Chemistry Curriculum

**Olivet: Standard 1 is common in all science content areas. The first letter of Standard 1 correlates with the content area: Biology is B, Physics is P, Chemistry is C, Earth Science is E. Standard 1 (S1) is embedded into the units in all content areas. All scientific inquiry benchmarks that are measured by EXPLORE, PLAN, and/or ACT Science tests and Work Keys are achieved through the laboratory reports. All Scientific Reflection and Social Implications benchmarks that are measured by EXPLORE, PLAN, and/or ACT Science tests and Work Keys are achieved through the persuasive essays.**

**Standard C1: INQUIRY, Reflection, and Social Implications**

*Students will understand the nature of science and demonstrate an ability to practice scientific reasoning by applying it to the design, execution, and evaluation of scientific investigations. Students will demonstrate their understanding that scientific knowledge is gathered through various forms of direct and indirect observations and the testing of this information by methods including, but not limited to, experimentation. They will be able to distinguish between types of scientific knowledge (e.g., hypotheses, laws, theories) and become aware of areas of active research in contrast to conclusions that are part of established scientific consensus. They will use their scientific knowledge to assess the costs, risks, and benefits of technological systems as they make personal choices and participate in public policy decisions. These insights will help them analyze the role science plays in society, technology, and potential career opportunities.*

**C1.1 Scientific Inquiry**

Science is a way of understanding nature. Scientific research may begin by generating new scientific questions that can be answered through replicable scientific investigations that are logically developed and conducted systematically. Scientific conclusions and explanations result from careful analysis of empirical evidence and the use of logical reasoning. Some questions in science are addressed through indirect rather than direct observation, evaluating the consistency of new evidence with results predicted by models of natural processes. Results from investigations are communicated in reports that are scrutinized through a peer review process.

C1.1A Generate new questions that can be investigated in the laboratory or field.

C1.1B Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions.

C1.1C Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity—length, volume, weight, time interval, temperature—with the appropriate level of precision).

C1.1D Identify patterns in data and relate them to theoretical models.

C1.1E Describe a reason for a given conclusion using evidence from an investigation.

C1.1f Predictwhat would happen if the variables, methods, or timing of an investigation were changed.

C1.1g Use empirical evidence to explain and critique the reasoning used to draw a scientific conclusion or explanation.

C1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.

C1.1i Distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate. **(not measured by EXPLORE, PLAN, and/or ACT Science tests and Work Keys)**

**C1.2 Scientific Reflection and Social Implications**

The integrity of the scientific process depends on scientists and citizens understanding and respecting the “nature of science.” Openness to new ideas, skepticism, and honesty are attributes required for good scientific practice. Scientists must use logical reasoning during investigation design, analysis, conclusion, and communication. Science can produce critical insights on societal problems from a personal and local scale to a global scale. Science both aids in the development of technology and provides tools for assessing the costs, risks, and benefits of technological systems. Scientific conclusions and arguments play a role in personal choice and public policy decisions. New technology and scientific discoveries have had a major influence in shaping human history. Science and technology continue to offer diverse and significant career opportunities.

**C1.2A** Critique whether or not specific questions can be answered through scientific investigations. **(not measured by EXPLORE, PLAN, and/or ACT Science tests and Work Keys)**

**C1.2B** Identify and critique arguments about personal or societal issues based on scientific evidence.

**C1.2C** Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information.

**C1.2D** Evaluate scientific explanations in a peer review process or discussion format. **(not measured by EXPLORE, PLAN, and/or ACT Science tests and Work Keys)**

**C1.2E** Evaluate the future career and occupational prospects of science fields. **(not measured by EXPLORE, PLAN, and/or ACT Science tests and Work Keys)**

**C1.2f** Critique solutions to problems, given criteria and scientific constraints.

**C1.2g** Identify scientific tradeoffs in design decisions and choose among alternative solutions. **(not measured by EXPLORE, PLAN, and/or ACT Science tests and Work Keys)**

**C1.2h** Describe the distinctions between scientific theories, laws, hypotheses, and observations. **(not measured by EXPLORE, PLAN, and/or ACT Science tests and Work Keys)**

**C1.2i** Explain the progression of ideas and explanations that leads to science theories that are part of the current scientific consensus or core knowledge. **(not measured by EXPLORE, PLAN, and/or ACT Science tests and Work Keys)**

**C 1.2j** Apply science principles or scientific data to anticipate effects of technological design decisions. **(not measured by EXPLORE, PLAN, and/or ACT Science tests and Work Keys)**

**C 1.2k** Analyze how science and society interact from a historical, political, economic, or social perspective. **(not measured by EXPLORE, PLAN, and/or ACT Science tests and Work Keys).**

**Unit 1**

**Matter, the Periodic Table and Interpreting Data.**

Big Ideas (core concepts)

-Matter exists and interacts at the atomic and molecular level. Chemical and physical properties differ and dictate how matter acts.

-Density is a physical property that can be calculated with the equation (m/v) or through finding the slope of a mass vs. volume graph.

Standards:

C2: Forms of energy

C3: Energy Transfer and Conservation

C4: Properties of Matter

C5: Changes in Matter

Content Statements:

C5.4d: Explain why freezing is an exothermic change of state.  
  
Clarification: None

C2.2d: Explain convection and the difference in transfer of thermal energy for solids, liquids, and gases using evidence that molecules are in constant motion.  
  
Clarification: None

C4.7a: Investigate the difference in the boiling point or freezing point of pure water and a salt solution.  
  
