The Mission of the Chardon Local Schools is High Achievement for All Students, Where Learning is Our Most Important Work.

Science Course of Study:

CHEMISTRY — *General*

Revised January 2022

CHARDON
LOCAL SCHOOLS

#WeAreChardon

General Chemistry

Committee Members: Eric Bartley, Jill Carpenter, Jeanne Clark

Strand: Structure and Properties of Matter

Learning Standards: **C.PM: STRUCTURE AND PROPERTIES OF MATTER** **C.PM.1: Atomic structure/Evolution of atomic models/theory/Electrons/Electron Configuration** ● Compare the nature of protons, neutrons and electrons among different atomic models. ● Compare the strengths and limitations of particular atomic models. Investigate the principles used to develop atomic models (e.g. a blackbox problem.) ● Predict which isotope is most abundant given an element's atomic mass and the mass numbers of its isotopes. ● Identify atomic models (e.g., Dalton's, Thomson's, Rutherford's, Bohr's) and the work used to produce each of these models. ● Interpret the classic historical experiments that were used to identify the components of an atom and behavior of electrons. ● Calculate atomic mass given the abundance of various isotopes. ● Determine the atomic number, mass number, number of protons, neutrons and electrons. ● Compare the electron configuration of various ions based on data from an experiment (e.g., flame test, spectral tubes). Explore the color of various salts by looking at the electromagnetic spectrum. ● Identify the extended and noble gas notation electron configurations for elements in the first three periods. ● Using the periodic table, determine the electron configuration of an atom. ● Construct an orbital diagram or electron configuration to show the probable arrangement of electrons in an atom.	**How Taught?** **Teaching activities may include, but are not limited to:** ● Students closely read select passages from documents to analyze text structure, development, and consequent meanings. ● Teacher provides direct instruction, give feedback, and model critical thinking ● Small group and class discussions ● Cooperative learning groups ● Students to define, use, and connect to content area and based vocabulary ● Students analyze video content related to standards that provide a broader global perspective of content. ● Design and conduct lab-based investigations that connect content to real-life experiences. ● Provide opportunities for out of building excursions (field trips) to provide additional real world application of standards. ● Using technology and mathematics to improve investigations and communications. ● Utilize data to impact instruction
Materials: ● Chemistry textbook ● Chemistry lab manual ● Lab equipment and chemicals ● Vernier probes ● Worksheets ● Online resources (pHet, Physics Classroom, Crash Course Chemistry, etc) ● Gradecam/Google Forms	**How Assessed?** **Assessments may include, but are not limited to:** ● Pre-Assessments (pre-tests, observation, questioning, diagnostics) ● Formative Assessments (entry/exit slips, mini analysis assignments, group work, discussions, homework/classwork, self and peer evaluations, checklists, guided notes, observations,quizzes,

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Learning Standards: **C.PM: STRUCTURE AND PROPERTIES OF MATTER** **C.PM.2: Periodic table/Properties/Trends** ● Predict the placement of an element on the periodic table given only a list of its properties. ● Describe ionization energy and relate it to atomic structure. ● Describe electronegativity and relate it to atomic structure. ● Describe periodic trends in ionic radii and electron affinity and relate them to atomic structure. ● Describe atomic radius and relate to atomic structure. ● For two atoms, identify the one that is larger, more electronegative, or more easily ionized based on where they are on the periodic table. Justify your answer ● Create a graphic to show the relationships between the trends of the periodic table and	**How Taught?** **Teaching activities may include, but are not limited to:** ● Students closely read select passages from documents to analyze text structure, development, and consequent meanings. ● Teacher provides direct instruction, give feedback, and model critical thinking ● Small group and class discussions ● Cooperative learning groups ● Students to define, use, and connect to content area and based vocabulary ● Students analyze video content related to standards that provide a broader global perspective of content. ● Design and conduct lab-based investigations that connect content to real-life experiences. ● Provide opportunities for out of building excursions (field trips) to provide additional real world application of standards. ● Using technology and mathematics to improve investigations and communications. ● Utilize data to impact instruction

