Curriculum Development
In the Fairfield Public Schools

Fairfield Public Schools
FAIRFIELD, CONNECTICUT

CHEMISTRY 32

Board of Education Approved 05/22/2007

CHEMISTRY 32

Statement of Purpose

Science education promotes essential understandings of the natural world and nurtures students' abilities to apply scientific knowledge to make informed and logical judgments about personal and societal issues. As such, this education requires that the fundamental approach to science be a creative and logical process for investigating, reasoning, critiquing and communicating about ideas, not just a static body of facts to be memorized. Understanding the interconnections between science and technology and their shared impact on the environment and societal issues is essential for all students.

Chemistry is an investigative science that deals with the composition of materials and the qualitative and quantitative changes that these materials undergo. Through the study of chemistry, students will understand the nature of these changes. This will help them to manipulate natural materials to their benefit. In addition, an understanding of these concepts will allow individuals to make informed choices and seek solutions to scientific and technological problems that citizens of the 21st century will face.

Audience

Grade 10, 11 and 12 students

Prerequisite

"C" or better in Algebra

Design and Description

This course will provide students with a fundamental knowledge of chemistry. Major topics of study include: atomic and molecular structure; chemical reactions; the periodic table; the separation of substances; energy in chemical change; and solutions. Major topics of study include: atomic and molecular structure, chemical reactions, the periodic table, the separation of substances, energy in chemical change, and solutions. Students will investigate these topics through a variety of classroom activities which include: pre-written and open-ended laboratory experiments; small group discussions; lectures and note taking; viewing videos; learning and applying problem-solving techniques; and relating chemical principles to daily experience. Students will understand the role of chemistry in explaining natural phenomena and in seeking solutions to scientific and technological problems that citizens of the 21st century will face.

Course Objectives

Students will be able to:

- define the field of chemistry and explain the importance of studying it.
- identify several ways in which chemistry affects daily life.
- apply the steps of the scientific method.
- trace how a hypothesis may become a natural law.
- identify the reason for each laboratory safety rule.
- distinguish among a quantity, a unit, and a measurement standard.
- distinguish between mass and weight.

- analyze data using the concepts of accuracy and precision.
- contrast inversely and directly proportional relationships.
- translate a calculated ratio into a meaningful written statement.
- compare and contrast chemical and physical properties and changes.
- apply the Law of Conservation of Matter/Energy.
- compare and contrast kinetic and potential energy.
- apply the kinetic molecular theory to describe the motion of particles in solids, liquids, and gases and the phase changes that they undergo.
- compare and contrast heat and temperature.
- trace the development of atomic theory from early Greek models to present knowledge; Democritus, Dalton, Thomson, Rutherford, Bohr, Heisenberg, Einstein.
- apply the postulates of Dalton's atomic model to explain the Law of Conservation of Mass and the Law of Definite Composition.
- relate atomic number, mass number, and location on the periodic table to subatomic particles and isotopes.
- define the processes of nuclear fission and fusion.
- define a wave in terms of its frequency, wavelength, speed, and amplitude.
- relate the electron configuration of an atom to its reactivity and to its location in the periodic table.
- trace the development of the modern periodic table.
- identify areas of the periodic table that contain metals, non-metals and metalloids.
- apply the periodic law.
- identify patterns in electron configuration within groups and periods.
- define the trends in atomic mass, atomic number, atomic radius, electronegativity and ionization energy.
- identify the reasons that atoms form chemical bonds.
- compare and contrast ionic, covalent and metallic bonding.
- differentiate between a molecule and a formula unit.
- define single, double and triple bonds.
- define polymerization and the resulting physical properties of polymers.
- analyze the significance of a chemical formula.
- distinguish between ionic and molecular compounds.
- differentiate among empirical, molecular, and structural formulas.
- define the mole concept using Avogadro's number.
- define molar volume of a substance and list factors that affect its value.
- predict the products of simple reactions, given the reactants.
- identify forms of evidence that a chemical reaction has occurred.
- interpret a balanced equation in terms of atoms, molecules, and ions.
- classify a reaction as synthesis, decomposition, single replacement, double replacement, combustion, neutralization, precipitation, and redox reaction.
- predict whether a reaction will occur using the activity series of metals.
- compare and contrast dissolution and precipitation.