Clarification: None

C4.8: Atomic Structure  
Electrons, protons, and neutrons are parts of the atom and have measurable properties, including mass and, in the case of protons and electrons, charge. The nuclei of atoms are composed of protons and neutrons. A kind of force that is only evident at nuclear distances holds the electrons inside of the atom.

**Olivet High School:**

**Atomic Structure / Classification of matter lecture. Students will learn / discuss Quantum numbers as “maps” for locating electrons. Periodic table will be used to determine the sub atomic particles.**

C4.10: Neutral Atoms, Ions, and Isotopes  
A neutral atom of any element will contain the same number of protons and electrons. Ions are charged particles with an unequal number of protons and electrons. Isotopes are atoms of the same element with different numbers of neutrons and essentially the same chemical and physical properties.

C4.10x: Average Atomic Mass  
The atomic mass listed on the periodic table is an average mass for all the different isotopes that exist, taking into account the percent and mass of each different isotope.

**Olivet High School:**

**Atomic Structure lecture. Students will discuss why the atomic masses aren’t whole numbers, why and given a Carbon 14 vs Carbon 12 example.**

C5.2: Chemical Change  
Chemical changes can occur when two substances, elements, or compounds interact and produce one or more different substances whose physical and chemical properties are different from the interacting substances. When substances undergo chemical change, the number of atoms in the reactants is the same as the number of atoms in the products. This can be shown through simple balancing of chemical equations. Mass is conserved when substances undergo chemical change. The total mass of the interacting substances (reactants) is the same as the total mass of the substances produced (products).

**Olivet High School:**

**Chemical and physical properties / Changes lecture. Students will write and discuss the differences between chemical and physical changes. Students will also determine when they have witnessed a chemical or physical change in lab.**

C4.3: Properties of Substances  
Differences in the physical and chemical properties of substances are explained by the arrangement of the atoms, ions, or molecules of the substances and by the strength of the forces of attraction between the atoms, ions, or molecules.

C2.5a: Determine the age of materials using the ratio of stable and unstable isotopes of a particular type.  
  
Clarification: Examples should be limited to the first 20 elements except for the long half life elements of uranium, iodine and cobalt.  
  
C3.5a: Explain why matter is not conserved in nuclear reactions.  
  
Clarification: Calculations are not necessary here except to illustrate E=mc2.  
  
C4.7b: Compare the density of pure water to that of a sugar solution.

**Olivet High School:**

**Density / Slope of a graph lecture. Students will solve the density of water through the use of the equation and by graphing the mass and volume of water and then solving for the slope. Students will also solve for their own % error.**  
  
Clarification: Compare properties that influence density. i.e. particle mass and packing of particles.

C4.9b: Identify metals, non-metals, and metalloids using the periodic table.  
  
Clarification: The “stair step” on the right side of the periodic table conveniently separates the elements with physical properties of metals from the nonmetals. The metalloids are approximately on the “stair step”.

**Olivet High School:**

**Covalent, Ionic, Polyatomic and Transition lectures. Students will write the formulas and names for ionic and covalent compounds.**

C2.1b: Describe energy changes associated with chemical reactions in terms of bonds broken and formed (including intermolecular forces).  
  
Clarification: None  
C3.4: Endothermic and Exothermic Reactions  
Chemical interactions either release energy to the environment (exothermic) or absorb energy from the environment (endothermic).

Clarification: Examples: exothermic, steel wool plus vinegar; endothermic, vinegar plus sodium bicarbonate.

**Olivet High School:**

**Mg + acid lab. Ice pack example. Ammonium Nitrate + water demo. Students will see and differentiate between the two different kinds of reactions.**

C3.2a: Describe the energy changes in photosynthesis and in the combustion of sugar in terms of bond breaking and bond making.  
  
Clarification: None  
  
**Olivet High School:**

**Classification of reactions (synthesis, decomposition, single and double replacement) lecture. Students will classify reactions as one of the above by looking at chemical equations and by observing in lab.**

C4.3e: Predict whether the forces of attraction in a solid are primarily metallic, covalent, network covalent, or ionic based upon the elements’ location on the periodic table.  
  
Clarification: None

**Summative assessment:**

**Unit 1 test given that cover all mentioned concepts. Students will indifidually do one of the labs that were assigned in the 2 week unit.**

**Vocabulary:**

Atomic mass  
Atomic nucleus  
Atomic number  
Atomic theory  
Atomic weight  
Charged object**,** Electrically neutral  
Electron  
Electron cloud  
Elementary particle  
Ion**,** Proton  
Weight of subatomic particle**.**

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| Lesson | Materials | Skills/Strategies | CCE | Assessments |
| Lab Reports | Power point, Zn, Acid | LR, N, Pre test,  Syllabus | S1 | FA |
| Density of water, Sugar and % Error | Scale, g. Cylinder, | Density of water lab. LR, N, % error calculations | S1  C4.7b | FA |
| Chemical and Physical Properties | 6 solutions | LR, N, LW | C.2  C5.2  S1  C2.1a  C2.1b | FA |
| Isotopes, fission & half life | Notes, Text | N, guided reading, W | C2.5a  C3.5a  C4.7b  C4.10e | W |
| Atomic Structure | Notes, Text | N, W | C4.8  C4.10 | FA |
| Periodic Table and trends. | P. Table | N, W | C4.9b  C4.9c | FA |
| % Composition | P. Table, Work sheet | N, W, LR | C4.10c  C4.10d | FA |

**Unit 2:**

**Bonding, Chemical Equations, % Composition, Electrolysis and Removing water from Copper Sulfate.**

Big Ideas (concepts):

-Students will know the differences between ionic and covalent compounds (names and formulas). Students will be able to balance chemical equations.

