Pacing Guide

Unit : 1	Structure and Properties of Matter		Minimum Number of Instructional Days
	Common Core Standards Covered	**Key Concepts**	**Total: 16**
1-1	**Atoms and Molecules** *HS-PS1-1.*	• Defining the atom • Size of an atom • Molecules and compounds • Counting atoms in molecules and compounds	1
1-2	**The Kinetic Molecular Theory and the Properties of Matter** *HS-PS1-3.*	• Arrangement of particles in solids, liquids, gases and plasma • Properties relating to each state • The forces between particles • Define the temperature of a substance as a measure of the average kinetic energy of the particles. • Kinetic energy of each state of matter • Changes of state require energy to be added or removed.	1
1-3	**Models of an Atom** *HS-PS1-1.*	The origins of the atom – Democritus and Leucippus Outline the findings of: • Solid Sphere - Dalton • Plum Pudding Model - Thomson • Nuclear Model – Rutherford • Planetary Model – Bohr • Quantum Model –Schrodinger • Discovering the neutron - James Chadwick Compare and contrast the models and identify key contributions to modern day atomic theory	2
1-4	**Atomic Structure** *HS-PS1-1.*	• Atoms are made of a nucleus consisting of protons and neutrons. The nucleus is surrounded by electrons. • Atomic mass • Atomic and Mass numbers	1

		• Protons and electrons are oppositely charged. • An atom has the same number of protons and electrons to making its overall charge zero (neutral). • Formation of Ions • Flame testing and identification of positive and negative ions	
1-5	**Isotopes** *HS-PS1-1.*	• Definition of the isotope as different forms of the same element. • Isotope notation and names – example hydrogen • Change in mass number while the number of protons and electrons (atomic number) remains the same. • Stable vs. radioactive isotopes (briefly) • Origin of isotopes (briefly)+ • Uses of isoptopes (briefly)	1
1-6	**Electron Configuration** *HS-PS1-1.* *HS-PS1-2.*	• Review of atomic number • Atoms are most stable when they have a full shell (reference to noble gases) • Electron configuration – written and drawn • Arrangement of electrons in orbitals • First energy level is filled first - 1s orbital, • Second level, 2s and 2p orbital • Orbital notation for atoms and ions • Aufbau principle, Hund's rule and Pauli Exclusion principle	5
1-7	**The Periodic Table of Elements** *HS-PS1-1.* *HS-PS1-2.*	• History of the Periodic table as proposed by early chemists such as: John Newlands and Dmitri Mendeleev • Comparison of early and current Periodic table. • Rows determine the number of orbitals present and groups organize elements based on similar properties and valence electrons. • The 'staircase' separates metals and non-metals • Periodic trends including atomic radius, ionization energy, electronegativity, electron affinity, melting point and metallic character (specific reference to Group I metals, Group II Alkali Earth Metals, Group 17 Halogens and Group 18 Noble Gases), ion formation • Transition metals	5

Unit : 2	Chemical Reactions		Minimum Number of Instructional Days
	Common Core Standards Covered	**Key Concepts**	**Total: 18**
2-1	**Atomic Combinations** *HS-PS1-1.* *HS-PS1-2.* *HS-PS1-4*	• Atoms join together to form compounds. The properties of the compound are often very different to the individual atoms in the compound. • Different elements react, by breaking and forming bonds • Forming bonds requires atoms giving, taking or sharing electrons • Energy and bonding • Why some elements bond and others do not. • Lewis Structures	1
2-2	**Covalent Bonding** *HS-PS1-1.* *HS-PS1-2.*	• Occurs between non-metals • Atoms share electrons in order to fill both outer (valence) shells • Properties of covalent molecules • Important examples: H_2O, HCl, NH_3, O_2, CO_2 • Lewis Structures in covalent bonding • Multiple bonds • Polar and non-polar covalent molecules • Pauling scale of electronegativity and the bonding continuum • Giant covalent structures e.g. Graphite, Diamond	3
2-3	**Ionic Bonding** *HS-PS1-1.* *HS-PS1-2.*	• Forms from a metal (positive ion) losing it electron(s) and a non-metal (negative ion) gaining electron(s) • Occurs to fill (or empty) the atoms valence shell • Properties of Ionic compounds • Ionic compounds occur as giant molecular lattices • Compounds have strong electrostatic forces holding them together • Important examples: NaCl, NaOH • Working out ionic formulae	4
2-4	**Metallic Bonding** *HS-PS1-1.* *HS-PS1-2.*	• Involves free electrons which produce the properties of unique to metals • Outline the properties of metals • Electrons free to move through the structure to allow conduction of	3