- determine whether a reaction is exothermic or endothermic using data or energy term placement.
- determine the mole ratios of substances in a balanced chemical reaction.
- determine which of two reactants the limiting reactant in a given equation is.
- apply the kinetic-molecular theory to explain changes of state and the relationships among pressure, temperature, volume and number of moles of gases.
- identify the physical properties of gases including the greenhouse effect.
- explain the significance of standard temperature and pressure (STP).
- compare and contrast real and ideal gases.
- identify real world applications for gas laws.
- apply kinetic molecular theory to explain the properties of solids and liquids and changes of state.
- compare and contrast the different types of intermolecular forces.
- compare and contrast ionic, molecular, metallic, and network covalent solids.
- apply the principles of equilibrium to explain the concept of vapor pressure.
- relate the unusual properties of water to hydrogen bonding.
- trace the solution process and the factors affecting solubility.
- interpret data in solubility curves and tables.
- identify two colligative properties of a solution (boiling point elevation, freezing point depression).
- apply collision theory to explain the factors that affect the rate of reaction.
- summarize the role of a catalyst in enzymes, catalytic convertors and solution chemistry.
- apply the concept of equilibrium to explain physical and chemical changes.
- distinguish between a reversible reaction that is in equilibrium and one that is not.
- apply Le Chatelier's principle to explain the effects of changes in concentration, pressure and temperature on an equilibrium system.
- predict the products and write balanced equations for acid-base reactions.
- categorize acids and bases based on strength.
- use laboratory data to determine the strength of an acid or base.
- calculate the hydrogen ion and hydroxide ion concentrations in any solution.
- calculate pH from hydrogen ion concentration or hydroxide ion concentration.
- perform an acid-base titration to determine the concentration of an unknown solution.

Skill Objectives

Students will:

- demonstrate basic safety rules when working in the laboratory.
- demonstrate proper use of basic laboratory safety equipment.
- identify common laboratory equipment.
- apply the rules of significant digits in measurements and calculations.
- collect valid data to determine mass, volume and density.
- perform calculations with numbers in scientific notation.
- draw and interpret graphs of scientific data

- apply dimensional analysis to solve problems.
- separate a mixture of substances based on their physical and chemical properties.
- classify a substance as an element, compound, or mixture based on observable physical and chemical properties.
- calculate average atomic mass of an element, and calculate percentage abundance of an isotope given its average atomic mass.
- write, balance, and interpret a nuclear equation.
- calculate the amount of a radioactive substance that remains after a given period of time.
- diagram the electromagnetic spectrum showing trends in frequency, wavelength and energy.
- calculate the energy of a photon
- write the electron configuration for any element using the Aufbau principle, the Pauli Exclusion Principle and Hund's rule. Use these configurations to predict chemical behavior.
- draw the Lewis dot structure for any atom or ion.
- identify general properties of main group elements.
- predict the charge or oxidation number of an element from its position on the periodic table.
- illustrate ionic and covalent bonding using orbital notation and Lewis dot structures.
- apply the VSEPR model to explain basic molecular shape.
- construct the correct chemical formula for a given ionic or molecular compound.
- name and write formulas for acids, bases, polyatomic ions, and hydrates.
- name and write formulas for simple organic compounds.
- apply the rules for assigning oxidation numbers in elements and compounds.
- calculate formula mass, molar mass and percent composition of elements, compounds, and hydrates.
- calculate the mass of a single atom or molecule.
- calculate empirical from percent composition data, actual mass data, and analysis of experimental results.
- write the word equation, formula equation, and balanced chemical equation for a given chemical reaction.
- write the net ionic equation of a precipitation reaction.
- collect data and use solubility tables to predict precipitate formation.
- assign oxidation numbers to reactants and products.
- calculate the quantity of a reactant or product in a balanced chemical equation.
- convert among mass, moles, particles, and volumes between reactants and products using a balanced chemical equation.
- calculate percent yield.
- illustrate how a barometer and a manometer work.
- convert among the measurement units of the four gas variables (V. T, P, n).
- perform calculations using Boyle's Law, Charles' Law, Avogadro's Hypothesis and Gay-Lussac's Law.

- solve problems involving the combined gas law, Dalton's law of partial pressure, Graham's law of diffusion, and the ideal gas laws.
- collect data to determine the molar volume of a gas.
- demonstrate the formation of the different types of solutions: saturated, supersaturated, unsaturated, dilute, and concentrated.
- solve concentration problems using the concepts of molarity and molality.
- calculate the value of the equilibrium constant for a given reaction.
- predict precipitate formation using the solubility product (K_{sp}).
- measure enthalpy changes in chemical reactions.
- predict the products and write balanced equations for acid-base reactions.
- categorize acids and bases based on strength.
- use laboratory data to determine the strength of an acid or base.
- calculate the hydrogen ion and hydroxide ion concentrations in any solution.
- calculate pH from hydrogen ion concentration or hydroxide ion concentration.
- perform an acid-base titration to determine the concentration of an unknown solution.

Science Core Standards

SCIENTIFIC INQUIRY (used in all high school courses)

Students will engage in a thoughtful and coordinated attempt to search out, describe, explain and predict natural phenomena.

Students will engage in a continuous process of questioning, data collection, analysis and interpretation.

Students will share findings and ideas for critical review by colleagues and other scientists.

SCIENTIFIC LITERACY (used in all high school courses)

Students will read, write, discuss and present coherent ideas about science.

Students will search for and assess the relevance and credibility of scientific information found in various print and electronic media.

SCIENTIFIC NUMERACY (used in all high school courses)

Scientific numeracy includes the ability to use mathematical operations and procedures to calculate, analyze and present scientific data and ideas.

