Robbinsville High School Honors Chemistry Curriculum

Title: Unit 1, **Introduction to Chemistry** **Grade:** 10

Length: 7 blocks

Enduring Understandings:	**Standards:**
Personal safety in the chemical laboratory is the first priority and the responsibility of each student. Laboratory instrumentation and equipment have measurement limits and those limits are communicated in the data and results. Laboratory investigations are described through lab reports that written according to defined conventions.	HS-PS1-7

Essential Questions:

What metric units are appropriate for precise measurement at different scales?
How are laboratory equipment and materials used safely?
What is measurement precision? What is the relationship between lab ware design and precision? How are materials measured precisely? How is precision expressed?
How are laboratory investigations conducted? What is the relationship between explanation and observation and data? What is an acceptable explanation of error?

Possible Phenomena:

Laboratory investigations may yield unexpected results and those unexpected results may have a valid scientific explanation.
There are multiple ways to carry out an investigation but some procedures may yield more precise results with fewer sources of error.

Disciplinary Core Ideas:	**Scientific & Engineering Practices:**	**Crosscutting Concepts:**
Optimizing design solutions	Using mathematics and Computational Thinking	Patterns

Possible Preconceptions/Misconceptions:

Personal safety is not an individual responsibility.
Measurements are infinitely precise. Calculators report results to the correct precision.
Personal pronouns can be used in formal scientific communication.
Experimental error can be explained as human or equipment error.

Possible Performance Expectations:

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data. *(thickness of Aluminum foil lab)*
Use mathematical representations to support claims *(thickness of aluminum foil lab)*
Different patterns may be observed at each of the scales at which a system is studied *(lab ware design and function)*

Big Ideas:

Science involves investigation and analysis of data. All equipment and materials have limitations that must be considered when designing and carrying out an investigation. There are patterns in laboratory equipment that relate to precision and function.

Students will be able to …

Describe appropriate safety precautions for a laboratory investigation and use them in the lab.

Use the metric system in mathematical computations, and to measure materials in the laboratory.

Relate lab ware size and shape to it's relative precision and metric units.

Describe laboratory precision and use it when conducting investigations, performing calculations and reporting results.

Solve mathematical problems to the correct number of significant figures.

Describe and identify common physical properties of materials.

Write an impersonal, supported hypothesis or research question that relates to the objective of an investigation.

Plan and carry out a laboratory investigation.

Analyze the results of an investigation.

Students will know …

The lab safety rules appropriate for a high school chemistry course.

The common metric units used in chemistry; meters, liters and grams, Kilo-, deci -, centi -, milli, and micro -

Common physical properties of materials.

Equation for % error.

Rules of significant figures and rounding.

Technology and the Nature of Science:

Assumes and Order and Consistency in Natural Systems

Constructing Explanations and Designing Solutions

Building / reinforcing literacy and mathematics skills: Students will …

Visually Represent written safety precautions in a poster. (RST.9-10.7)

Use the internet to find technical information about a material and describe in writing that information. Interpret the information and describe appropriate safety precautions based on the properties of the material. (WHST.11.12.8)

Write a lab report. (WHST.9-12.2)

Convert metric units. (HSN-Q.A.1)

Use the definition and equation for density to solve a laboratory problem and mathematical problems. (HSN-Q.A.1)

Chose equipment to yield best laboratory precision. (density lab) (HSN-Q.A.2)

Report answers rounded to the correct number of significant figures. (assignments and lab) (HSN-Q.A.3)

Assessments: Initial Student Growth Objective evaluation. Formative assessment made by listening to student conversations and observing student performance during group work. Formative assessment of individual student work by observing student performance on tasks. Safety Data Sheet interpretation assignment and safety poster Assignment Completion: measurement precision assignment, metric system conversion / significant figures practice assignment, density / significant figures assignment Thickness of Aluminum Foil lab report Quizzes and clicker review as needed Unit test
Learning Experiences: ACS lab safety video with graphic demonstrations of lab accidents Internet investigation of safety data sheets. Assignments: measurement precision assignment, metric system conversion / significant figures practice assignment, density / significant figures assignment Measurement precision lab, review metric system and lesson on precision of lab ware. Interpretation of distillation demonstration with discussion of physical properties. The lesson associated with the demonstration includes lab report expectations. Thickness of Aluminum Foil (density) lab with lab report.

Robbinsville High School Honors Chemistry Curriculum

<table>
<tr><td colspan="3">Title: Unit 2, Atomic Structure and the Periodic Table</td><td>Grade: 10</td></tr>
<tr><td colspan="4">Length: 8 blocks</td></tr>
<tr><td colspan="3">Enduring Understandings:
All matter is composed of atoms.
Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons.
The periodic table orders elements horizontally by the number of protons in the atom’s nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states.
Different isotopes of the same element have different numbers of neutrons. The atomic mass is a weighted average of isotope mass.
The properties of the elements are a function of effective nuclear charge.</td><td>Standards:
HS-PS1-1</td></tr>
<tr><td colspan="4">Essential Questions:
What is an atom? And why is understanding atomic structure important?
What are the properties of subatomic particles and the atom?
What is an isotope, and how does it affect average atomic mass?
What is the structure of the atom?
What is nuclear energy and how is it harnessed?
How is the periodic table organized and how does it relate to atomic structure?
How do the properties of the elements relate to atomic structure?</td></tr>
<tr><td colspan="4">Possible Phenomena:
The properties of each element are related to the element’s position in the periodic table.
Periodic table position is related to the element’s atomic structure.
As the atomic number in a period increases the atomic radius decreases.
As the atomic number in a period increases the ionization energy increases.
Average atomic mass reported in the periodic table is a weighted average of the mass of the isotopes of an atom.
Elements can be identified by atomic spectra. Atomic spectra are a function of electron energy.
Strong nuclear forces bond the protons and neutrons together. This energy can be harnessed in nuclear reactors.</td></tr>
<tr><td>Disciplinary Core Ideas:
Structure and Properties of Matter, HS-PS1-1.
Nuclear Processes</td><td>Scientific & Engineering Practices:
Developing and Using Models
Using Mathematics and Computational Thinking</td><td colspan="2">Crosscutting Concepts:
Patterns
Stability and Change
Energy and Matter</td></tr>
<tr><td colspan="4">Possible Preconceptions/Misconceptions:
Electrons freely orbit around the nucleus. (Jimmy Neutron model)
Atomic radius is proportional to the number of subatomic particles in the atom.
The mass of an atom should be a whole number.
A mole is a cute subterranean animal, blemish or an informant.</td></tr>
</table>

Possible Performance Expectations:

Develop a model based on evidence to illustrate the relationships between systems or between components of a system. *(nuclear structure and atomic structure)*

Use a model to predict the relationship between systems or between components of a system *(periodic properties)*

Use mathematical representations of phenomena to support claims *(nuclear energy, range of nuclear stability, effective nuclear charge, PES data, average atomic mass)*

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence of causality in explanations of phenomena. (nuclear structure, atomic structure and the periodic table)

Construct explanations of how things change and how they remain stable *(the number of protons in atoms of an element remains the same, each element has a unique number of protons)*

Big Ideas:

All matter is made up of extremely small atoms. The atoms of each element have unique structures due to the interactions of the electrons and the nucleus. The properties of the elements are a periodic function of their atomic number and effective nuclear charge.