-Students will run electricity through water and observe which gases are attracted to the negative and positive lead of an electric current. Students will remove water from a copper (II) sulfate compound to calculate the % of water lost.

Standards:

C5: Changes in Matter

C4: Properties of Matter

C2: Forms of Energy

Content Standards:

C5.5d: Compare the relative melting point, electrical and thermal conductivity, and hardness for ionic, metallic, and covalent compounds.

**Olivet High School:**

**Ionic / Covalent compounds lecture. Students will investigate the differences of two compounds (sugar and salt) in terms of solubility, conductivity and melting point.**  
  
Clarification: Comparing properties should lead to understanding trends.  
Examples: Ionic, NaCl; metallic, Na; covalent, paraffin.

C4.4a: Explain why at room temperature different compounds can exist in different phases.  
  
Clarification: None  
C4.1a: Calculate the percent by weight of each element in a compound based on the compound formula.  
  
Clarification: Compounds should include hydrates and compounds containing two or three different elements. A modern periodic table must be made available.

**Olivet High School:**

**% Composition lecture, Problems. Students will heat up a compound and mass the difference to calculate the % water lost (CuSO4 lab.**

C4.1b: Calculate the empirical formula of a compound based on the percent by weight of each element in the compound.  
  
Clarification: Compounds should include hydrates and compounds containing two or three different elements. A modern periodic table must be made available.  
  
C4.1c: Use the empirical formula and molecular weight of a compound to determine the molecular formula.  
  
Clarification: Compounds should include hydrates and compounds containing two or three different elements. A modern periodic table must be made available.

C5.2d: Calculate the mass of a particular compound formed from the masses of starting materials.  
  
Clarification: Expected product mass can be calculated given a balanced chemical equation, the formula masses of reactants, and starting masses of reactants

C5.2f: Predict volumes of product gases using initial volumes of gases at the same temperature and pressure.

**Olivet High School:**

**Boyl’s and Charles’ law lecture. Students will read, write and discuss the two laws that lead up to the ideal gas laws.**  
  
Clarification: The product gases should be at the same temperature and pressure as the reactant gases. Simple whole numbers for coefficients and volumes given with two significant figures will work here. Calculations requiring mental math only. Limiting reagents can be added to these problems.  
Example: 50 liters of hydrogen and 25 liters of oxygen as starting gases or,  
50 liters of hydrogen and 10 liters of oxygen as starting gases  
2H2 (g) + O2 (g) → 2H2O (g)  
C5.4 – Phase/Change Diagrams  
Changes of state require a transfer of energy. Water has unusually high-energy changes associated with its changes of state.

C2.3b: Draw and analyze a diagram to show the activation energy for an exothermic reaction that is very slow at room temperature.  
  
Clarification: The diagram to show a very slow exothermic reaction at room temperature is one in which the energy of activation is very large.  
  
C5.5x – Chemical Bonds  
Chemical bonds can be classified as ionic, covalent, and metallic. The properties of a compound depend on the types of bonds holding the atoms together.

C2.1c: Compare qualitatively the energy changes associated with melting various types of solids in terms of the types of forces between the particles in the solid.  
  
Clarification: Compare a variety of substances, free elements (monatomic and/or diatomic), ionic compounds, molecular compounds, and something with hydrogen bonding. You might consider looking at melting points of common materials, such as Na, O2, CH4, H2O, and NaCl.

C4.9c: Predict general trends in atomic radius, first ionization energy, and electronegativity of the elements using the periodic table.  
  
Clarification: Given the names of two or three elements either from the same family or from the same period, arrange them from greatest to least with respect to atomic radius, first ionization energy and electronegativity. Limit examples to elements 1 – 20.

C4.2c: Given a formula, name the compound.  
  
Clarification: Use the first 20 elements from the periodic table plus copper, iron, lead and mercury. Problems should include molecular compounds (two nonmetals) three element compounds with common ions. Common ions should be limited to: acetate, hydroxide, sulfate, sulfite, nitrate, nitrite, carbonate and ammonium.  
  
C4.2d: Given the name, write the formula of ionic and molecular compounds.  
  
Clarification: Same as C4.2c.

C5.2x: Balancing Equations  
A balanced chemical equation will allow one to predict the amount of product formed.  
  
C4.3x – Solids  
Solids can be classified as metallic, ionic, covalent, or network covalent. These different types of solids have different properties that depend on the particles and forces found in the solid.  
  
C5.4x – Changes of State  
All changes of state require energy. Changes in state that require energy involve breaking forces holding the particles together. The amount of energy will depend on the type of forces

C4.3i: Explain why ionic solids have higher melting points than covalent solids. (For example, NaF has a melting point of 995°C while water has a melting point of 0° C.)  
  
Clarification: None

C5.5e: Relate the melting point, hardness, and electrical and thermal conductivity of a substance to its structure.  
Clarification: Physical properties of a substance depend on the strength and types of bonding holding it together. Use examples: common covalent network (diamond or silicon dioxide), a metal (copper or gold), and ionic substance (sodium chloride).