Students will identify questions that can be answered through scientific investigation.

Students will read, interpret and examine the credibility and validity of scientific claims in different sources of information.

Students will formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment.

Students will design and conduct appropriate types of scientific investigations to answer different questions.

Students will identify independent and dependent variables, including those that are kept constant and those used as controls.

Students will use appropriate tools and techniques to make observations and gather data.

Students will use appropriate tools and techniques to make observations and gather data.

Students will assess the reliability of the data that was generated in the investigation.

Students will use mathematical operations to analyze and interpret data, and present relationships between variables in appropriate forms.

Students will articulate conclusions and explanations based on research data, and assess results based on the design of the investigation.

Students will communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.

Chemical Structures and Properties – Properties of Matter
Atoms react with one another to form new molecules.

Students will describe the general structure of the atom, and explain how the properties of the first 20 elements in the Periodic Table are related to their atomic structures.

Students will describe how atoms combine to form new substances by transferring electrons (ionic bonding) or sharing electrons (covalent bonding).

Students will explain the chemical composition of acids and bases, and explain the change of pH in neutralization reactions.

Due to its unique chemical structure, carbon forms many organic and inorganic compounds.

Students will explain how the structure of the carbon atom affects the type of bonds it forms in organic and inorganic molecules.

Students will describe combustion reactions of hydrocarbons and their resulting by-products.

Students will explain the general formation and structure of carbon-based polymers, including synthetic polymers, such as polyethylene, and biopolymers, such as carbohydrate.

Chemical Structures and Properties - Science and Technology in Society
Chemical technologies present both risks and benefits to the health and well-being of humans, plants and animals.

Students will explain how simple chemical monomers can be combined to create linear, branched and/or cross-linked polymers.

Students will explain how the chemical structure of polymers affects their physical properties.

Students will explain the short- and long-term impacts of landfills and incineration of waste materials on the quality of the environment.

Global Interdependence – Science and Technology in Society
The use of resources by human populations may affect the quality of the environment.

Students will explain how the accumulation of carbon dioxide (CO_2) in the atmosphere increases Earth's "greenhouse" effect and may cause climate changes.

<u>Chemistry Enrichment Standards</u>
Atomic and Molecular Structure
The periodic table displays the elements in increasing atomic number and shows how periodicity of the physical and chemical properties of the elements relates to atomic structure

Students will explain the nucleus of the atom is much smaller than the atom yet contains most of its mass.

Students will explain the quantum model of the atom is based on experiments and analyses by many scientists, including Dalton, Thomson, Bohr, Rutherford, Millikan, and Einstein.

Students will relate the position of an element in the periodic table is related to its atomic number.

Students will use the periodic table can be used to identify metals, semimetals, non-metals, and halogens.

Students will use the periodic table can be used to identify trends in ionization energy, electronegativity, the relative sizes of ions and atoms and the number of electrons available for bonding.

Students will relate the electronic configuration of elements and their reactivity can be identified based on their position in the periodic table.

Chemical Bonds

Biological, chemical, and physical properties of matter result from the ability of atoms to form bonds from electrostatic forces between electrons and protons and between atoms and molecules

Students will explain that atoms combine to form molecules by sharing electrons to form covalent or metallic bonds or by exchanging electrons to form ionic bonds.

Students will identify chemical bonds between atoms in molecules such as H_2, CH_4, NH_3, H_2CCH_2, N_2, Cl_2, and many large biological molecules are covalent.

Students will explain that the atoms and molecules in liquids move in a random pattern relative to one another because the intermolecular forces are too weak to hold the atoms or molecules in a solid form.

Students will use Lewis dot structures can provide models of atoms and molecules.

Students will predict the shape of simple molecules and their polarity can be predicted from Lewis dot structures.

Students will explain that solids and liquids held together by van der Waals forces or hydrogen bonds have effects on their volatility and boiling/melting point temperatures.

Conservation of Matter and Stoichiometry

The conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants.

Students will describe that chemical reactions can be described by writing balanced equations.

Students will apply that one mole equals $6.02.x\ 10^{23}$ particles (atoms or molecules).

Students will determine the molar mass of a molecule can be determined from its chemical formula and a table of atomic masses

Students will convert among moles, number of particles, or volume of gas at standard temperature and pressure using the mass of a molecular substance.

Reaction Rates

Chemical reaction rates depend on factors that influence the frequency of collision of reactant molecules.

Students will explain that the rate of reaction is the decrease in concentration of reactants or the increase in concentration of products with time.

Students will explain that reaction rates depend on such factors as concentration, temperature and pressure.

Students will explain that equilibrium is established when forward and reverse reaction rates are equal.

Students will explain that catalysts play a role in increasing the reaction rate by changing the activation energy in a chemical reaction.

Essential Questions

- How is scientific knowledge created and communicated?
- How does the structure of matter affect the properties and uses of materials?
- How do science and technology affect the quality of our lives?
- What is the role of energy in our world?