		electricity, malleability etc • Electrons hold the metal together in a fixed shape through strong electrostatic forces. • Alloys are mixtures which make the new metal harder than the original elements. • Examples of alloys used in industry	
2-5	**Molecular Substances** *HS-PS1-1.* *HS-PS1-2.*	• Solids made of separate substances packed together • Intramolecular and intermolecular forces • Van der Waals forces • Properties of molecular substances – electrical conductivity, solubility • Examples: Solid CO_2, ammonia, iodine • Comparisons with ionic, giant covalent and metallic solids • Determining bond type	2
2-6	**Writing Chemical Formula** *HS-PS1-1.* *HS-PS1-2.*	• Ionic and covalent compounds • Review of subscripts and coefficients • Shows the type and number of atoms in a substance • Cancellation of charges (ionic formula) • Use of brackets • Correct naming conventions e.g. –ate, -ide, etc.	2
2-7	**Molecular Shape and VESPR Theory** *HS-PS1-1.* *HS-PS1-2.* *HS-PS1-4*	• Electron pairs in bonds and lone pairs repel thus adopting the specific geometric shapes so that electron pairs are as far apart as possible. • Polar vs non-polar molecules • Lewis structures for compounds • Linear (180^o) E.g. CO_2 • Bent (119.3^o) E.g. SO_2 • Trigonal pyramidal (106.7^o) E.g. NH_3 • Trigonal Planar (120^o) E.g. BCl_3 • Tetrahedral E.g. CCl_4 • Wedge and dash diagrams • Testing for polarity	3

Unit : 3	Changes in Matter		Minimum Number of Instructional Days
	Common Core Standards Covered	**Key Concepts**	**Total: 14**
3-1	**Physical and Chemical Change** *HS-PS1-4* *HS-PS1-5*	• Chemical change – permanent, involving new substances being made, indicated by color change, smell • Physical Change – requires adding or removing heat to cause a change in state. • Physical changes are reversible • Identify chemical and physical change from experiments • Examples of chemical and physical Change	2
3-2	**Conservation of Energy in Chemical Reactions** *HS-PS1-4* *HS-PS1-5* *HS-PS1-7*	• Chemical reactions involve energy which is used to break bonds in reactants. • Energy is released when new bonds form in products. • Endothermic reactions absorb energy • Exothermic reactions release energy. • The law of conservation of energy – matter cannot be created or destroyed	3
3-3	**Conservation of Mass in Chemical Reactions** *HS-PS1-6.* *HS-PS1-7.*	• Mass is always conserved in a chemical reaction, due to no atoms being created or destroyed • Same number and types of atoms will be present in the reactants as well as the products • Adding up masses on both sides of the equation to observe the conservation of mass. • Calculating mass in reactions	1
3-4	**Law of Constant Composition** *HS-PS1-6.* *HS-PS1-7*	• Proust's Law • Mass ratios • Important example – H_2O	1
3-5	**Chemical Change Representation** *HS-PS1-7.*	6 types of chemic al reactions • Synthesis • Combustion • Decomposition	5

		• Single displacement • Double displacement • Acid-base	
3-6	**Balancing Chemical Equations** *HS-PS1-7*	• Placing numbers in from of the compounds (stiochiometric coefficients) • Balancing one type of atom at a time • Reactants equal products • Net ionic equations	2

Unit : 4	The Mole Concept		Minimum Number of Instructional Days
	Common Core Standards Covered	**Key Concepts**	**Total: 12**
4-1	**The Mole and Molar Mass** *HS-PS1-7*	• Finding Relative atomic mass (Ar) • Defining the mole as: One mole of a substance equals its Mr in grams • Calculating Molar mass (M) and Relative formula mass (Mr) • Isotopes and molar mass • Defining Avogadro number	2
4-2	**Mole Concept for Elements** *HS-PS1-7*	• Number of moles = mass of element (grams)/Mr • Mass conversions between tone, kg, g , mg • Relating number of moles to number of atoms • Formula triangles	2
4-3	**Mole Concept for Molecules and Compounds** *HS-PS1-7.*	• Number of moles = mass of compound (grams)/Mr • Relating number of moles to number of atoms	2
4-4	**Molecular and Empirical Formula** *HS-PS1-7.*	• Calculating percentage composition • Calculating empirical formulas from masses or percentages • Understanding the difference between molecular and empirical formula • Calculating molecular formula • Water of crystallization	4
4-5	**Stoichiometry** *HS-PS1-7.*	• Mole ratios • Relating amounts and masses in equations • Percentage yield • Limiting reagents	2