Students will be able to:

Model the nucleus and explain why the ratio of protons to neutrons increases with increasing atomic number.

Interpret PES data

Assign electrons in any atom to the correct shell and write the electron configuration notation

Relate the organization of the periodic table to position of ground state electrons in the atom

Relate ionization energy and atomic radius to effective nuclear charge.

Predict the properties of an element based on it's position in the periodic table.

Use dimensional analysis to solve problems involving the mole.

Calculate average atomic mass from relative abundance of each isotope.

Calculate nuclear forces and describe nuclear power and it's risks and benefits.

Students will know:

The charge and relative mass of the proton, neutron and electron.

The names and position of the 4 blocks in the periodic table; s, p, d, and f.

The names of major groups in the periodic table; alkali metal, alkaline earth metal, transition metals, inner transition metals, halogens and noble gases.

The name and location of 38 elements in the periodic table.

The mole = 6.022×10^{23} atoms or molecules

Other Terms: nucleus, atomic number, atomic mass, isotope, periodic table group/family and period, inner, outer and valence electrons, ionization energy, atomic radius, electronegativity

(The memorization tasks in this unit are necessary to avoid student frustration in subsequent units. Students who do not learn this basic information spend a lot of time looking up the elements and terms until they become frustrated and give up on chemistry.)

Technology and the Nature of Science:

Scientific knowledge assumes an order and consistency in natural systems.

Building / reinforcing literacy and mathematics skills: Describe in writing models of the nucleus and atom. Describe in writing graphed trends. (RST.9-10.7) Reason abstractly, atomic structure is an abstract concept. (MP.2) Graph data and develop models based on that data. (HSN-QA.1) Students will use dimensional analysis to solve problems involving the mole. (HSN-QA.1) Answers to problems are rounded to the correct number of significant figures and reported in the correct units. (HSN-QA.3)
Assessments: Formative assessment made by listening to student conversations and observing student performance during modeling of the nucleus and the atom. Formative assessment of individual student work by observing student performance on tasks. Assignment Completion: the nucleus and nuclear stability assignment, atomic model assignment, electron configuration and the periodic table assignment, periodic table organization assignment, periodic trends assignment, the mole and dimensional analysis assignment, and average atomic mass assignment Quizzes and clicker reviews Periodic table memory tests (grade is average of best two out of three) Unit test
Learning Experiences: Use round cereal to model the nucleus. Determine number of neutrons in an atom from atomic number and atomic mass. Plot neutrons vs protons and explain why the ratio of neutrons to protons increases with increasing atomic number. Students will calculate the strong force of the nucleus. Students will investigate nuclear decay and reactions and the uses of nuclear energy. Students will use PES data to model the relative position and energy of ground state electrons in their shells. Lesson on atomic structure, the periodic table and electron configuration notation for the first two periods. Students continue the pattern for subsequent periods. Students answer questions about periodic table organization after a short lesson on same. Students will plot periodic trends, against valence electrons, which also represent effective nuclear charge, and develop models to explain the trend in ionization energy and atomic radius. Short lesson on electronegativity. Students will do a lab to model the size of a mole and use dimensional analysis to solve problems involving the mole. Short lesson on weighted mass and average atomic mass with practice.

Robbinsville High School Honors Chemistry Curriculum

<table>
<tr><td colspan="3">Title: Unit 3, Covalent Bonding Grade: 10

Length: 10 blocks</td></tr>
<tr><td colspan="2">Enduring Understandings:
Conductivity is a function of the bonding between atoms.
The nature of the bonding between atoms is dependent on the number of valence electrons and the effective nuclear charge of the atoms involved.
Electrons are shared in covalent bonds. The number of bonds depends on the number of valence electrons.
Bond energy is a function of the number of covalent bonds and the effective nuclear charge of the elements involved.
The melting / boiling point of molecules is a function of molecular polarity.
The solubility of molecules is a function of molecular polarity.</td><td>Standards:
HS-PS1-1
HS-PS1-2
HS-PS1-3
HS-PS1-4
HS-PS2-6</td></tr>
<tr><td colspan="3">Essential Questions:
Why do atoms bond?
Why do some materials conduct current while others do not?
What is the relationship between atomic structure and bonding?
What is the relationship between bond energy and atomic structure?
How are covalently bonded molecules represented?
What is the relationship between solubility and molecular structure?
What is the relationship between the melting / boiling points of materials and molecular structure?
What is molar mass, how is it calculated and how is it used?</td></tr>
<tr><td colspan="3">Possible Phenomena:
Material conductivity is a function of bonding which is a function of effective nuclear charge.
The solubility of a compound is a function of molecular polarity.
The melting / boiling point of a compound is a function of molecular polarity.
Many of the materials used to day are polymers. Polymers are large covalently bonded compounds.</td></tr>
<tr><td>Disciplinary Core Ideas:
Structure and Properties of Matter; HS-PS1-1, HS-PS1-2, HS-PS1-3, HS-PS1-4
Types of Interactions; HS-PS1-1, HS-PS1-2
Molecular Design and Function; HS-PS2-6</td><td>Scientific & Engineering Practices:
Developing and Using Models
Constructing Explanations
Using Mathematics and Computational Thinking</td><td>Crosscutting Concepts:
Patterns
Energy and Matter
Stability and Change</td></tr>
</table>

Possible Preconceptions/Misconceptions:

All chemical bonds are the same.
Material solubility is a function of molecular size.
Material melting point / boiling point is a function of molecular size.

Possible Performance Expectations:

Develop a model based on evidence to illustrate the relationships between systems or between components of a system. *(conductivity is a function of bonding which is a function of atomic structure, bonding models are a function of valence electrons)*
Use a model to predict the relationship between systems or between components of a system. *(Use valence electrons and Lewis Dot Structures to predict molecular structure)*
Construct explanations from solubility and melting / boiling point data to relate observable phenomena to molecular structure.
Different patterns may be observed at each of the scales at which a system is studied and can provide evidence of causality in explanations of phenomena. *(material solubility and melting / boiling point is a function of molecular polarity)*
Changes in energy in a system can be described in terms of the energy that flows into and out of the system. (HS-PS1-4, *covalent bond energy*)

Big Ideas:

All matter can be understood in terms of arrangements of atoms.
The chemical and physical properties of materials can be explained by the structure and the arrangement of atoms.

Students will be able to …

Relate the conductivity of materials to atomic structure and intramolecular bonding.
Model covalently bonded compounds using physical 3D models and interpret 3D models of compounds.
Model covalently bonded compounds using Lewis Dot Structures and interpret Lewis Dot Structures.
Relate bond energy to the nature of a bond.
Relate the solubility of a molecule to it's polarity and predict the solubility of a molecule.
Relate the melting points and boiling points of a molecule to it's polarity and predict the relative melting / boiling points of materials.
Calculate the molar mass of a compound and solve problems involving molar mass, moles, mass, number of molecules and number of atoms.