Focus Questions

- How do Chemists use the scientific method?
- When does a hypothesis become a law?
- How is mathematics used as a tool to investigate chemical concepts?
- What is matter?
- What is energy?
- What do we use to distinguish one substance from another?
- How do we separate substances?
- What are atoms made of?
- What evidence supports current atomic theory?
- What is radioactivity?
- What is light?
- How are elements arranged in the Periodic Table?
- Why does the Periodic Table have the shape that it does?
- Why do atoms form chemical bonds?
- Are there different types of chemical bonds?
- How strong are chemical bonds?
- Does the arrangement of chemical bonds affect the strength of materials?
- What does a chemical formula tell us?
- How are chemical formulae written?
- How are compounds named?
- What is a "mole"?
- How is the mole used in Chemistry?
- How can we describe chemical reactions?
- What types of chemical reactions exist?
- How do we predict the products of a reaction?
- What are the quantitative relationships in a chemical reaction?
- How do gasses behave?

- What is a “greenhouse” gas?
- How do solids and liquids behave?
- What factors affect solubility?
- How do solutions differ from pure substances?
- What factors affect reaction rate?
- What is chemical equilibrium?
- What is an acid?
- What is a base?
- How do we categorize acids and bases?

UNITS of STUDY

Unit 1: Scientific Knowledge & Reasoning

Science Core Standards

Scientific Inquiry

Students will engage in a thoughtful and coordinated attempt to search out, describe, explain and predict natural phenomena.

Students will engage in a continuous process of questioning, data collection, analysis and interpretation.

Students will share findings and ideas for critical review by colleagues and other scientists.

Scientific Literacy

Students will read, write, discuss and present coherent ideas about science.

Students will search for and assess the relevance and credibility of scientific information found in various print and electronic media.

Essential Question

- How is scientific knowledge created and communicated?

Focus Questions

- How do Chemists use the scientific method?
- When does a hypothesis become a law?

Core Topics

- Scientific method
- Laboratory safety

Unit Objectives

Students will be able to:

- define the field of chemistry and explain the importance of studying it.
- identify several ways in which chemistry affects daily life.
- apply the steps of the scientific method.
- trace how a hypothesis may become a natural law.
- identify the reason for each laboratory safety rule.

Skill Objectives

Students will:

- demonstrate basic safety rules when working in the laboratory.
- demonstrate proper use of basic laboratory safety equipment.
- identify common laboratory equipment.

Sample Assessment
Evidence of Interaction

Pacing
1 week

Unit 2: Dimensional Analysis, Problem Solving & Significant Figures

Science Core Standards

Scientific Numeracy

Scientific numeracy includes the ability to use mathematical operations and procedures to calculate, analyze and present scientific data and ideas.

Students will identify questions that can be answered through scientific investigation.

Students will read, interpret and examine the credibility and validity of scientific claims in different sources of information.

Students will formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment.

Students will design and conduct appropriate types of scientific investigations to answer different questions.

Students will identify independent and dependent variables, including those that are kept constant and those used as controls.

Students will use mathematical operations to analyze and interpret data, and present relationships between variables in appropriate forms.

Students will articulate conclusions and explanations based on research data, and assess results based on the design of the investigation.

Students will communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.

Students will assess the reliability of the data that was generated in the investigation.

Students will use appropriate tools and techniques to make observations and gather data.

Essential Question

- How is scientific knowledge created and communicated?

Focus Question

- How is mathematics used as a tool to investigate chemical concepts?

Core Topics

- Dimensional analysis
- Significant digits
- Graph construction
- Graph interpretation

Unit Objectives

Students will be able to:

- distinguish among a quantity, a unit, and a measurement standard.
- distinguish between mass and weight.
- analyze data using the concepts of accuracy and precision.
- contrast inversely and directly proportional relationships.
- translate a calculated ratio into a meaningful written statement.

Skill Objectives

Students will:

- apply the rules of significant digits in measurements and calculations.
- collect valid data to determine mass, volume and density.
- perform calculations with numbers in scientific notation.
- draw and interpret graphs of scientific data
- apply dimensional analysis to solve problems.

Sample Assessment

What's density?

Pacing

1 week

Unit 3: States of Matter & Energy Changes

Chemistry Enrichment Standards

Chemical Bonds

Biological, chemical, and physical properties of matter result from the ability of atoms to form bonds from electrostatic forces between electrons and protons and between atoms and molecules

The atoms and molecules in liquids move in a random pattern relative to one another because the intermolecular forces are too weak to hold the atoms or molecules in a solid form.

Essential Question

- How does the structure of matter affect the properties and uses of materials?

Focus Questions

- What is matter?
- What is energy?
- What do we use to distinguish one substance from another?
- How do we separate substances?