**Summative assessment:**

**Unit 2 test given that cover all mentioned concepts. Students will individually do one of the labs that were assigned in the 2 week unit.**

**Vocabulary**

Ion, Atomic bonding principles, Chemical bond  
Chemical properties of elements  
Covalent bond  
Earth’s elements  
Electrical conductivity  
Electronegativity  
Electron sharing  
Electron transfer  
Element family  
Elements of matter  
Energy sublevels  
Periodic table of the elements  
Ionic bond

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| Lesson | Materials | Skills/Strategies | CCE | Assessments |
| Endothermic and Exothermic | 3 metals, 4 solutions | LR, N, W | 3.2c  C4.4a | FA |
| Lewis Dot Structure  Valence electrons | Notes, P. table | W, N, Draw | C5.5c | FA |
| Ionic and Covalent Properties | Notes, Table, Molecule model, Ionic compound and Covalent compound | W, N, LR | C5.5d | FA |

**Unit 3:**

**Equilibrium, Reversable Reactions, Flame Tests and**

**Periodic Trends.**

Big Ideas (Concepts):

-The students will know what equilibrium is, when it is and is not attainable and how it is related to stability and entropy.

-The students will use flame test to identify the metal in an unknown ionic compound.

-The students will know how to do an “ion exchange” with single and double replacement reactions in order to identify the products in a chemical reaction.

Standards:

C2: Forms of Energy

C3: Energy transfer and Conservation

C4: Properties of Matter

C5: Changes in Matter

Benchmark Standard:

C3.2x – Enthalpy  
Chemical reactions involve breaking bonds in reactants (endothermic) and forming new bonds in the products (exothermic). The enthalpy change for a chemical reaction will depend on the relative strengths of the bonds in the reactants and products.

C3.4x Enthalpy and Entropy  
All chemical reactions involve rearrangement of the atoms. In an exothermic reaction, the products have less energy than the reactants. There are two natural driving forces: (1) toward minimum energy (enthalpy) and (2) toward maximum disorder (entropy).  
  
C5.2: Chemical Changes  
Chemical changes can occur when two substances, elements, or compounds interact and produce one or more different substances whose physical and chemical properties are different from the interacting substances. When substances undergo chemical change, the number of atoms in the reactants is the same as the number of atoms in the products. This can be shown through simple balancing of chemical equations. Mass is conserved when substances undergo chemical change. The total mass of the interacting substances (reactants) is the same as the total mass of the substances produced (products).

C5.6b: Predict single replacement reactions.  
  
Clarification: Students should learn to predict hypothetical products from single replacement reactions and then predict if the reaction will actually form products indicated using the appropriate activity series table.  
3CuCl2 (aq) + 2Al (s) → 3Cu (s) + 2AlCl3 (aq).

C2.2: Molecules in Motion  
Molecules that compose matter are in constant motion (translational, rotational, and vibrational). Energy may be transferred from one object to another during collisions between molecules.  
  
C2.2x: Molecular Entropy  
As temperature increases, the average kinetic energy and the entropy of the molecules in a sample increases.

C2.2c: Explain changes in pressure, volume, and temperature for gases using the kinetic molecular model.  
  
Clarification: Emphasize the understanding of the kinetic model. No calculation or relationship of measurable quantities needed.  
  
C2.2f: Compare the average kinetic energy of the molecules in a metal object and a wood object at room temperature.  
  
Clarification: Note both objects are at the same temperature.

C3.4x – Enthalpy and Entropy  
All chemical reactions involve rearrangement of the atoms. In an exothermic reaction, the products have less energy than the reactants. There are two natural driving forces: (1) toward minimum energy (enthalpy) and (2) toward maximum disorder (entropy).

C5.5c: Draw Lewis structures for simple compounds.  
  
Clarification: Lewis structures can only be drawn for covalent compounds. Examples should be limited to nonmetal binary compounds with single center atoms, for example: H2, N2, O2, F2, Cl2, Br2, I2, H2O, H2S, HCl, HBr, HI, SF2, SCl2, SBr2, SI2, NCl3, NBr3, NI3, PCl3, PBr3, PI3, CH4.

**Summative assessment:**

**Unit 3 test given that cover all mentioned concepts. Students will indifidually do one of the labs that were assigned in the 2 week unit.**

**Vocabulary:**

Binary compound  
Ionization energy  
Lewis structures  
Main energy level  
Main group elements  
Metalloids  
Metallic bond  
Orbital shape  
Outer electron  
Thermal conductivity, Bond energy  
Carbon atom  
Charged object  
Chemical bond  
Crystalline solid

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| Lesson | Materials | Skills/Strategies | CCE | Assessment |
| Periodic Trends | Notes | Notes, Reading and discussion. | C2.2 | FA |
| Balancing Chemical Equations | Note, handouts | Notes, Activity | C5.2 | FA |
| Single Replacement and Double Replacement lab | Lab equipment | Lab group work | C5.6b | FA |

**Unit 4:**

**Activity Series, Predicting Products, Phases of Matter in Chemical Equations,**

**The Mole and Solubility**.

Big Ideas (concepts):

-The students will know what activity series are how to make them and what they are for.

-Based on a given activity series the students will be able to predict if a single replacement reaction will occur or not. Base on the solubility rules, the students will be able to predict if a double replacement reaction will occur or not.

-The students will recognize the phases given to matter in a chemical equation (Example H2O (s).

-The students will know what solubility is and what it depends on.

- The students will know what the Mole is, what it measures and how it was derived.

Standards:

C2: Forms of Energy

C3: Energy Transfer and Conservation

C5: Changes in Matter

Benchmark Standards:

C5.2g: Calculate the number of atoms present in a given mass of element.

**Olivet High School:**

**The Mole Lecture. Bean lab. Avogadro’s # Handout.**  
  
Clarification: Avogadro’s number, (6.02 X 1023 atoms/gram atomic mass), is a constant and a conversion factor. Examples should include only monatomic elements.  
  
C3.3c: Explain why it is necessary for a molecule to absorb energy in order to break a chemical bond.