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Learning Standard: **C.PM: STRUCTURE AND PROPERTIES OF MATTER** **C.PM.3: Chemical bonding:Ionic/Polar/covalent** ● Compare the stability of ions when they are separated vs. when they are in their lattice. Construct models or diagrams (e.g., Lewis dot structures, ball and stick models) of common compounds and molecules (e.g., NaCl, SiO2, O2, H2, CO2) and distinguish between ionically and covalently bonded compounds. ● Using electron configurations, hypothesize how	**How Taught?** **Teaching activities may include, but are not limited to:** ● Students closely read select passages from documents to analyze text structure, development, and consequent meanings. ● Teacher provides direct instruction, give feedback, and model critical thinking ● Small group and class discussions ● Cooperative learning groups ● Students to define, use, and connect to content area and based vocabulary

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an atom becomes a cation or anion and illustrate how and why they would form ionic compounds.
● Define bond energy and recognize that bond-breaking is an endothermic process and bond-forming is an exothermic process. (Honors only)
● Represent the formation of a bond using electron configurations of individual atoms. Explain the tendency of elements to transfer or share electrons based on their location on the periodic table.
● Identify valence electrons as the highest energy electrons in the atom and use the octet rule to predict the most stable ion formed
● Using electron dot diagrams, generate models showing that molecular compounds result from atoms sharing electrons.
● Include carbon bonds showing the formation of chains, rings and branching networks.
● Distinguish between bond polarity and molecular polarity. (Honors only)
● Compare the stability of atoms when they are separated vs. when they are bonded.
● Distinguish between ionic and polar/nonpolar covalent bonds based on their electronegativity values.
● Write equations for covalent bond formation between two atoms using Lewis structures.
● Explain the difference between a single, double and triple bond in terms of electrons shared. Compare the bond energies and lengths for single, double and triple bonds conceptually (no numbers).
● Illustrate how freely moving electrons in metallic bonds affect properties such as conductivity, malleability and ductility. (Honors only)
● Explain how the structure of metal atoms give them the ability to conduct heat and electricity. (Honors only)
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Learning Standard: **C.PM: STRUCTURE AND PROPERTIES OF MATTER** **C.PM.4: Representing compounds/Formula writing/Nomenclature/Models and shapes (Lewis structures, ball and stick, molecular geometries)** ● Given elements from the periodic table and/or polyatomic ions, predict the formula of a compound. ● Write a formula from the name of an acid. ● Given the formula of an ionic compound or a binary covalent compound, determine the compound's name. ● Name an acid based on its chemical formula. ● Construct simple Lewis structures of compounds made up of hydrogen, carbon, nitrogen, oxygen, phosphorus, sulfur and the halogens. ● Predict the three-dimensional shapes of simple Lewis structures using valence shell electron pair repulsion (VSEPR) theory. ● Construct three-dimensional ball-and stick models to determine the shapes of simple covalent compounds. ● Predict the bond angle based on VSEPR theory ● Predict the hybridization based on VSEPR Theory.	**How Taught?** **Teaching activities may include, but are not limited to:** ● Students closely read select passages from documents to analyze text structure, development, and consequent meanings. ● Teacher provides direct instruction, give feedback, and model critical thinking ● Small group and class discussions ● Cooperative learning groups ● Students to define, use, and connect to content area and based vocabulary ● Students analyze video content related to standards that provide a broader global perspective of content. ● Design and conduct lab-based investigations that connect content to real-life experiences. ● Provide opportunities for out of building excursions (field trips) to provide additional real world application of standards. ● Using technology and mathematics to improve investigations and communications. ● Utilize data to impact instruction