Core Topics

- Physical vs. chemical
- States of matter
- Kinetic molecular theory

Unit Objectives

Students will be able to:

- compare and contrast chemical and physical properties and changes.
- apply the Law of Conservation of Matter/Energy.
- compare and contrast kinetic and potential energy.
- apply the kinetic molecular theory to describe the motion of particles in solids, liquids, and gases and the phase changes that they undergo.
- compare and contrast heat and temperature.

Skill Objectives

Students will:

- separate a mixture of substances based on their physical and chemical properties.
- classify a substance as an element, compound, or mixture based on observable physical and chemical properties.

Sample Assessment

Who brings the heat?

Pacing

2 weeks

Unit 4: Structure of Matter

Science Core Standards
Properties of Matter
Atoms react with one another to form new molecules.

Students will describe the general structure of the atom, and explain how the properties of the first 20 elements in the Periodic Table are related to their atomic structure.

Chemistry Enrichment Standards
Atomic and Molecular Structure
The periodic table displays the elements in increasing atomic number and shows how periodicity of the physical and chemical properties of the elements relates to atomic structure

Students will explain that the nucleus of the atom is much smaller than the atom yet contains most of its mass.

Students will explain that the quantum model of the atom is based on experiments and analyses by many scientists, including Dalton, Thomson, Bohr, Rutherford, Millikan, and Einstein.

Students will relate the position of an element in the periodic table to its atomic number.

Essential Question

- How does the structure of matter affect the properties and uses of materials?

Focus Questions

- What are atoms made of?
- What evidence supports current atomic theory?
- What is radioactivity?
- What is light?

Core Topics

- Use laboratory data to determine the strength of an acid or base.
- History of atomic theory
- Atomic structure
- Octet rule
- Lewis dot notation
- Radioactivity
- Wave properties

Unit Objectives
Students will be able to:

- trace the development of atomic theory from early Greek models to present knowledge; Democritus, Dalton, Thomson, Rutherford, Bohr, Heisenberg, Einstein.
- apply the postulates of Dalton's atomic model to explain the Law of Conservation of Mass and the Law of Definite Composition.
- relate atomic number, mass number, and location on the periodic table to subatomic particles and isotopes.
- define the processes of nuclear fission and fusion.
- define a wave in terms of its frequency, wavelength, speed, and amplitude.
- relate the electron configuration of an atom to its reactivity and to its location in the periodic table.

Skill Objectives

Students will:

- calculate average atomic mass of an element, and calculate percentage abundance of an isotope given its average atomic mass.
- write, balance, and interpret a nuclear equation.
- calculate the amount of a radioactive substance that remains after a given period of time.
- diagram the electromagnetic spectrum showing trends in frequency, wavelength and energy.
- calculate the energy of a photon
- write the electron configuration for any element using the Aufbau principle, the Pauli Exclusion Principle and Hund's rule. Use these configurations to predict chemical behavior.
- draw the Lewis dot structure for any atom or ion.

Sample Assessment

Bean Bag Isotopes

Pacing

2 weeks

Unit 5: Periodic Table

Chemistry Enrichment Standards

Atomic and Molecular Structure

The periodic table displays the elements in increasing atomic number and shows how periodicity of the physical and chemical properties of the elements relates to atomic structure

Students will use the periodic table to identify metals, semimetals, non-metals, and halogens.

Students will use the periodic table to identify trends in ionization energy, electronegativity, the relative sizes of ions and atoms and the number of electrons available for bonding.

Students will relate the electronic configuration of elements and their reactivity to their position in the periodic table.

Essential Question

- How does the structure of matter affect the properties and uses of materials?

Focus Questions

- How are elements arranged in the Periodic Table?
- Why does the Periodic Table have the shape that it does?

Core Topics

- History of the Periodic table
- Sections of the table
- Periodic law
- Periodic trends

Unit Objectives

Students will be able to:

- trace the development of the modern periodic table.
- identify areas of the periodic table that contain metals, non-metals and metalloids.
- apply the periodic law.
- identify patterns in electron configuration within groups and periods.
- define the trends in atomic mass, atomic number, atomic radius, electronegativity and ionization energy.

Skill Objectives

Students will:

- identify general properties of main group elements.
- predict the charge or oxidation number of an element from its position on the periodic table.

Sample Assessment
Mendeleev for a Day

Pacing
3 weeks

Unit 6: Bonding & Molecular Structure

Science Core Standards

Chemical Structures and Properties – Properties of Matter

Due to its unique chemical structure, carbon forms many organic and inorganic compounds.

Students will explain how the structure of the carbon atom affects the type of bonds it forms in organic and inorganic molecules.

Students will explain the general formation and structure of carbon-based polymers, including synthetic polymers, such as polyethylene, and biopolymers, such as carbohydrate.

Chemical Structures and Properties – Science, Technology and Society

Chemical technologies present both risks and benefits to the health and well being of humans, plants and animals.

Students will explain how simple chemical monomers can be combined to create linear, branched and/or cross-linked polymers.

Students will explain how the chemical structure of polymers affects their physical properties.