Students will know …

How to name binary molecular compounds.
Major organic functional groups. How to name simple organic compounds.
The names and formulas of common polyatomic ions
Names of intra and intermolecular bonds.
Terms associated with solution formation; soluble, insoluble, solute, solvent
(The memorization tasks in this unit are necessary to avoid student frustration in subsequent units. Students who spend a lot of time looking up chemical formulas become frustrated and give up on chemistry.)

Technology and the Nature of Science:

Scientific knowledge assumes an order and consistency in natural systems.

Building / reinforcing literacy and mathematics skills: Explain in writing molecular models and explain the physical characteristics of molecules based on molecular structure. (RST.9-10.7) Write a short lab report on the solubility lab. (WHST.9-12.2) Begin research project on material stability. (WHST.9-12.7, WHST.11-12.8) Reason abstractly about the structure and interactions of molecules (MP.2) Use dimensional analysis to solve problems involving molar mass. (HSN-Q.A.1) Round answers to problems to the correct number of significant figures and report in the appropriate units. (HSN-Q.A.3)
Assessments: Formative assessment made by listening to student conversations and observing student work as they make physical and Lewis dot models of molecules. Formative assessment made by listening to student conversations and observing student work as they evaluate data to develop models relating molecular structure to physical phenomena. Formative assessment made by listening to student conversations and observing student work while solving math based problems. Assignment Completion; Intramolecular bonding assignment, effective nuclear charge and electronegativity assigment, covalent bonding models assignment, binary molecular compound nomenclature assignment, bond energy assignment, organic compounds assignment, intermolecular bonding assignment, molar mass assignment Solubility lab report Quizzes and clicker reviews as needed Polyatomic Ion memory test (average of two) Unit test

Learning Experiences:

Conductivity lab in which students will determine the relative conductivity of pure materials and compounds to conclude there are different types of intramolecular bonding that are based on atomic structure.

Students will; use beads to make physical models of covalently bonded compounds and relate models to atomic structure and effective nuclear charge, make Lewis dot structures of the models, then make models of known compounds using beads and Lewis dot structures. May require short lesson on Lewis dot structures.

Short lesson on naming binary molecular compounds.

Students will make or interpret physical models and Lewis dot structures of compounds and polyatomic ions and determine the polarity of the compounds.

Students will use a chart of bond energies to generate a model relating covalent bond energy to bond polarity and number of bonds.

Students will use a chart of bond energies to calculate the energy stored in molecules.

Students will make or interpret physical models and Lewis dot structures of organic compounds and determine the polarity of the compounds. Short lesson on organic functional groups, simple organic nomenclature and polymers.

Students do a small lab or work from data to relate the solubility of covalent compounds to molecular polarity and then use their model to predict the relative solubility of materials.

Students work from data to relate the melting / boiling point of covalent compounds to molecular polarity. Short lesson on intermolecular bonding. Students then use their model to predict the relative melting / boiling points of materials.

Short lesson on molar mass, students solve problems involving molar mass with guided practice.

Robbinsville High School Honors Chemistry Curriculum

Title: Unit 4, **Ionic Bonding** **Grade:** 10 **Length:** 7 blocks	
Enduring Understandings: The nature of the bonding between atoms is dependent on the number of valence electrons and the effective nuclear charge of the atoms involved. Electrons are given and taken to form ions. Ions of opposite charge bond to form ionic compounds. Formation of ionic compounds is a function of effective nuclear charge and coulombic force. The strength of the bond in ionic compounds is a function of coulombic forces. The melting / boiling point of ionic compounds is much higher than that of covalently bonded compounds. Many Ionic compounds are soluble in water and solutions of ionic compounds conduct current. Metallic bonding holds metal atoms together. Metallic bonding involves free electrons and unfilled orbitals.	**Standards:** HS-PS1-1 HS-PS1-2 HS-PS1-3 HS-PS1-4 HS-PS2-6
Essential Questions: Why do atoms bond? Why do some materials conduct current while others do not? What is the relationship between atomic structure and bonding? What is the relationship between bond energy and atomic structure? How are ionically bonded molecules represented? What are the solubility and melting / boiling points of ionic compounds relative to molecules? What are percent composition. Empirical formula and molecular formula, how are they calculated and how can they be empirically determined?	
Possible Phenomena: Material conductivity is also a function of the number of ions in solution. In nature, most metals exist as ions.	

Disciplinary Core Ideas: Structure and Properties of Matter; HS-PS1-1, HS-PS1-2, HS-PS1-3, HS-PS1-4 Types of Interactions; HS-PS1-1, HS-PS1-2, HS-PS1-3 Molecular Design and Function; HS-PS2-6	**Scientific & Engineering Practices:** Developing and Using Models Planning and Carrying Out Investigations Using Mathematics and Computational Thinking Constructing Explanations	**Crosscutting Concepts:** Patterns Energy and Matter

Possible Preconceptions/Misconceptions:

- All chemical bonds are the same.
- Only metals conduct current.
- Material solubility is a function of compound size.
- Material melting point / boiling point is a function of compound size.
- Most metals exist as free metals in nature.

Possible Performance Expectations:

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. *(conductivity is a function of bonding which is a function of atomic structure, bonding models are a function of valence electrons)*
- Use a model to predict the relationship between systems or between components of a system. *(predict the charge of an ion based on the patterns in the periodic table, predict the formulas of ionic compounds based on the charges of the ions)*
- Plan and conduct an investigation to determine the empirical formula of a compound. *(empirical formula lab)*
- Use mathematical representations of phenomena to support claims *(relative melting / boiling points from data, conductivity lab, empirical formula lab)*
- Use data and evidence gathered about bonding to explain the relative strength of different intramolecular bonds *(bond energy as a function of coulombic forces)*
- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence of causality in explanations of phenomena. *(the periodic table can be used to predict the formula of ionic compounds) (material solubility and melting / boiling point is a function of ionic charge)*

Big Ideas:

- All matter can be understood in terms of arrangements of atoms.
- The chemical and physical properties of materials can be explained by the structure and the arrangement of atoms.

Students will be able to …

- Determine the common ions of main group s block metals and nonmetals.
- Determine the formula of ionic compounds based on the charges of common ions or the stock name of the compound.
- Draw models of binary ionic compounds.
- Interpret models of binary and ternary ionic compounds.
- Name ionic compounds.
- Relate the conductivity of solutions to ionic bonding.
- Relate bond energy in ionic compounds to coulombic forces.
- Rank compounds according to relative solubility.
- Rank compounds according to relative melting / boiling points.
- Calculate the percent composition of a compound.
- Experimentally determine the empirical formula of a compound.
- Calculate the empirical formula and the molecular formula of a compound.