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Learning Standard:	How Taught?
C.PM: STRUCTURE AND PROPERTIES OF MATTER **C.PM.5: Quantifying matter** ● Devise a method to indirectly determine the value of a measurement that common laboratory tools cannot provide (e.g., thickness of aluminum foil, number of sand particles, moles of chalk used to write your name, drop from a pipet) - Mole Lab ● Design a method to determine the empirical formula or percent composition of an unknown hydrate/compound. ● Determine the percent by mass of carbon in sodium bicarbonate. ● Compare moles and mass. Identify situations where each is most appropriate to use. ● Investigate the relationship between the volume of any liquid sample and its mass. ● Measure the volume of an irregular solid using SI units. Provide your answer using correct significant figures and units. ● Distinguish accuracy from precision. ● Carry out laboratory measurements with a variety of equipment (e.g., graduated cylinders, beakers, balances) and report measurements to the correct number of significant figures. ● Compare the accuracy of each measuring device. ● Apply the rules for determining significant digits when performing mathematical operations. ● Determine the average atomic mass of an element based on the percent abundance of its naturally occurring isotopes. ● Convert between mass, moles, volume and number of representative particles using Avogadro's number, molar mass and density using dimensional analysis.	● Students closely read select passages from documents to analyze text structure, development, and consequent meanings. ● Teacher provides direct instruction, give feedback, and model critical thinking ● Small group and class discussions ● Cooperative learning groups ● Students to define, use, and connect to content area and based vocabulary ● Students analyze video content related to standards that provide a broader global perspective of content. ● Design and conduct lab-based investigations that connect content to real-life experiences. ● Provide opportunities for out of building excursions (field trips) to provide additional real world application of standards. ● Using technology and mathematics to improve investigations and communications. ● Utilize data to impact instruction
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Learning Standard:

C.PM: STRUCTURE AND PROPERTIES OF MATTER

C.PM.6: Intermolecular forces of attraction/Types and strengths/Implications for properties of substances/Melting and boiling point/Solubility/Vapor pressure

- Apply the idea of intermolecular forces to biological implications (e.g., hydrogen bonding between two DNA strands, cell membrane formation of lipids).
- Illustrate the differences between intermolecular forces. Represent the cause of intermolecular forces between molecules using models.
- Describe intermolecular forces for molecular compounds.
    - H-bond as attraction between molecules when H is bonded to O, N, or F.
    - Dipole-dipole attractions between polar molecules.
    - London dispersion forces (electrons of one molecule attracted to the nucleus of another molecule) – i.e. liquefied inert gases.

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○ Relative strengths (H>dipole>London/van der Waals). ● Demonstrate the effect the strength of intermolecular forces has on various properties (e.g., change in evaporation temperature, polarizability, viscosity). Predict which compound will have the highest/lowest vapor pressure and melting/boiling point based on intermolecular forces. ● Differentiate between bond polarity and molecular polarity. ● Explain why greater solubility occurs when dissolving a substance in a solvent with similar intermolecular forces ("like dissolves like").	
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Strand: INTERACTIONS OF MATTER

Learning Standard:	How Taught?
C.IM: INTERACTIONS OF MATTER **C.IM.1: Chemical reactions/Types of reactions/Kinetics/Energy/Equilibrium/Acids/bases** • Classify a chemical reaction as synthesis, decomposition, single replacement, double replacement or organic combustion. • Identify which substance is oxidized and which substance is reduced in an oxidation/reduction reaction. • Using activity series and solubility rules construct an outcome for single replacement and double replacement reactions. • Explain the energy changes in photosynthesis and in the combustion of sugar in terms of bond breaking and bond formation. • Draw a particle diagram representing the interactions of particles in a chemical reaction. • Evaluate oxidation-reduction reactions occurring in real-world settings (e.g., rusting, electroplating) that cause engineering/manufacturing challenges and propose a solution. • Identify the ways the rate of a chemical reaction can be affected (e.g., concentrations of reactions, surface area, changing temperature or pressure of gaseous substances, using a catalyst). • Critique the effects of a catalyst on everyday chemical reactions (e.g., biological enzymes, catalytic converters). Redesign a process which is more cost effective and/or environmentally friendly. • Generate and analyze qualitative potential energy diagrams for endothermic and exothermic reactions with and without the presence of a catalyst (e.g., decomposition of H2O2 with KI and without KI). Include reactants, products and activated complexes. • Calculate the thermal energy change (q), the change of temperature (ΔT), initial or final temperature and mass of a material using specific heat. • Given a table of bond energies, determine whether a given reaction is exothermic or endothermic. • Track the flow of energy and explain why a reaction is an exothermic or endothermic process. • Compare how the specific heat of different substances impacts temperature change. • Show that equilibrium is dynamic and that the rates of the forward and reverse reactions are equal.	• Students closely read select passages from documents to analyze text structure, development, and consequent meanings. • Teacher provides direct instruction, give feedback, and model critical thinking • Small group and class discussions • Cooperative learning groups • Students to define, use, and connect to content area and based vocabulary • Students analyze video content related to standards that provide a broader global perspective of content. • Design and conduct lab-based investigations that connect content to real-life experiences. • Provide opportunities for out of building excursions (field trips) to provide additional real world application of standards. • Using technology and mathematics to improve investigations and communications. • Utilize data to impact instruction