**Olivet High School:**

**Electrolysis of water lab.**

C4.6x: Moles The mole is the standard unit for counting atomic and molecular particles in terms of common mass units.

C3.3: Heating Impacts  
Heating increases the kinetic (translational, rotational, and vibrational) energy of the atoms composing elements and the molecules or ions composing compounds. As the kinetic (translational) energy of the atoms, molecules, or ions increases, the temperature of the matter increases. Heating a sample of a crystalline solid increases the kinetic (vibrational) energy of the atoms, molecules, or ions. When the kinetic (vibrational) energy becomes great enough, the crystalline structure breaks down, and the solid melts.

**Olivet High School:**

**Solubility lecture. Heating solvent and solute lab.**

C4.7x – Solutions  
They physical properties of a solution are determined by the concentration of solute.

**Olivet High School:**

**Concentration and Reaction Rate lecture. Heating Acid + Mg lab.**

C3.4g: Explain why gases are less soluble in warm water than cold water.  
  
Clarification: As temperature increases the more disordered state is favored. Dissolved gases have less entropy than undissolved gases so as temperature increases the change is forced toward the gaseous phase.

**Olivet High School:**

**Charles’ Law lecture.**

C4.5a: Provide macroscopic examples, atomic and molecular explanations, and mathematical representations (graphs and equations) for the pressure-volume relationship in gases.  
  
Clarification: None  
  
C4.5b: Provide macroscopic examples, atomic and molecular explanations, and mathematical representations (graphs and equations) for the pressure-temperature relationship in gases.  
  
Clarification: None  
  
C4.5c: Provide macroscopic examples, atomic and molecular explanations, and mathematical representations (graphs and equations) for the temperature-volume relationship in gases.  
  
Clarification: None

**Olivet High School:**

**Ideal Gas Laws lecture. Reading from the text.**

**Summative assessment:**

**Unit 4 test given that cover all mentioned concepts. Students will individually do one of the labs that were assigned in the 2 week unit.**

**Vocabulary:**

Release of energy  
Single bond  
Synthetic polymer  
Binary  
Carbon atom  
Carbon dioxide  
Empirical formula  
Fossil fuel  
Hydrocarbons  
Isomers  
Mole  
Molecular formula

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| Lesson | Materials | Skills/Strategies | CCE | Assessment |
| Activity Series, Single and Double Replacement reactions. | Notes, lab. Equipment. | Writing, Reading, Group work | C4.5b  C4.5c  C4.5a | FA |
| Phases and chemical Equations | Notes. | Writing, Reading | C3.4g  C4.7x  C3.3 | FA |
| The Mole | Beans, Notes, Avogadro’s Handout | Writing, reading, calculations | C3.3c | FA |

**Unit 5:**

**Stoichiometry, Atoms, Molecules or Formula Units,**

**Limiting Reactant, Theoretical yield and % Yield**.

Big Ideas (concepts):

-The students will identify and calculate the limiting reactant of a chemical reaction.

-The students will use the limiting reactant to calculate the theoretical yield and % yield.

-The students will make conversions from the different kinds of sub – atomic particles to moles and vise versa.

Strands:

C2: Forms of Energy

C3: Energy Transfer and Conservation

C5: Changes in Matter

Benchmark Standards:

C5.2g: Calculate the number of atoms present in a given mass of element.

Benchmark Standards:

C4.10c: Calculate the average atomic mass of an element given the percent abundance and mass of the individual isotopes.  
  
Clarification: Atomic mass numbers of isotopes will be given.  
  
C4.10d: Predict which isotope will have the greatest abundance given the possible isotopes for an element and the average atomic mass in the periodic table.  
  
Clarification: No calculations are required here. This expectation should just require conceptualizing the isotope in greatest amount. Example: If B has only isotopes of B11 and B10 but the atomic mass is listed as B10.81; atoms of isotope 11 must be more abundant than isotope 10.

**Olivet High School: isotopes will be defined in notes and discussed in group work. Carbon 14 vs Carbon 12 example.**

Clarification: The main group elements are found in columns 1, 2, and 13-18 on modern periodic tables. Column 18 does not react under normal conditions and will not be used here.  
C4.6a: Calculate the number of moles of any compound or element given the mass of the substance.  
  
Clarification: Notice these calculations should include compounds as well as elements. A modern periodic table must be made available.  
C4.6b: Calculate the number of particles of any compound or element given the mass of the substance.  
  
Clarification: A modern periodic table must be made available

**Olivet High School: The mole will be reemphasized and Avagadro’s number will be calculated in the “Bean” lab.**

C5.2e: Identify the limiting reagent when given the masses of more than one reactant.  
  
Clarification: Limiting reagents can be predicted given a balanced chemical equation, the formula masses of reactants, and starting masses of reactants.  
Simple calculations should suffice here and can be determined using mental math (simple multiplication of atomic weights).  
Example: 200 grams of Fe are reacted with 100 grams of O2.  
4Fe (s) + 3O2 (g) → 2Fe2O3(s)  
  
Notice in this example the masses are close to the stoichiometric value for iron and oxygen, but iron is slightly less and oxygen is slightly greater. If oxygen is greater then the iron would need to be greater also, therefore the iron is limited. Further examples should follow this pattern. Keep the mass of at least one of the reagents nearly a multiple of the stoichiometric value.