Students will explain the short- and long-term impacts of landfills and incineration of waste materials on the quality of the environment.

Chemistry Enrichment Standards

Chemical Bonds

Biological, chemical, and physical properties of matter result from the ability of atoms to form bonds from electrostatic forces between electrons and protons and between atoms and molecules

Students will explain that atoms combine to form molecules by sharing electrons to form covalent or metallic bonds or by exchanging electrons to form ionic bonds.

Students will identify chemical bonds between atoms in molecules such as H_2, CH_4, NH_3, H_2CCH_2, N_2, Cl_2, and many large biological molecules as covalent.

Students will use Lewis dot structures to show models of atoms and molecules.

Students will predict the shape of simple molecules and their polarity from Lewis dot structures.

Essential Question

- How does the structure of matter affect the properties and uses of materials?

Focus Questions

- Why do atoms form chemical bonds?
- Are there different types of chemical bonds?
- How strong are chemical bonds?
- Does the arrangement of chemical bonds affect the strength of materials?

Core Topics

- Driving force behind bonding
- Types of chemical bonds
- VSEPR theory
- Molecular shape
- Polymerization

Unit Objectives

Students will be able to:

- identify the reasons that atoms form chemical bonds.
- compare and contrast ionic, covalent and metallic bonding.
- differentiate between a molecule and a formula unit.
- define single, double and triple bonds.
- define polymerization and the resulting physical properties of polymers.

Skill Objectives

Students will:

- illustrate ionic and covalent bonding using orbital notation and Lewis dot structures.
- apply the VSEPR model to explain basic molecular shape.

Sample Assessment

Models of Molecular Compounds

Pacing

3 weeks

Unit 7: Formula Writing

Science Core Standards

Chemical Structures and Properties – Properties of Matter
Atoms react with one another to form new molecules.

Students will describe how atoms combine to form new substances by transferring electrons (ionic bonding) or sharing electrons (covalent bonding).

Essential Question

- How does the structure of matter affect the properties and uses of materials?

Focus Questions

- What does a chemical formula tell us?
- How are chemical formulae written?
- How are compounds named?

Core Topics

- Ratios of elements
- Subscripts
- Formula construction
- Oxidation numbers

Unit Objectives

Students will be able to:

- analyze the significance of a chemical formula.
- distinguish between ionic and molecular compounds.
- differentiate among empirical, molecular, and structural formulas.

Skill Objectives

Students will:

- construct the correct chemical formula for a given ionic or molecular compound.
- name and write formulas for acids, bases, polyatomic ions, and hydrates.
- name and write formulas for simple organic compounds.
- apply the rules for assigning oxidation numbers in elements and compounds.

Sample Assessment

Formula of an ionic compound

Pacing

2.5 weeks

Unit 8: Mathematics of Chemical Formulas

Chemistry Enrichment Standards

Conservation of Matter and Stoichiometry

The conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants.

Students will apply the definition that one mole equals 6.02.x 10^{23} particles (atoms or molecules).

Students will determine the molar mass of a molecule from its chemical formula and a table of atomic masses

Essential Question

- How does the structure of matter affect the properties and uses of materials?

Focus Questions

- What is a "mole"?
- How is the mole used in Chemistry?

Core Topics

- Mole as amount
- Conversions
- Empirical formulas

Unit Objectives

Students will be able to:

- define the mole concept using Avogadro's number.
- define molar volume of a substance and list factors that affect its value.

Skill Objectives

Students will:

- calculate formula mass, molar mass and percent composition of elements, compounds, and hydrates.
- calculate the mass of a single atom or molecule.
- calculate empirical from percent composition data, actual mass data, and analysis of experimental results.

Sample Assessment

Thirsty? How many water particles do you drink in a sip?

Pacing

3.5 weeks

MID-YEAR COMPLETION POINT

Unit 9: Types of Reactions

Science Core Standards

Chemical Structures and Properties – Properties of Matter

Due to its unique chemical structure, carbon forms many organic and inorganic compounds.

Students will describe combustion reactions of hydrocarbons and their resulting by-products.

Essential Question

- How does the structure of matter affect the properties and uses of materials?

Focus Questions

- How can we describe chemical reactions?
- What types of chemical reactions exist?
- How do we predict the products of a reaction?

Core Topics

- Parts of a chemical equation
- Evidence for chemical reactions
- Types of reactions
- Net ionic equations
- Solubility tables
- Reaction driving forces

Unit Objectives

Students will be able to:

- predict the products of simple reactions, given the reactants.
- identify forms of evidence that a chemical reaction has occurred.
- interpret a balanced equation in terms of atoms, molecules, and ions.
- classify a reaction as synthesis, decomposition, single replacement, double replacement, combustion, neutralization, precipitation, and redox reaction.
- predict whether a reaction will occur using the activity series of metals.
- compare and contrast dissolution and precipitation.
- determine whether a reaction is exothermic or endothermic using data or energy term placement.