Students will know … How to name binary and ternary ionic compounds. Terms associated with solution formation; electrolyte, nonelectrolyte Terms associated with metals; alloy, malleable, ductile (The memorization tasks in this unit are necessary to avoid student frustration in subsequent units. Students who spend a lot of time looking up chemical formulas become frustrated and give up on chemistry.)
Technology and the Nature of Science: Conductivity is a function of intramolecular bonding, solubility and the number of ions in solution. The solubility of compounds can be determined empirically and is available in the scientific literature. The stability of materials can be determined empirically.
Building / reinforcing literacy and mathematics skills: A model of a compound can be determined from the formula or name and visa versa. (RST.9-10.7) Generate models from empirical data and data from texts to relate physical properties to bonding. (MP.4) Write a short lab report relating the solubility and conductivity of ionic compounds to ionic charges and coulombic attractions. (WHST.9-12.2) Research and write an introduction to a research project on material stability. (WHST.9-12.7, WHST.11-12.8, WHST.9-12.2) Cite sources in the introduction of their research project. (RST.11-12.1) Write a formal lab report. (WHST.9-12.2) Draw evidence from informational text to support the results of a laboratory investigation (WHST.9-12.9) Reason abstractly, modeling ionic compounds is an abstract process (MP.2) Use dimensional analysis to solve problems involving molar mass. (HSN-Q.A.1) Report answers in the correct units that have been rounded to the correct number of significant figures. (HSN-Q.A.1, HSN-Q.A.3) Reason quantitatively by solving problems involving percent composition, empirical and molecular formula. (MP.2)

Assessments:

Formative assessment made by listening to student conversations or observing student work as students work in groups to generate or evaluate data and to develop models relating atomic and/or compound structure to physical phenomena.

Formative assessment made by listening to student conversations or observing student work as students work in groups to determine the empirical formula of a compound.

Formative assessment of individual student work by observing student performance on tasks.

Assignment Completion: common ions assignment, ionic compounds and ionic nomenclature assignment, metallic bonding assignment, percent composition and empirical formula assignment

Short lab report relating solubility and conductivity to coulombic attractions.

Formal lab report, Empirical Formula Lab.

Quizzes and clicker reviews as needed

Polyatomic Ion memory test (average of 2)

Unit test

Learning Experiences:

Demonstrations of a few simple synthesis reactions resulting in the formation of ionic compounds. Students work in groups to determine why the reactions occur *(exchange of electrons due to effective nuclear charge)* and the type of compounds formed. Students predict the charges of s block metals and nonmetals and possible compounds of these ions.

Short lesson on ionic compound nomenclature with guided practice

Short lesson on metallic bonding and properties of metals.

Lab on ionic compound solubility and the conductivity of ionic compounds in solution.

Empirical Formula lab

Title: Unit 5, **Water and Solutions** **Grade:** 10

Length: 9 blocks

Enduring Understandings:	**Standards:**
Intermolecular bonding is a function of intramolecular bonding Compounds dissolve in materials with similar polarities It is very difficult to remove soluble contaminants from water, the best way to ensure clean water in the future is not to contaminate it in the first place. Water is a necessary and precious resource that must be conserved and protected. Matter is neither created nor destroyed in a chemical reaction.	HS-PS1-2 HS-PS1-3 HS-PS1-4 HS-PS1-5 HS-ESS3-2 HS-PS2-6

Essential Questions:
- How and why do materials dissolve?
- Why is water considered the universal solvent?
- How is water solubility quantified?
- What factors increase the solubility of compounds in water?
- What are the issues facing the supply of clean water?
- What are the costs of providing potable water?
- How can water be conserved and protected?
- What is a double replacement reaction? How is it written? How is it balanced?

Possible Phenomena:
- Compounds dissolve in materials with similar polarities
- Each compound has a finite solubility in each solvent.
- There is a limited supply of fresh water.
- Colligative Properties, Freezing Point Depression *(why salt is put on the roads in the winter)* and Boiling Point Elevation.

Disciplinary Core Ideas:	**Scientific & Engineering Practices:**	**Crosscutting Concepts:**
Structure and Properties of Matter; HS-PS1-2, HS-PS1-3 Chemical Reactions, HS-PS1-2 Types of Interactions; HS-PS1-2, HS-PS1-3	Developing and Using Models Planning and Carrying Out Investigations Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	Energy and Matter Stability and Change

Possible Preconceptions/Misconceptions:
- Everything is soluble in any solvent.
- The quantity of fresh water is infinite
- The cost of providing potable water is low.
- Everything reacts.

Possible Performance Expectations:

- Models can be developed and used to predict solubility and to explain the solution process *(solubility patterns due to bonding, material separation labs)*
- Plan and conduct a lab to investigate the relationship between solubility and intermolecular bonding *(paper chromatography lab)*
- Conduct a lab to determine the relationship between coulombic charge and ionic compound solubility *(double replacement reactions lab)*
- Use mathematics to quantify solution concentration and describe the effects of colligative properties.
- Apply scientific principles to separate compounds from water *(separate insoluble materials from water lab)*
- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence of causality in explanations of phenomena. *(solubility and intermolecular bonding lab, double replacement reactions lab, chemical removal of ions lab)*
- Changes in energy and matter in a system can be described in terms of energy and matter flow into and out of the system *(energy of solution formation, freezing point depression and boiling point elevation, double replacement reactions)*
- Much of science deals with constructing explanations of how things change and how they remain stable *(double replacement reactions, solubility curves and solubility product, long range material stability project)*

Big Ideas:

- Chemical and physical properties of materials can be explained by the structure and arrangement of atoms, ions or molecules and the forces between them.
- Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.

Students will be able to:

- Describe the process and energy of solution formation in pictures, words and equations.
- Describe the quantity of a compound that dissolves in water from solubility charts and the solubility equilibrium constant.
- Calculate solution percent by mass and molarity.
- Describe and balance double replacement reactions using picture, sentence, word, formula, ionic and net ionic equations.
- Separate insoluble materials from water.
- May or may not be able to separate ions from solution.
- Describe Colligative properties and calculate the freezing point depression and boiling point elevation of simple solutions.
- Evaluate the pros and cons of water resource and purification options.

Students will know:

- Terms associated with concentration of a compound in solution such as; ppm, ppb, percent by mass and molarity, supersaturated, saturated, concentrated and dilute.
- Solution dilution equation.
- Terms associated with colligative properties; phase diagrams, molality, freezing point depression, boiling point elevation.
- The simplified solubility table and how to use the more extensive solubility table.

Technology and the Nature of Science:

Scientific knowledge assumes an order and consistency in natural systems.
Constructing explanations and designing solutions.