**Olivet High school: Limiting reactant will be defined in lecture. Sample problems will be assigned and discussed.**

**Limiting reactant and % yield lab.**

**Summative assessment:**

**Unit 5 test given that cover all mentioned concepts. Students will individually do one of the labs that were assigned in the 2 week unit.**

**Vocabulary:**

Delta (meaning change)  
Endothermic reaction  
Exothermic reaction  
Limiting reagent  
Molar Volume  
Oxidation-Reduction reactions  
Pressure  
Product  
Properties of reactants  
Reactant  
Reagent  
Release of energy

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| Lesson | Materials | Skills/Strategies | CCE | Assesment |
| Catalysts | Notes, H2O / H2O2  Manganese Dioxide | Lecture, reading, writning lab. | C2: Forms of Energy  C3: Energy Transfer and Conservation  C5: Changes in Matter | FA |
| Limiting Reactant | Notes, Mg + HCl | Limiting reactant lecture and lab | C3: Energy Transfer and Conservation | FA |
| Stoichiometery | Notes, problems | Group discussion on conversions steps. | C3: Energy Transfer and Conservation | FA |

**Unit 6**

**Acids, Bases, pH and Titration.**

Big Idea (concepts):

-The students will know the definition of an acid, base and neutral mixtures.

-The students will use basic titration techniques and stoichiometery to calculate the Molarity of an unknown concentration of a hydrochloric or sulfuric acid.

Strands:

C2: Forms of Energy

C3: Energy Transfer and Conservation

C5: Changes in Matter

Benchmark Standards:

C5.7f: Write balanced chemical equations for reactions between acids and bases and perform calculations with balanced equations.  
  
Clarification: Use only strong acids (HCl, H2SO4 and HNO3) and strong bases, (the hydroxides of alkali and alkaline earth metals). Calculations would review concepts presented in Unit 6, “Equations and Stoichiometry.”

**Olivet High School:**

**The students will use a simple acid/base titration to determine the strength of acids, bases and salts.**  
  
C5.7g: Calculate the pH from the hydronium ion or hydroxide ion concentration.  
  
Clarification: Calculate the pH from hydronium ion concentration, -log[H3O+], or using Kw, 1 x 10-14.  
Exclusion: Molarity is not a vocabulary word.  
[H+O] = Hydronium ion concentration and the units are mole/liter. Molarity is not required

**Olivet High School:**

**The students will know what pH stands for, what it means when a solution has a pH of “2 or 2.5” and how it is related to Molarity.**  
  
C5.7h: Explain why sulfur oxides and nitrogen oxides contribute to acid rain  
  
Clarification: Sulfuric and nitric acids can be formed when sulfur oxides and nitrogen oxides mix with rain water.

**Olivet High School:**

**The students will be able to name different kinds of acids and be able to give examples of common acids (Battery acid, Acid rain).**  
C4.4x – Molecular Polarity  
The forces between molecules depend on the net polarity of the molecule as determined by shape of the molecule and the polarity of the bonds.  
  
 **Olivet High School:**

**The students will know what a polar molecule is, how this is related to the water molecule and how to compare the polarity of different colors of inks based on what happens when water runs through it.**  
Content Expectations and Content Statement Clarifications:  
C2.1a: Explain the changes in potential energy (due to electrostatic interactions) as a chemical bond forms and use this to explain why bond breaking always requires energy.  
  
Clarification: None

**Summative assessment:**

**Unit 6 test given that cover all mentioned concepts. Students will individually do one of the labs that were assigned in the 2 week unit.**

**Vocabulary:**

Acid rain  
Acid/base reaction  
Acidic  
Alkaline  
Basic  
Bronsted-Lowry  
Carboxyl group  
Hydrogen ion  
Hydronium ion  
Hydroxide  
Ion  
Kw,  
Neutral  
Neutralize  
pH

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| Lesson | Materials | Skills/Strategies | CCE | Assessment |
| pH, acids, bases and how to tell the difference. | Indicator, NaOH, HCl, buret. | Lecture, read, write , discuss.  Titration lab | C2: Forms of Energy  C3: Energy Transfer and Conservation  C5: Changes in Matter | FA |
| Polar Molecules, chromotagraphy, | Markers, coffee filters & water. | Chromotagraphy lab. Penny lab | C3: Energy Transfer and Conservation | FA |
| Calculation Molarity | Notes, text, problems. | Lecture, read, write discuss. Sample problems. | C3: Energy Transfer and Conservation | FA |

**Unit 7**

**Polarity, Polymers, Surface tension, catalysts and reaction rate.**

Big Ideas (core concepts):

* The students will learn what surface tension, its effect on polarity and what a polar molecule is.
* The students will learn what a salt is and how they are produced.
* The students will learn what a polymer is and the elements (Hydrogen and Carbon) that are in them and how they behave.
* The students will learn the effects that a solute has on both polarity and surface tension.
* The students will learn the effects of catalysts , temperature and concentration on reaction rate.
* The students will know what a buffer is and how they wrok.
* The students will know what oxidation/reduction reactions are.
* The students will know what electrolytes are and how to tell if they are working better than another.

Standards:

Content Standards:

C4.4b: Identify if a molecule is polar or nonpolar given a structural formula for the compound.  
  
Clarification: The polarity of a molecule is based on two ideas. One is the bonding itself, whether it is polar or nonpolar. The second part is the geometry or shape of the molecule and whether or not the polar bonds cancel out. Symmetric molecules are always nonpolar. Polar molecules will align themselves a set way within an electric field because they have a greater electron density on one side then another. CH2Cl2 is polar molecule whereas CCl4 is nonpolar molecule. They both have the same geometry but one is symmetrical and the polar bonds cancel out.