Skill Objectives

Students will:

- write the word equation, formula equation, and balanced chemical equation for a given chemical reaction.
- write the net ionic equation of a precipitation reaction.
- collect data and use solubility tables to predict precipitate formation.
- assign oxidation numbers to reactants and products.

Sample Assessment
Metal reactivity

Pacing
3.5 weeks

Unit 10: Stoichiometry of Chemical Reactions

Chemistry Enrichment Standards

Conservation of Matter and Stoichiometry

The conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants.

Students will describe chemical reactions by writing balanced equations.

Essential Question

- How does the structure of matter affect the properties and uses of materials?

Focus Question

- What are the quantitative relationships in a chemical reaction?

Core Topics

- Ratios and amounts
- Limiting reactant
- Percent yield

Unit Objectives

Students will be able to:

- determine the mole ratios of substances in a balanced chemical reaction.
- determine which of two reactants the limiting reactant in a given equation is.

Skill Objectives

Students will:

- calculate the quantity of a reactant or product in a balanced chemical equation.
- convert among mass, moles, particles, and volumes between reactants and products using a balanced chemical equation.
- calculate percent yield.

Sample Assessment

Percent Yield

Pacing

3 weeks

Unit 11: Gas Laws

Science Core Standards

Global Interdependence – Science, Technology and Society

The use of resources by human populations may affect the quality of the environment.

Students will explain how the accumulation of carbon dioxide (CO_2) in the atmosphere increases Earth's greenhouse effect and may cause climate change.

Chemistry Enrichment Standards

Conservation of Matter and Stoichiometry

The conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants.

Students will convert among moles, number of particles, or volume of gas at standard temperature and pressure using the mass of a molecular substance.

Essential Question

- How do science and technology affect the quality of our lives?

Focus Questions

- How do gasses behave?
- What is a "greenhouse" gas?

Core Topics

- Kinetic-molecular theory
- Pressure/temperature/volume relationships
- Real vs. ideal gasses

Unit Objectives

Students will be able to:

- apply the kinetic-molecular theory to explain changes of state and the relationships among pressure, temperature, volume and number of moles of gases.
- identify the physical properties of gases including the greenhouse effect.
- explain the significance of standard temperature and pressure (STP).
- compare and contrast real and ideal gases.
- identify real world applications for gas laws.

Skill Objectives

Students will:

- illustrate how a barometer and a manometer work.
- convert among the measurement units of the four gas variables (V. T, P, n).
- perform calculations using Boyle's Law, Charles' Law, Avogadro's Hypothesis and Gay-Lussac's Law.

- solve problems involving the combined gas law, Dalton's law of partial pressure, Graham's law of diffusion, and the ideal gas laws.
- collect data to determine the molar volume of a gas.

Sample Assessment
Boyle's Law by the Book

Pacing
3 weeks

Unit 12: Solids, Liquids, and Solutions

Chemistry Enrichment Standards

Chemical Bonds

Biological, chemical, and physical properties of matter result from the ability of atoms to form bonds from electrostatic forces between electrons and protons and between atoms and molecules

Students will explain that solids and liquids held together by van der Waals forces or hydrogen bonds have effects on their volatility and boiling/melting point temperatures.

Students will explain that the atoms and molecules in liquids move in a random pattern relative to one another because the intermolecular forces are too weak to hold the atoms or molecules in a solid form.

Essential Questions

- How does the structure of matter affect the properties and uses of materials?

Focus Questions

- How do solids and liquids behave?
- What factors affect solubility?
- How do solutions differ from pure substances?

Core Topics

- Changes of state
- Vapor pressure
- Solubility
- Colligative properties

Unit Objectives

Students will be able to:

- apply kinetic molecular theory to explain the properties of solids and liquids and changes of state.
- compare and contrast the different types of intermolecular forces.
- compare and contrast ionic, molecular, metallic, and network covalent solids.
- apply the principles of equilibrium to explain the concept of vapor pressure.
- relate the unusual properties of water to hydrogen bonding.
- trace the solution process and the factors affecting solubility.
- interpret data in solubility curves and tables.
- identify two colligative properties of a solution (boiling point elevation, freezing point depression).

Skill Objectives

Students will:

- demonstrate the formation of the different types of solutions: saturated, supersaturated, unsaturated, dilute, and concentrated.
- solve concentration problems using the concepts of molarity and molality.

Sample Assessment
Percent of oxygen in a chlorate

Pacing
2.5 weeks

Unit 13: Kinetics, Equilibrium, and Thermodynamics

Chemistry Enrichment Standards

Reaction Rates

Chemical reaction rates depend on factors that influence the frequency of collision of reactant molecules.

Students will explain that the rate of reaction is the decrease in concentration of reactants or the increase in concentration of products with time.

Students will explain that reaction rates depend on such factors as concentration, temperature and pressure.

Students will explain that equilibrium is established when forward and reverse reaction rates are equal.