Building / reinforcing literacy and mathematics skills:

Translate sentence equations to skeleton equations and visa versa. (RST.9-10.7)
Describe investigations; procedures, data and conclusions in writing and with drawings. (RST.9-10.7, WHST.9-12.2)
Strengthen writing in the stability research project introduction. (WHST.9-12.5)
Conduct research to support a proposal to meet future water needs for a given area. (WHST.9-12.7, WHST.9-12.8)
Use digital media in the water research project presentation. (SL.11-12.5)
Cite references used in the water research project. (RST.11-12.1)
Explain solution formation by reasoning abstractly.(MP.2)
Reason quantitatively to calculate solution concentration (MP.2)
Calculate solution concentration and freezing point depression and boiling point elevation and report the results in the correct units and rounded to the correct number of significant figures. (HSN-Q.A.3)
Use units when modeling with mathematics to determine the relative cost of generating pure water by different methods. (MP.4, HSN-Q.A.1)

Assessments:

Formative assessment made by listening to student conversations or observing student work as students work in groups to generate or evaluate data and to develop a water plan.
Formative assessment of individual student work by observing student performance on tasks.
Assignment Completion; solution process and concentration assignment, double replacement reactions assignment, colligative properties assignment
Short lab reports on separation lab, double replacement lab and removing ions from solution lab.
Water supply proposal presentation.
Quizzes and clicker reviews as needed
Short Unit test

Learning Experiences:

Paper chromatography lab, review the relationship between intra / inter molecular bonding and solubility.
Lesson on solution formation, enthalpy of solution and solution concentration.
Lab to separate insoluble materials from water.
Double replacement reaction minilab, with lesson on double replacement reactions and balancing equations with guided practice
Removal of ions from water lab.
Colligative properties minilab and lesson.
Water supply project and presentations.

Robbinsville High School Honors Chemistry Curriculum

Title: Unit 6, **Reactions** **Length:** 10 blocks			**Grade:** 10
Enduring Understandings: Matter is neither created nor destroyed during a chemical reaction. Most reactions involve a transfer of electrons. Many reactions involve and exchange of energy.			**Standards:** HS-PS1-2 HS-PS1-4 HS-PS1-5 HS-PS1-6
Essential Questions: What is a chemical reaction and how is it expressed? How are chemical reactions balanced? What are synthesis and decomposition reactions? What is an oxidation – reduction reaction? What is a single replacement reaction? What is a galvanic cell and why do electrons flow from one half cell to another? What is a combustion reaction? What is heat of reaction and how is it determined and calculated?			
Possible Phenomena: Most reactions are Re-Dox Reactions. Synthesis and decomposition reactions usually involve a significant exchange of energy, so it is a good thing we do not often observe them in the “real” world. Single replacement reactions involve an exchange of electrons between two metals through a medium. *(Why steel nails should not used to attach aluminum gutters to a house.)* A galvanic cell *(battery)* can be used to harness the energy of a reaction. The heat of a combustion reaction can be measured and harnessed.			
Disciplinary Core Ideas: Structure and Properties of Matter; HS-PS1-2, HS-PS-4, HS-PS-5 Chemical Reactions; HS-PS1-2, HS-PS-4, HS-PS-5	**Scientific & Engineering Practices:** Developing and Using Models Planning and Carrying Out Investigations Using Mathematics and Computational Thinking Constructing Explanations and Designing solutions	**Crosscutting Concepts:** Patterns Energy and Matter Stability and Change	
Possible Preconceptions/Misconceptions: Atoms change in a chemical reaction. Nothing reacts. Everything reacts. All reactions are visible. A galvanic cell exists only in a battery. All reactions occur at the same rate.			

Possible Performance Expectations:

- Models can be used to predict the products of a reaction *(synthesis, decomposition, single replacement, combustion reactions and ReDox reactions)*
- Plan and carry out investigations to determine reaction patterns. *(single replacement reactions and the galvanic cell)*
- Use mathematics to determine the heat of a reaction; empirically and from enthalpy tables.
- Construct explanations and design solutions based on the data generated in the single replacement and galvanic cell labs
- The pattern of valence electrons from the periodic table can be used to determine what elements will react, and to predict the products of a reaction.
- The energy of a reaction can be determined in the lab and from data.
- Compounds change in a chemical reaction but the number of atoms remains the same.

Big Ideas:

- Atoms retain their identity during chemical reactions.
- Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.
- Rates of reactions are determined by details of the molecular collisions.
- Energy transfer in a reaction explains the direction of change in matter.

Students will be able to:

- Describe and model oxidation and reduction reactions; synthesis, decomposition, single replacement, combustion and complex ReDox reactions.
- Determine the products of simple reactions; synthesis, decomposition, single replacement, double replacement, and combustion.
- Write and balance equations for oxidation and reduction reactions; synthesis, decomposition, single replacement, combustion and complex ReDox reactions.
- Describe and model what occurs in a galvanic cell and calculate the cell potential (energy transfer) of simple cells.
- Students will be able to determine the heat of reaction (empirically and from data).

Students will know:

- The simplified activities series.
- Terms associated with equations; reactants, products, sentence, word, skeleton, balanced, ionic and net ionic.
- Terms associated with reactions; synthesis, decomposition, single replacement, double replacement, combustion and ReDox reaction.
- Terms associated with the galvanic cell; anode, cathode, salt bridge, electromotive force, oxidation and reduction.
- Terms associated with reaction rate; collision theory, heat of reaction, forward and reverse reactions, catalyst.

Technology and the Nature of Science:

- Scientific knowledge assumes an order and consistency in natural systems.
- Constructing explanations and designing solutions.

Building / reinforcing literacy and mathematics skills:

- Describe laboratory investigations; procedures, data and conclusions in writing and with drawings (RST.9-10.7, WHST.9-12.5)
- Translate sentence equations to skeleton equations and visa versa (RST.9-10.7)
- Use abstract reasoning to model reactions and balance equations (RST.9-10.7)
- Calculate energy of reactions and report the results rounded to the correct number of significant figures and with the correct units. (HSN-Q.A.1, HSN-Q.A.3)

Assessments:

- Formative assessment made by listening to student conversations or observing student work as they work in groups to generate or evaluate data.
- Formative assessment of individual student work by observing student performance on tasks.
- Assignment Completion; synthesis and decomposition reactions assignment, single replacement reactions assignment, combustion reactions assignment, ReDox reactions assignment, heat of reaction assignment, reaction rate assignment and reaction review assignment
- Short lab reports on single replacement reactions, galvanic cell, combustion reaction, and reaction kinetics
- Quizzes and clicker reviews as needed
- Unit test

Learning Experiences:

- Decomposition lab demo, synthesis reaction minilab, short lesson on determining the products of synthesis and decomposition reactions and balancing equations. Guided practice.
- Metal reactivity lab, with short lesson on single replacement reactions, the activity series and balancing equations.
- Galvanic cell inquiry lab, short lesson on the galvanic cell and calculating the energy generated by the galvanic cell.
- Combustion lab and calculating the heat of reaction. Short lesson on using enthalpy tables.
- Lesson on balancing complex oxidation / reduction reactions by the half cell method with practice.

Title: Unit 7, **Reaction Stoichiometry** **Grade:** 10
Length: 9 blocks

Enduring Understandings:	**Standards:**
Matter is neither created nor destroyed in a chemical reaction. The quantity of each material involved in a chemical reaction can be determined if the quantity of one of the materials is known. In many situations there exists a dynamic balance between the forward reaction and the reverse reaction.	HS-PS1-2 HS-PS1-6 HS-PS1-7

Essential Questions:
How are quantities of reactants and products determined?
What is reaction equilibrium?
How are the quantities of reactants and products in dynamic equilibrium determined?