**Olivet High School:**

**The students will be given notes during lecture that define and give examples of polar molecules. They will investigate (in lab) the effects of salt and soap on the polarity of water, overhead ink and dry erase ink through the use of chromatography.**

C5.6x: Reduction/Oxidation Reactions  
Chemical reactions are classified according to the fundamental molecular or submolecular changes that occur. Reactions that involve electron transfer are known as oxidation/ reduction (or “redox”).

C5.6a: Balance half-reactions and describe them as oxidations or reductions.

Clarification: Limit these reactions to balancing electrons on reactant or product side of the equation.  
Example: Mg → Mg2+ + 2e-  
Cl2 + 2e- → 2Cl-  
Exclusion: Reactions in acidic or basic conditions

C5.6c: Explain oxidation occurring when two different metals are in contact.

Clarification: None  
  
C5.6d: Calculate the voltage for spontaneous redox reactions from the standard reduction potentials.

Clarification: None  
  
C C 5.6e: Identify the reactions occurring at the anode and cathode in an electrochemical cell.  
Clarification: Oxidation occurs at the anode and reduction occurs at the cathode  
  
OIL RIG (Oxidation Is Loss, Reduction Is Gain) in regards to electrons.  
  
Models that demonstrate one metal protecting another metal as a  
sacrificial anode.

**Olivet High School:**

**The students will be given examples of oxidation (rust and burning) an analogy to remember it (OIL RIG) and a diagram of half reactions that illustrate the concept in notes and lecture.**

C4.3c: Compare the relative strengths of forces between molecules based on the melting point and boiling point of the substances.  
  
Clarification: None

**Olivet High School:**

**The students will need to retain the differences between Ionic and covalent compounds in order to investigate the differences in solubility and melting point of salt vs. sugar in lab.**  
  
C4.3d: Compare the strength of the forces of attraction between molecules of different elements. (For example, at room temperature, chlorine is a gas and iodine is a solid.)  
  
Clarification: Compare the elements within one family only at a time. (i.e. alkali metals, alkaline earth metals, halogens, noble gases)

**Olivet High School:**

**The students will find the elements in the above families and be given the differences in properties of those families in lecture. The students will also, be shown demonstrations of the alkali family (Brainiac video) and answer questions that requires them to compare to the most stable family (Noble gases). The students will also discuss the difference between the properties of hydrogen and helium.**

C4.3f: Identify the elements necessary for hydrogen bonding (N, O, F).  
  
Clarification: None  
  
C4.3g: Given the structural formula of a compound, indicate all the intermolecular forces present (dispersion, dipolar, hydrogen bonding).  
  
Clarification: None  
  
C4.3h: Explain properties of various solids such as malleability, conductivity, and melting point in terms of the solid’s structure and bonding.  
  
Clarification: None  
  
  
C5.4c: Explain why both the melting point and boiling points for water are significantly higher than other small molecules of comparable mass (e.g., ammonia and methane).  
  
Clarification: None

C5.6a: Balance half-reactions and describe them as oxidations or reductions.

Clarification: Limit these reactions to balancing electrons on reactant or product side of the equation.  
Example: Mg → Mg2+ + 2e-  
Cl2 + 2e- → 2Cl-  
Exclusion: Reactions in acidic or basic conditions

C5.6c: Explain oxidation occurring when two different metals are in contact.

Clarification: None  
  
C5.6d: Calculate the voltage for spontaneous redox reactions from the standard reduction potentials.

Clarification: None

C5.6e: Identify the reactions occurring at the anode and cathode in an electrochemical cell.  
Clarification: Oxidation occurs at the anode and reduction occurs at the cathode  
  
OIL RIG (Oxidation Is Loss, Reduction Is Gain) in regards to electrons.  
  
Models that demonstrate one metal protecting another metal as a  
sacrificial anode.

**Summative assessment:**

**Unit 7 test given that cover all mentioned concepts. Students will individually do one of the labs that were assigned in the 2 week unit.**

**Vocabulary:**

Electron transfer  
Endothermic process  
Enthalpy  
Exothermic process  
Hydrocarbon  
Intermolecular force  
Ion  
Isomers  
Monomer  
Moving electric charge  
Polarity  
Potential energy

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| Lesson | Material | Skills/Strategies | CCE’s | Assesment |
| Surface tension, polarity and salts. | Notes, sugar, salt, soap, coffee filter, markers. | Read, write and discuss the mentioned concepts along with lecture and labs (polarity lab and chromatography lab.) | C5  C4  C3 | FA |
| Polymers Intro | Notes, Ethyl alcohol, Sodium Silicate | Read, write and discuss. Super ball lab | Same | FA |
| Buffers, Reaction Rate,Redox and electrolytes. | Notes, Buffers A and B, Salts, power source, electrolysis leads, acids and bases. | Lecture and labs (buffer lab, electrolyte lab, effects of temp and concentration lab. | Same | FA |

**Unit 8**

**Enthalpy, Entropy, Heat, Exothermic and endothermic reactions.**

Big Ideas (Core Concepts):

-The students will read write and discuss the heat of a chemical reaction (enthalpy) and how to calculate it.

-The students will know what causes the forces between water molecules and what they are called (hydrogen bonds).

-The students will know how to name acids and be able to compare the properties of several different acids.

- The students will know what happens to the freezing point of water when salt is dissolved in it.

-The students will know the general rules (Alkene, Alkane and Alkyne series) for organic chemistry and how to name and draw several different versions of organic molecules (isomers).

Standards:

Content Standards:

C4.10e: Write the symbol for an isotope, XZA , where Z is the atomic number, A is the mass number, and X is the symbol for the element.  
  