Unit : 5	Energy Changes in Chemical Reactions		Minimum Number of Instructional Days
	Common Core Standards Covered	**Key Concepts**	**Total: 9**
5-1	**Bond Energy and the Types of Reactions** *HS-PS1-4* *HS-PS1-5* *HS-PS1-6*	• Heat energy and kinetic energy • What causes energy changes in chemical reactions? • Defining bond energy • Outline the factors that affect the strength of the chemical bond (bond length, bond energy, bond order) • Calculating bond energy • Endothermic and exothermic reactions • Dissolving and energy	3
5-2	**Heat of Reaction** *HS-PS1-4* *HS-PS1-5* *HS-PS1-6*	• Enthalpy of a reaction • Energy level diagrams – interpretation and drawing • Thermochemical equations • Using n=m/M and stiochiometry • Calculating overall energy change of a reaction	3
5-3	**Spontaneous and Non-Spontaneous Reactions** *HS-PS1-4* *HS-PS1-5* *HS-PS1-6*	• Spontaneous reactions (exothermic reactions) are favored when they result in a decrease in enthalpy and an increase in entropy of the system. Energy is released to the surroundings as heat. • Non-spontaneous reactions (endothermic reactions), decreases the entropy. • The driving force of a reaction • Entropy and factors affecting it. • Gibbs free energy and using $\Delta G = \Delta H - T\Delta S$	3

Unit : 6	Reaction Rate		Number of Instructional Minimum Number of Instructional Days
	Common Core Standards Covered	**Key Concepts**	**Total: 24**
6-1	**Reaction Rate and Factors Affecting It** *HS-PS1-4* *HS-PS1-5* *HS-PS1-6*	Defining rate: • Instantaneous rate • Calculating rate Reaction rate is affected by changes in: • Temperature • Catalysts • Concentration or pressure • Surface area	6
6-2	**Reaction Rate and the Collision Theory** *HS-PS1-4* *HS-PS1-5* *HS-PS1-6*	• Collision theory • Particles are in constant motion • Reactions occur when particles collide with sufficient force and in the correct orientation. • Activation energy • Comparing exothermic and endothermic reactions • Describing particle behavior when factors affecting the rate of reaction are changed.	2
6-3	**Measuring Reaction Rates** *HS-PS1-4* *HS-PS1-5* *HS-PS1-6*	Planning a rates investigation • Identification of variables • Writing a method Observations of: • Precipitation • Change in mass • Volume of gas given off Interpreting data • Tables • Graphs	2
6-4	**Catalysts and Reaction Rates**	• Does not participate in reaction	3

	HS-PS1-4 *HS-PS1-5* *HS-PS1-6*	• Specific • Reduces energy requirement • Increases number of successful collisions Key examples include: • Catalysts in industry • Surface catalysts in catalytic converters • Enzymes as an example of a biological catalyst	
6-5	**Chemical Equilibrium** *HS-PS1-4* *HS-PS1-5* *HS-PS1-6*	• The rate of a reversible reaction in a closed system • Occurs when the forward and backward reactions occur at the same rate. • As reactants react concentration of these falls so forward reaction slows down. • Equilibrium position right vs. left based on the amounts of reactants and products • Le Chateliers Principle – Factors which change equilibrium – temperature, pressure, concentration • The Haber process as an example of equilibrium • Calculating equilibrium constants and quotients	5
6-6	**Acids and Bases**	• Acid Base chemistry • Strong vs weak acids and bases • Conjugate acid-base pairs • pH scale • Calculating pH • Kw	6

Unit : 7	Nuclear Processes		Minimum Number of Instructional Days
	Common Core Standards Covered	**Key Concepts**	**Total: 8**
7-1	**Nuclear Structure and Radiation** *HS-PS1-8*	• Unstable nuclei release particles • Strong Nuclear force vs electromagnetic force • Neutron to proton ratio • Band of stability • Magic numbers	1
7-2	**Types of Radiation** *HS-PS1-8*	Compare and contrast types of radiation • Alpha (helium nuclei) • Beta (electrons) • Gamma (short wavelength EM waves) • Balancing nuclear equations • Materials which block radiation • Effects of magnetic fields on radiation • Nuclear equations	1
7-3	**Half-Life** *HS-PS1-8*	• Defined as the average time taken to halve the number of radioactive nuclei in an isotope • Short vs. long half-life • Calculating number of half lives in a sample • Finding amount of an isotope left through calculation	1
7-4	**Sources of Radiation** *HS-PS1-8*	• Unstable Isotopes • Space • Background radiation • Artificial sources	1
7-5	**Dangers and Uses of Radiation** *HS-PS1-8*	Dangers: • Harms living tissue Uses: • Smoke detectors	1

		• Medical tracers • Sterilization • X-Rays • Radioactive dating • Radiotherapy/cancer treatment • Power stations	
7-6	**Nuclear Fission** *HS-PS1-8*	• Splitting/subdivision of nuclei into two nuclei of roughly even mass. • Occurs in nuclear reactors and atomic bombs	1
7-7	**Nuclear Fusion** *HS-PS1-8*	• Joining of two or more nuclei together • Requirements of a fusion reaction • Occurs in stars • Comparison with fission reaction	1
7-8	**Nucleosynthesis** *HS-PS1-8*	• New nuclei formed from pre-existing nuclei • Big Bang theory • Stellar Nucleosynthesis • Supernova nucleosynthesis	1