **● I will be able to identify and explain the triple points, boiling, freezing, and evaporation pop into on a phase diagram of water.** **● I will be able to calculate energy changes, using molar heat of fusion and molar heat of vaporization from laboratory data and class examples**	

	● I will be able to measure and calculate energy changes, using specific heat capacity. ● I will carry out laboratory activities in which I will examine the polarity of various solutes and solvents in solution formation.	
4th 9 Weeks	**SOL Objectives**	**Vocabulary**
90 Minute Class: 5.5 Days **45 Minute Class:** 11 Days	**CH.4 The student will investigate and understand that chemical quantities are based on on molar relationships. Key concepts include:** d) **acid/base theory; strong electrolytes, weak electrolytes, and nonelectrolytes; dissociation and ionization; pH and pOH; and the titration process.** **LI: In order to meet this standard, it is expected that students will · 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. · identify the limiting reactant (reagent) in a reaction. · calculate percent yield of a reaction. · 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 nonelectrolytes. · relate the hydronium ion concentration to the pH scale. · perform titrations in a laboratory setting using indicators.**	molarity, solution, dilution, solubility/solubility curve, saturated/unsaturated, supersaturated, Arrhenius theory, Bronsted-Lowry theory, acid/base, electrolytes, pH/pOH, titration, indicator, dissociation, ionization.
90 Minute Class: 3.5 Days **45 Minute Class:** 7 Days	**CH.3 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.**	entropy exothermic endothermic activation energy diagram equilibrium Le Chatlelier's Principle
90 Minute Class: 3 Days **45 Minute Class:** 6 Days	**CH.6 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.** **LI: In order to meet this standard, it is expected that students will · describe how saturation affects shape and reactivity of carbon compounds. · draw Lewis dot structures, identify geometries, and describe polarities of the following molecules: CH4, C2H6, C2H4, C2H2, CH3CH2OH, CH2O, C6H6, CH3COOH. · recognize that organic compounds play a role in natural and synthetic pharmaceuticals. · recognize that nucleic acids and proteins are important**	organic, hydrocarbon, functional group, polymer, nylon, saturation

	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).	
90 Minute Class: 15 Days **45 Minute Class:** 21 Days	**SOL Review** **Extended Topics**	