Students will explain that catalysts play a role in increasing the reaction rate by changing the activation energy in a chemical reaction.

Essential Question

- What is the role of energy in our world?

Focus Questions

- What factors affect reaction rate?
- What is chemical equilibrium?

Core Topics

- Reaction rate
- Catalyst
- Le Chatelier's principle

Unit Objectives

Students will be able to:

- apply collision theory to explain the factors that affect the rate of reaction.
- summarize the role of a catalyst in enzymes, catalytic convertors and solution chemistry.
- apply the concept of equilibrium to explain physical and chemical changes.
- distinguish between a reversible reaction that is in equilibrium and one that is not.
- apply Le Chatelier's principle to explain the effects of changes in concentration, pressure and temperature on an equilibrium system.

Skill Objectives

Students will:

- calculate the value of the equilibrium constant for a given reaction.
- predict precipitate formation using the solubility product (K_{sp}).
- measure enthalpy changes in chemical reactions.

Sample Assessment
Rate of a chemical reaction

Pacing
3 weeks

Unit 14: Acids & Bases

Science Core Standards
Chemical Structures and Properties – Properties of Matter
Atoms react with one another to form new molecules.

Students will explain the chemical composition of acids and bases, and explain the change in pH in neutralization reactions.

Essential Question
- How does the structure of matter affect the properties and uses of materials?

Focus Questions
- What is an acid?
- What is a base?
- How do we categorize acids and bases?

Core Topics
- Classification acids and bases
- pH
- titration

Unit Objectives
Students will be able to:
- identify the common physical and chemical properties of acids and bases.
- classify acids, bases, and salts, and recognize their presence in common substances.
- compare and contrast the Arrhenius and Bronsted-Lowry models for acids and bases.

Skill Objectives
Students will:
- predict the products and write balanced equations for acid-base reactions.
- categorize acids and bases based on strength.
- use laboratory data to determine the strength of an acid or base.
- calculate the hydrogen ion and hydroxide ion concentrations in any solution.
- calculate pH from hydrogen ion concentration or hydroxide ion concentration.
- perform an acid-base titration to determine the concentration of an unknown solution.

Sample Assessment
Titration

Pacing
2 weeks

CAPT PREPARATION

The following standards must be addressed for all grade 10 students prior to March 1st of each school year. Below each standard is a link to the online resources students may use. These may be done independently by students outside of class time.

Global Interdependence – The Changing Earth
Elements on Earth move among reservoirs in the solid earth, oceans, atmosphere and organisms as part of biogeochemical cycles.

Students will explain how chemical and physical processes cause carbon to cycle through the major earth reservoirs.

Students will explain how solar energy causes water to cycle through the major earth reservoirs.

Students will explain how internal energy of the Earth causes matter to cycle through the magma and the solid earth.

LINKS:
http://earthobservatory.nasa.gov/Library/CarbonCycle/carbon_cycle3.html
http://www2.wwnorton.com/college/chemistry/gilbert/tutorials/ch4.htm
http://ga.water.usgs.gov/edu/watercyclesummary.html
http://www.physicalgeography.net/fundamentals/10a.html

Energy Transformations - Energy Transfer and Transformations
The electrical force is a universal force that exists between any two charged objects.

Students will explain the relationship among voltage, current and resistance in a simple series circuit.

Students will explain how electricity is used to produce heat and light in incandescent bulbs and heating elements.

Students will describe the relationship between current and magnetism.

Energy Transformations - Science and Technology in Society
Various sources of energy are used by humans and all have advantages and disadvantages.

Students will explain how heat is used to generate electricity.

Students will describe the availability, current uses and environmental issues related to the use of fossil and nuclear fuels to produce electricity.

Students will describe the availability, current uses and environmental issues related to the use of hydrogen fuel cells, wind and solar energy to produce electricity.

LINKS:
http://www.thinkquest.org/library/websitena.html?28032
http://www.nfcrc.uci.edu/fcresources/FCexplained/FC_animation.htm
http://www2.wwnorton.com/college/chemistry/gilbert/tutorials/ch4.htm
http://www.ballard.com/be_informed/fuel_cell_technology/how_the_technology_works#

Global Interdependence – Science and Technology in Society
The use of resources by human populations may affect the quality of the environment.

Students will explain how the release of sulfur dioxide (SO_2) into the atmosphere can form acid rain, and how acid rain affects water sources, organisms and human-made structures.

Students will explain how the accumulation of mercury, phosphates and nitrates affects the quality of water and the organisms that live in rivers, lakes and oceans.

Some materials can be recycled, but others accumulate in the environment and may affect the balance of the Earth systems.

Students will explain how land development, transportation options and consumption of resources may affect the environment.

Students will describe human efforts to reduce the consumption of raw materials and improve air and water quality.

LINKS:
http://www.epa.gov/acidrain/what/index.html
http://www.umich.edu/~gs265/society/waterpollution.htm
http://www.eia.doe.gov/kids/energyfacts/index.html