• Describe key features of equilibrium (two opposing processes occur simultaneously at the same rate). • Perform calculations relating pH to hydronium ion concentration. • Identify acids based on the formation of the hydronium ion in water. • Identify bases by their dissociation in water to form the hydroxide ion. • Evaluate neutralization reactions quantitatively by performing titration experiments.	
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Learning Standard:

C.IM: INTERACTIONS OF MATTER

C.IM.2: Gas laws

Pressure, volume and temperature

- Using simulations and/or laboratory experiences, determine the relationships between pressure and volume, pressure and temperature, and temperature and volume.
- Explain both the quantitative and qualitative relationships between pressure, volume and temperature.
- Construct models representing the relationship of pressure, volume and temperature related to collisions and energy of particles.
- Apply gas laws to common scenarios (e.g. hot air balloons, tire blowouts) Use the kinetic molecular theory to explain the motion of gas particles and how they are affected by changes in pressure, temperature and/or volume.
- Identify units of pressure, volume and temperature.
- Convert between different pressure units.
- Solve problems using appropriate gas law equations. (Combined gas law)
- Determine whether pressure, temperature and volume are increasing or decreasing in a given situation.
- Use Dalton’s Law of Partial Pressures to calculate the partial pressure of a gas in a mixture or the total pressure, given the partial pressures of each gas in the mixture.
- Use Dalton’s Law to determine the pressure of a dry gas when collected by water displacement.

Ideal gas law

- Detects and measures the volume of a gas produced during a chemical reaction and relates to molar volume at standard temperature and pressure. (molar volume of a gas law)
- Use an Ideal Gas Law Simulator to represent and interpret the connection between pressure, volume, temperature and number of particles.
- Apply the ideal gas law to solve for an appropriate variable.
- Experimentally determine the value of the ideal gas constant, R.

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Learning Standard: **C.IM: INTERACTIONS OF MATTER** **C.IM.3: Stoichiometry/Molar calculations/Solutions/Limiting reagents** • Calculate the reactants needed to produce an exact amount of a product (e.g., produce silver through the reaction of silver nitrate and copper or zinc and hydrochloric acid). Produce the product in the laboratory. • Calculate the percent difference between the theoretical amount and the amount actually produced. Provide possible explanations for the discrepancy. • Explain how the creation of a standardized solution (a solution of known molarity) allows you to determine the concentration of an unknown solution. • Compare limiting to excess reagents in a chemical reaction (e.g., copper (II) sulfate and an iron nail).	**How Taught?** • Students closely read select passages from documents to analyze text structure, development, and consequent meanings. • Teacher provides direct instruction, give feedback, and model critical thinking • Small group and class discussions • Cooperative learning groups • Students to define, use, and connect to content area and based vocabulary • Students analyze video content related to standards that provide a broader global perspective of content. • Design and conduct lab-based investigations that connect content to real-life experiences. • Provide opportunities for out of building excursions (field trips) to provide additional real world application of standards. • Using technology and mathematics to improve investigations and communications. • Utilize data to impact instruction

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