Possible Phenomena:
The quantity of reactants required and product formed in a reaction can be calculated.
A fire can be extinguished by adding the reaction product water.

Disciplinary Core Ideas:	**Scientific & Engineering Practices:**	**Crosscutting Concepts:**
Chemical Reactions: HS-PS1-2, HS-PS1-6, HS-PS1-7	Developing and Using Models Planning and Carrying Out Investigations Using Mathematics and Computational Thinking Constructing Explanations	Energy and Matter Stability and Change

Possible Preconceptions/Misconceptions:
All reactions go to completion.

Possible Performance Expectations:
Develop a model for reaction equilibrium.
Use a model to predict the quantities of reactant used or product created during a chemical reaction.
Plan and carry out an investigation to determine the percent yield of a reaction.
Use mathematics to predict the quantities of reactant used or product created during a chemical reaction.
Construct explanations to explain the observations bade during the equilibrium lab.
Describe and calculate the changes in energy and matter in reaction systems.
Compounds change in a chemical reaction but the number of atoms and the mass remains the same.

Big Ideas:

Atoms and mass are conserved during a chemical reaction.

Any bond or intermolecular attraction that can be formed can be broken. These two processes are in a dynamic competition, sensitive to initial conditions and external perturbations.

Students will be able to:

Use dimensional analysis to determine the moles or mass of reactant consumed or product produced in a chemical reaction given the moles or mass of at least one material involved in the reaction.

Use dimensional analysis to determine the moles, mass or volume of reactant consumed or product produced in a chemical reaction given the moles, mass or volume and concentration of at least one material involved in a reaction that occurs in solution.

Determine the limiting reactant in a reaction, and determine the moles or mass of reactant consumed or product produced given the moles or mass of the limiting reactant.

Calculate percent yield.

Empirically determine the percent yield of a reaction.

Calculate the heat of a reaction.

Model dynamic equilibrium from laboratory observations.

Calculate the equilibrium constant and quantities of reactant or product for simple reactions.

Students will know:

The percent yield equation

Terms associated with reaction equilibrium; forward reaction, reverse reaction, equilibrium constant, Le Chatelier's Principle

Technology and the Nature of Science:

Scientific knowledge assumes an order and consistency in natural systems.

Constructing explanations and designing solutions.

Building / reinforcing literacy and mathematics skills:

Describe laboratory investigations; procedures, data and conclusions in writing and with drawings (RST.9-10.7, WHST.9-12.2)

Translate sentence equations to skeleton equations and visa versa (RST.9-10.7)

Read short sections of text on limiting reactant and percent yield, use textual references in the formal lab report to support results. (WHST.9-12.9)

Cite references used in a formal lab report. (RST.11-12.1)

Write a formal lab report (WHST.9-12.2)

Use abstract reasoning to model reactions and balance equations (MP.2)

Use mathematics to model a reaction at different stages of equilibrium. (MP.4)

Calculate energy of reactions and report the results rounded to the correct number of significant figures and with the correct units. (HSN-Q.A.1, HSN-Q.A.3)

Dimensional analysis will be used throughout the unit to determine the quantity of reactant used and product formed in a chemical reaction. All results will be reported in the correct number of significant figures and with the correct units. (HSN-Q.A.1, HSN-Q.A.3)

Define appropriate quantities from the best precision in the percent yield lab (HSN-Q.A.2)

Assessments: Formative assessment made by listening to student conversations or observing student work as they work in groups to generate or evaluate data. Formative assessment of individual student work by observing student performance on tasks. Assignment Completion; mole – mole and solution stoichiometry assignment, mole – mole – mass and mass – mole – mole assignment, mass – mole – mole – mass stoichiometry assignment, limiting reactant assignment, percent yield assignment, equilibrium assignment, unit review assignment. Short lab report on equilibrium. Formal lab report on lab involving limiting reactant and percent yield equations. Quizzes and clicker reviews as needed Unit test
Learning Experiences: Mole ratio POGIL, short lesson on mol – mol stoichiometry with guided practice. Solution stoichiometry group problem, short lesson on solution stoichiometry with guided practice. Short lesson on using dimensional analysis to solve stoichiometry problems involving mass and mole with guided practice Reading on limiting reactant, followed by a short lesson including chart method for solving stoichiometry problems with guided practice. Reading on percent yield with short lesson and guided practice. Limiting reactant lab. Equilibrium lab or demonstration. Lesson on the equilibrium constant and calculations.

Title: Unit 8, **Gases** **Grade:** 10
Length: 10 blocks

Enduring Understandings:
- Gases have mass.
- Gas particles move independently and are far apart from each other.
- Differences in the physical properties of solids, liquids and gases are explained by the ways in which the atoms or the substances are arranged, and by the strength of the forces of attraction between the atoms, ions or molecules.
- Kinetic molecular theory can be used to explain the relationships between pressure, volume, temperature and number of molecules.

Standards:
- HS-PS1-2
- HS-PS1-3
- HS-PS1-4
- HS-PS1-5
- HS-PS1-6
- HS-PS1-7

Essential Questions:
- What is a gas? What is an ideal gas? What is a real gas?
- What are the relationships between gas pressure, volume, temperature and number of moles?
- What is standard molar volume?
- How are the quantities of gases in a reaction determined?
- How do gas molecules move? What are effusion and diffusion?
- What is rate of reaction? Why are some reactions fast and others slow?
- What factors influence reaction rate?

Possible Phenomena: (many concepts in this unit relate to the "real" world, a few are listed below)
- Atmospheric pressure is the total body ace bandage.
- Food cooks faster at higher pressure and slower at lower pressure.
- Aerosol cans and balloons break at high temperatures.
- Balloons expand at low pressures.
- A catalytic converter removes noxious gases from automobile exhaust.

Disciplinary Core Ideas:	Scientific & Engineering Practices:	Crosscutting Concepts:
Chemical Bonding; HS-PS1-2, HS-PS1-3 Chemical Reactions; HS-PS1-2, HS-PS1-4, HS-PS1-5, HS-PS1-6, HS-PS1-7	Developing and Using Models Planning and Carrying Out Investigations Using Mathematics and Computational Thinking Construct Explanations	Energy and Matter Stability and Change

Possible Preconceptions/Misconceptions:
- Air does not have mass.
- Gas molecules just float around in space.
- *(in general students know very little about gases except what they have previously learned in this course)*

Possible Performance Expectations:

Develop models to explain the behavior of gases.
Use models to predict the behavior of gases.
Conduct investigations to explain the behavior of gases and explain the limits of the lab investigation.
Plan an investigation that will result in a solution to global warming. (see next unit)
Generate mathematical models of gas behavior from data.
Use mathematical models to explain and quantify the behavior of gases.
Construct and revise explanations to explain experimental observations or data.
Temperature is the average kinetic energy of gas molecules, this concept can be used to model the behavior of gas molecules.
The energy exchange in gas reactions can be calculated.
Compounds change in a chemical reaction but the number of atoms and the mass remains the same.