Clarification: To teach this topic for conceptual understanding students should be given exercises with the location of the A and Z switched so students don’t memorize the location as the key to the answer. Example: XZA, XAZ

**Olivet High School:**

**Using a periodic table and an isotope handout, the students will be given the sub – atomic particles of several isotopes and be required to identify the most common form of the element.**  
C3.2b: Describe the relative strength of single, double, and triple covalent bonds between nitrogen atoms.  
  
Clarification: The three bond examples in increasing order of strength are: single < double < triple.  
  
  
Clarification: None  
  
  
C5.8a: Draw structural formulas for up to ten carbon chains of simple hydrocarbons.  
  
Clarification: Simple hydrocarbons should include alkanes, alkenes, and alkynes to take into account the versatility of carbon and the fact that multiple bonds were introduced in C3.2b.

C5.8b: Draw isomers for simple hydrocarbons.  
  
Clarification: Isomers should be limited to structure only at this point (no geometric isomers). Most likely limit examples and work to six carbon compounds for alkanes and either four or five for alkenes and alkynes.  
  
C4.2e: Given the formula for a simple hydrocarbon, draw and name the isomers.  
  
Clarification: Limit hydrocarbons to 6 carbon compounds with all single bonds. Isomer names should be limited to IUPAC naming rules.

**Olivet High School:**

**The students will read, write and discuss the general “language” used to name carbon chains and their isomers using prefixes up to “Hex” (meaning 6). The students will identify and draw organic molecules.**  
  
C3.4c: Write chemical equations including the heat term as a part of equation or using ΔH notation.  
  
Clarification: Do not calculate ΔH from heat of formation tables.

C3.1c: Calculate the ΔH for a chemical reaction using simple coffee cup calorimeter.  
  
Clarification: None  
  
C3.1d: Calculate the amount of heat produced for a given mass of reactant from a balanced chemical equation.  
  
Clarification: The heat of reaction for the balanced equation must be given.  
C3.2x: Enthalpy  
Chemical reactions involve breaking bonds in reactants (endothermic) and forming new bonds in the products (exothermic). The enthalpy change for a chemical reaction will depend on the relative strengths of the bonds in the reactants and products.  
  
C2.2e: Compare the entropy of solids, liquids, and gases.  
  
Clarification: None.  
  
C3.1a: Calculate the ΔH for a given reaction using Hess’s Law.  
  
Clarification: Use reactions involving only a two step process when the overall reaction and the heats of formation are given.  
  
C3.1b: Draw enthalpy diagrams for exothermic and endothermic reactions.  
  
Clarification: Activation energies need to be included in all diagrams.  
  
   
C3.4d: Draw enthalpy diagrams for reactants and products in endothermic and exothermic reactions.  
  
Clarification: (see C3.1b)  
  
C3.4e: Predict if a chemical reaction is spontaneous given the enthalpy (ΔH) and entropy (ΔS) changes for the reaction using Gibb’s Free Energy, ΔG = ΔH - TΔS (Note: mathematical computation of ΔG is not required.)  
  
Clarification: There are two driving forces for all reactions, (1) decreasing energy (ΔH -), and (2) increasing entropy (ΔS +). If both forces are favorable (ΔH (-), ΔS (+)) the reaction is always spontaneous. If both forces are unfavorable (ΔH (+), ΔS (-)) the reaction cannot be spontaneous. If one force is favorable and the other unfavorable the spontaneity will depend on the temperature. If ΔG is negative then the reaction is spontaneous. If ΔG is zero then the reaction is at equilibrium.  
  
C3.4f: Explain why some endothermic reactions are spontaneous at room temperature.  
  
Clarification: None

C5.3b: Predict shifts in a chemical system caused by changing conditions (Le Châtelier’s Principle).  
Clarification: None

C5.3c: Predict the extent reactants are converted to products using the value of the equilibrium constant.  
Clarification: No calculations are necessary. If the Keq is greater than 1 the products are favored when equilibrium is reached. If Keq is less than 1 the reactants are favored.

**Olivet High School:**

**The students will read, write, discuss and investigate the differences between enthalpy and entropy. The differences between the heat of an endothermic reaction as opposed to an exothermic reaction.**

**Summative assessment:**

**Unit 8 test given that cover all mentioned concepts. Students will individually do one of the labs that were assigned in the 2 week unit.**

**Vocabulary:**

Concentration, Activation energy  
Disorder  
Endothermic reaction  
Enthalpy  
Entropy  
Exothermic reaction  
Gibb’s Free Energy  
Hess’s Law  
Reaction rate  
Release of energy  
Spontaneous  
Convection current  
Convection heating  
Crystalline solid  
Electrostatic attractions  
Enthalpy  
Entropy  
Equilibrium  
Exothermic reaction  
Freezing point depression  
Hess’s Law  
Ionic motion  
Joules  
Kinetic energy  
Mass to energy conversion  
Potential energy  
Release of energy  
Solute  
Specific heat  
Transforming matter and/or energy

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| Lesson | Material | Skills/Strategies | CCE’s | Assesment |
| Enthalpy of exothermic and endothermic reactions. | Notes, Mg, HCl, H2SO4, Thermometer, peanut, cashew, matches, wooden splint. | Read, write and discuss the mentioned concepts. Delta H of sulfuric and hydrochloric acid with Mg lab. Calories in a peanut vs. a cashew lab | C3  C4  C5 | FA |
| Hydrogen Bonds and Naming acids | Notes | Lecture on “H” bonds and Naming acids. Naming acids activity | Same | FA |
| Organic Chemistry | Notes, Text, laptops | Lecture on the language of Organic Chem. Drawing and naming handout of organic molecules and their isomers | Same | FA |