Big Ideas:

Chemical and physical properties of materials can be explained by the structure and the arrangement of molecules and the forces between them.
The laws of thermodynamics describe the essential role of energy.
Rates of chemical reactions are determined by details of molecular collisions.

Students will be able to:

Describe the kinetic behavior of the gases.
Define gas pressure and describe the ramifications of gas pressure.
Convert temperature and pressure units.
Use the ideal and ratio gas laws to solve problems involving the pressure, volume, temperature and number of moles of a gas.
Determine the volume, moles or mass of a gas used or produced during a reaction given the volume, moles or mass of a reactant or product.
Describe collision theory and the factors that influence reaction rate.
Calculate simple reaction rates.

Students will know:

Conversion factor between Celsius and Kelvin temperature scales.
The ideal gas law and how to derive the ratio gas laws from the ideal gas law or know the ratio gas laws.
Standard temperature and pressure (STP). 0 ^{o}C and 1 atm.
Standard molar volume; 22.4 L of gas / mol of a gas at STP.
Dalton’s law of partial pressure.
Graham’s law of diffusion or the equations for kinetic energy of a gas.

Technology and the Nature of Science:

Scientific knowledge assumes an order and consistency in natural systems
Constructing explanations and designing solutions

Building / reinforcing literacy and mathematics skills:

Describe laboratory investigations; procedures, data and conclusions in writing and with drawings (RST.9-10.7, WHST.9-12.2)
Translate sentence equations to skeleton equations and visa versa (RST.9-10.7)
Write a formal lab report (WHST.9-12.2)
Cite references used in a formal lab report. (RST.11-12.1)
Use abstract reasoning to model gas behavior and balance equations (MP.2)
Use mathematics to model the behavior of gasses. (MP.4)
Use models to quantify the pressure, volume, temperature and energy of gasses. Report results in the correct number of significant figures and with the correct units. (HSN-Q.A.1, HSN-Q.A.3)
Dimensional analysis will be used the unit to determine the quantity of reactant used and product formed in a chemical reaction involving gasses. All results will be reported in the correct number of significant figures and with the correct units. (HSN-Q.A.1, HSN-Q.A.3)
Define appropriate quantities from the best precision in the molar mass of a gas lab. (HSN-Q.A.2)

Assessments:

Formative assessment made by listening to student conversations and observing student work as they work in groups to generate or evaluate data.
Formative assessment of individual student work by observing student performance on tasks.
Assignment Completion; gas pressure assignment, ideal gas law assignment, ratio gas laws assignment, Dalton's law assignment, standard molar volume assignment, gas stoichiometry assignment, Graham's law assignment, gas reaction mechanisms assignment, unit review assignment
Short lab reports on gas pressure and Boyle's law.
Formal lab report on molar mass of butane.
Quizzes and clicker reviews as needed
Unit test

Learning Experiences:

Atmospheric pressure minilab, followed by short lesson on atmospheric pressure, how gas pressure is measured and pressure conversions.
Kinesthetic activity in which students act as gas molecules under different conditions, Evaluation of data from the kinesthetic activity and short lesson on ideal gas law and using the ideal gas law to solve problems with guided practice.
Volume vs pressure minilab, derivation of the ratio gas laws from the ideal gas law and short lesson on using ratio laws to solve problems with guided practice.
Short lesson on Dalton's Law or Partial Pressure with guided practice.
Short lesson on standard molar volume and using standard molar volume to determine the volume, moles or mass of a gas used or produced in a chemical reaction with guided practice.
Short demonstration and lesson on Graham's law with guided practice.
Chemical Kinetics Inquiry lab with data analysis and evaluation
Molar Mass of Butane lab.

Robbinsville High School Honors Chemistry Curriculum

Title: Unit 9, **Sustainable Energy Project** (an interdisciplinary project During PARCC) **Grade:** 10 **Length:** 7 blocks		
Enduring Understandings: Global Warming is occurring and the consequences may be dire. There are many solutions to global warming. All involve costs and benefits. The solutions for different regions of the country and world may depend on non technical factors.		**Standards:** HS-PS1-1 HS-PS1-2 HS-PS1-3 HS-PS1-4 HS-ESS3-2
Essential Questions: What is global warming and how will it impact planet earth and the life on it. How is the energy we consume generated and what are the consequences of that energy generation? What is steam generated power? How is energy produced from steam? What are the costs, risks and benefits of steam power? What is a nuclear reaction? How is energy produced in a nuclear reaction? What are the costs, risks and benefits of nuclear power? What is an internal combustion engine? How does it produce energy? What are the costs, risks and benefits of the internal combustion reaction? What are the clean sources of energy? How do they produce energy? What are the costs, risks and benefits of the energy sources? What is a feasible sustainable energy plan for a given region?		
Possible Phenomena: Global warming and its consequences. Energy production; benefits, costs and risks. Sustainable energy; benefits, costs and risks.		
Disciplinary Core Ideas: Chemical Reactions; HS-PS1-2, HS-PS1-3, HS-PS1-4 Nuclear Processes; HS-PS1-1 Natural Resources, Human Impact; HS-ESS3-2	**Scientific & Engineering Practices:** Developing and Using Models Planning and Carrying Out Investigations Using Mathematics and Computational Thinking	**Crosscutting Concepts:** Energy and Matter Stability and Change
Possible Preconceptions/Misconceptions: “Electricity just comes out of the three hole thingy in the wall” All electricity is green, it does not generate CO_2		

Possible Performance Expectations:

Plan how to use information media to investigate sources of energy and their costs, risks and benefits.

Develop a model to provide sustainable energy to a region of the country by 2030 or play to "Wedges" game to propose a sustainable energy future.

Use mathematics to determine the costs and benefits of different energy sources.

Concepts of energy and matter are used throughout this unit.

Big Ideas:

Resource availability has guided the development of human society and use of natural resources has associated costs and benefits.

Sustainability of the human species requires responsible management of natural resources.

Students will be able to:

Use media to research current and potential sources of energy production.

Weigh the costs, risks and benefits of sources of energy production.

Develop a sustainable energy model for a region of the country or the world.

Present the sustainable energy model they develop.

Question and comment on proposed energy models.

Students will know:

Concepts and terms associated with energy production; turbine, engine, solar; passive and active, photovoltaic cells, hydroelectric; gravity and tidal, wind power, batteries, hydrogen generation, geothermal,

Concepts and terms associated with energy production and transmission; base, intermediate and peak loads, power grid

Technology and the Nature of Science:

Scientific knowledge assumes an order and consistency in natural systems

Constructing explanations and designing solutions

Building / reinforcing literacy and mathematics skills:

Conduct research to support their proposal to meet future energy needs for a given area. (WHST.9-12.7, WHST.11-12.8)

Cite references in energy proposal. (RST.11-12.1)

Write a energy proposal based on the information and evidence gathered in research, (WHST.9-12.2)

Use media to present a proposal on meeting future energy needs (SL.11-12.5)

Use mathematics to calculate current and proposed energy costs. (HSN-Q.A.1)

Assessments:

Formative assessment of group discussions during the research process, provide help as needed.

Assignment Completion; nuclear reactions and power assignment.

Written and oral project presentation.

Short Unit test

Learning Experiences:

Video and lesson on energy production.
Students work in groups to research sustainable energy resources.
Students work in groups to develop a sustainable energy proposal.
Students work in groups to prepare a presentation on the proposal they develop.
Student question and comment on proposed energy models.

Robbinsville High School Honors Chemistry Curriculum

<table>
<tr><td colspan="3">Title: Unit 10, Acids, Bases and pH (final exam review included in this unit) Grade: 10
Length: 8 blocks</td></tr>
<tr><td colspan="2">Enduring Understandings:
Chemical and physical properties of materials can be explained by the structure and arrangement of atoms, ions or molecules and the forces between them.
Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.
Any bond or intermolecular attraction that can be formed can be broken. These two processes are in a dynamic competition.</td><td>Standards:
HS-PS1-2
HS-PS1-3
HS-PS1-6
HS-PS1-7
HS-PS2-6</td></tr>
<tr><td colspan="3">Essential Questions:
What are acids and bases?
What is pH and how is it determined?
What are weak acids and bases?
How is the concentration of acids and bases determined?</td></tr>
<tr><td colspan="3">Possible Phenomena: (many concepts in this unit relate to the “real” world, a few are listed below)
Many products around the house are acids or bases or include acids and bases in their formulation.
Water is seldom at pH 7.
Almost all living organisms exist in a very narrow pH range.</td></tr>
<tr><td>Disciplinary Core Ideas:
Chemical Bonding; HS-PS1-2, HS-PS1-3
Chemical Reactions; HS-PS1-2, HS-PS1-6, HS-PS1-7</td><td>Scientific & Engineering Practices:
Developing and Using Models
Planning and Carrying Out Investigations
Using Mathematics and Computational Thinking</td><td>Crosscutting Concepts:
Stability and Change</td></tr>
<tr><td colspan="3">Possible Preconceptions/Misconceptions:
All acids and bases are corrosive and dangerous.
pH is only dependent on acid / base concentration.</td></tr>
</table>

Possible Performance Expectations:

- Plan and conduct an investigation to model what an acid is and what as base is.
- Plan and conduct an investigation to model relationship between pH and acid / base concentration.
- Plan and conduct an investigation to model what a weak acid is and what as weak base is.
- Use the definition of pH to calculate the pH of an acid or base or to calculate the concentration of an acid or base.
- Plan and conduct an investigation to empirically determine the concentration of an acid from a base of known concentration.
- Use the equilibrium constant to determine the concentration of a weak acid or base at equilibrium. The concept of equilibrium involves the constant changes that occur in a stable system.

Big Ideas:

- The chemical and physical properties of materials can be explained by their structure and the arrangement of atoms, ions or molecules, and the forces of attraction between them.
- Changes in matter involve the rearrangement and/or reorganization of atoms and/or the transfer of electrons.
- Any bond or interaction that can be formed can be broken. These two processes are in dynamic competition.

Students will be able to:

- Describe and name common acids and bases.
- Describe the ionization process of strong and weak acids and relate that process to solution pH.
- Relate the pH scale to acid / base concentration.
- Determine pH or pOH given concentration and concentration given pH or pOH.
- Determine the concentration of a strong acid or base by titration.

Students will know:

- Terms associated with acids and bases; acid, base, pH, pOH, Arrhenius acid / base, Bronsted / Lowry acid / base, conjugate acid / base, strong vs weak acids and bases.
- Terms associated with acid /base concentration determination; litmus paper, pH paper, pH meter and electrode, titration, endpoint, indicator.
- Solution dilution equation.
- Titration equation.
- Definition of pH = - log [H_3O^+], pOH = - log [OH^-]
- Ionization constant of water; 10^{-7}

Technology and the Nature of Science:

- Scientific knowledge assumes an order and consistency in natural systems
- Constructing explanations and designing solutions

Building / reinforcing literacy and mathematics skills: Describe investigations; procedures, data and conclusions in writing and with drawings. (RST.9-10.7, WHST.9-12.5) Translate sentence equations to skeleton equations and visa versa. (RST.9-10.7) Write up the stability project report. (WHST.9-12.5) Cite references used in the stability project. (RST.11-12.1) Use information from texts to support the conclusions of their stability research project. (WHST.9-12.9) Reason abstractly to understand dissociation and reactions of acids and bases. (MP.2) Mathematically model the relationship between acid / base concentration and pH (MP.4) Calculate solution concentration and report the results rounded to the correct number of significant figures and with the correct units. (HSN-Q.A.1, HSN-Q.A.3) Define appropriate quantities for solution dilution. (HSN-Q.A.2)
Assessments: Formative assessment of group discussions during labs; what are acids and bases, concentration and pH, and titration. Assignment Completion; acids and bases assignment, acid / base concentration and pH assignment, titration assignment. Weak acids and bases assignment. Short lab report on acid / base titration. Stability project presentation and written report. Quizzes and clicker reviews as needed Unit test *Completion of final exam review assignments.*
Learning Experiences: Characteristics of acids and bases minilab Acid / base concentration and pH minilab, with short lesson on calculating acid base concentration and pH. Weak / acid base minilab, with short lesson on weak acids and basses and using the equilibrium constant to determine concentration and pH. Lesson on acid / base determination and titrations with guided practiced on math. Acid / base titration lab. Review for final exam.

Robbinsville High School Honors Chemistry Curriculum

<table>
<tr><td colspan="2">**Title:** Unit ,
Length: blocks</td><td colspan="2">**Grade:** 10</td></tr>
<tr><td colspan="3">**Enduring Understandings:**</td><td>**Standards:**</td></tr>
<tr><td colspan="4">**Essential Questions:**</td></tr>
<tr><td colspan="4">**Possible Phenomena:**</td></tr>
<tr><td>**Disciplinary Core Ideas:**</td><td>**Scientific & Engineering Practices:**</td><td colspan="2">**Crosscutting Concepts:**</td></tr>
<tr><td colspan="4">**Possible Preconceptions/Misconceptions:**</td></tr>
<tr><td colspan="4">**Possible Performance Expectations:**</td></tr>
<tr><td colspan="4">**Big Ideas:**</td></tr>
<tr><td colspan="4">**Students will be able to:**</td></tr>
<tr><td colspan="4">**Students will know:**</td></tr>
<tr><td colspan="4">**Technology and the Nature of Science:**</td></tr>
<tr><td colspan="4">**Building / reinforcing literacy and mathematics skills:**</td></tr>
<tr><td colspan="4">**Assessments:**</td></tr>
<tr><td colspan="4">**Learning Experiences:**</td></tr>
</table>