

**Title:** Experience Chemistry!

**Topic:** Chemistry

**Rationale:** Change is inevitable in all aspects of life. The science of chemistry creates varied changes resulting in outcomes that can affect all living and non-living organisms. It is important to understand the role that chemistry plays in the changes that occur which affect all matter.

**Suggested Grade Level:** 5<sup>th</sup>/6<sup>th</sup>

**Supporting Concepts:** Matter, properties, action/reaction, system, substance, interaction, change, influence, rate of change, structure, similarities and differences, time, temperature, volume, and heat

**Careers:** Chemistry: Analytical chemistry, atmospheric chemistry, biochemistry, computational chemistry, electrochemistry, environmental chemistry, geochemistry, inorganic chemistry, materials science, medicinal chemistry, neurochemistry, nuclear chemistry, organic chemistry, polymer chemistry, physical chemistry, quantum chemistry, spectroscopy, stereochemistry, thermochemistry, and thermodynamics

**Process Skills:** Lab safety, lab techniques, measurement, written communication, following directions, research, classifying, analyzing, data interpretations, recording, reflection, representing compounds, writing/balancing chemical equations, predictions, synthesizing, organizing, identifying variables

**Vocabulary:**

**accuracy** - Accuracy is a measure of how close a measured value is to its true value. For example, if an object is exactly a meter long and you measure it as 1.1 meters long, that is more accurate than if you measured it at 1.5 meters long.

**acid** - There are several ways to define an acid, but they include any chemical that gives off protons or H<sup>+</sup> in water. Acids have a pH less than 7. They turn the pH indicator phenolphthalein colorless and turn litmus paper red.

**alcohol** - An alcohol is any organic molecule that has an -OH group.

**aldehyde** - An aldehyde is any organic molecule that has a -COH group.

**alkali metal** - An alkali metal is a metal in Group I of the periodic table. Examples of alkali metals include lithium, sodium, and potassium.

**alkaline earth metal** - An alkaline earth metal is an element belonging to Group II of the periodic table. Examples of alkaline earth metals are magnesium and calcium.

**atom** - the smallest complete building block of the universe.

**base** - A base is a compound that produces OH<sup>-</sup> ions or electrons in water or that accepts protons. An example of a common base is sodium hydroxide, NaOH.

**binary compound** - A binary compound is one made up of two elements.

**binding energy** - Binding energy is the energy that holds protons and neutrons together in the atomic nucleus.

**bond energy** - Bond energy is the amount of energy required to break one mole of chemical bonds.

**bond length** - Bond length is the average distance between the nuclei of two atoms that share a bond.

**catalyst** - A catalyst is a substance that lowers the activation energy of a reaction or speeds it up without being consumed by the reaction. Enzymes are proteins that act as catalysts for biochemical reactions.

**chemical change**-two or more chemicals combining to form a new compound with new characteristics. Indicators of this are a change in state, color, temperature, density, odor, or magnetism. This new compound also had a new boiling point, melting point, density, and so on. It's a complete makeover from a molecular point of view.

**chemical equation** - A chemical equation is a description of a chemical reaction, including what reacts, what is produced, and which direction(s) the reaction proceeds.

**chemical formulas**-a combination of letters and numbers representing molecules and atoms. Written as an equation showing the changes and new by-products. Shorthand for chemists.

**chemical property** - A chemical property is a property that can only be observed when a chemical change occurs. Flammability is an example of a chemical property, since you can't measure how flammable a substance is without igniting it (making/breaking chemical bonds).

**Chemical symbols**—one or two letter “abbreviations” that represent the elements. Elements are substances that cannot be chemically broken down into simpler basic substances.

**Chromatography**—the separation of colors, pigments, or molecules in general, by using a solvent and porous piece of paper or a gel and an electrical charge. The compound separate from lightest to heaviest or by charges.

**colloid**—a solid, liquid, or gas dispersed into a second solid, liquid, or gas but not chemically connected to that other compound. Styrofoam is one of the most famous examples. Air is trapped in spaces created when polystyrene plastic is extracted from a mold. The air is still air, the polystyrene is still polystyrene. They just happen to like to hang out together.

**compound** - A substance formed by the combination of elements in fixed proportions. The formation of a compound involves a chemical reaction: i.e. there is a change in the configuration of the valence electrons of the atoms. Compounds, unlike mixtures, cannot be separated by physical means.

**covalent bond** - A covalent bond is a chemical bond formed when two atoms share two electrons.

**dilution** - Dilution is when solvent is added to a solution, making it less concentrated.

**dissociation** - Dissociation is when a chemical reaction breaks a compound into two or more parts. For example, NaCl dissociates into  $\text{Na}^+$  and  $\text{Cl}^-$  in water.

**electrolyte** - An electrolyte is an ionic compound that dissolves in water to produce ions, which can conduct electricity. Strong electrolytes completely dissociate in water, while weak electrolytes only partially dissociate or break apart in water.

**element** - A substance that cannot be decomposed into simpler substances. In an element, all the atoms have the same number of protons or electrons although the number of neutrons may vary. There are 92 naturally occurring elements.

**endothermic** - Endothermic describes a process that absorbs heat. Endothermic reactions feel cold.

**end point** - A known pH point of an acid and base interaction as shown by a chemical indicator change in color.

**enzyme** - An enzyme is a protein that acts as a catalyst in a biochemical reaction.

**equilibrium** - Equilibrium occurs in reversible reactions when the forward rate of the reaction is the same as the reverse rate of the reaction.

**exothermic** - Exothermic describes a process that gives off heat.

**family** - A family is a group of elements sharing similar properties. It is not necessarily the same thing as an element group. For example, the chalcogens or oxygen family consists of some different elements from the nonmetal group.

**graphs**—quick, easy-to-view pictures of data. There are several kinds of graphs: pie, bar, line, best fit and pictorial.

**hypothesis**—a thoughtful, reasoned guess about something, based on what is known. A hypothesis must be proven by experimentation.

**Kelvin** - Kelvin is a unit of temperature. A Kelvin is equal in size to a degree Celsius, although Kelvin starts from absolute zero. Add 273.15 to a Celsius temperature to get the Kelvin value. Kelvin is *not* reported with a ° symbol. For example, you would simply write 300K not 300°K.

**Litmus paper**—a device used by chemists to measure the pH of a substance; that is, its acidity or alkalinity. It is a dye made from certain plants. A substance which is an acid will turn blue litmus paper red. Alkalines turn red litmus paper blue or deep violet. If the solution is neutral, it will not change the color of the paper. Litmus paper is inexpensive to buy.

**mass**—how much “stuff” an object is made of. The more mass it has, the heavier it is. A ping-pong ball and a golf ball are about the same size and shape, but a golf ball has more mass.

**mixture** - A system of two or more distinct chemical substances. Homogeneous mixtures are those in which the atoms or molecules are interspersed, as in a mixture of gases or in a solution. Heterogeneous mixtures have distinguishable phases, e.g. a mixture of iron filings and sulphur. In a mixture there is no redistribution of valence electrons, and the components retain their individual chemical properties. Unlike compounds, mixtures can be separated by physical means (distillation, crystallization, etc).

**observation**—using your senses—smelling, touching, looking, listening and tasting—to study something closely, sometimes over a long period of time.

**period** - A period is a row (left to right) of the periodic table.

**pH Scale** - A logarithmic scale (from 1 (acid) to 14 (base)) for expressing the acidity or alkalinity of a solution. To a first approximation, the pH of a solution can be defined as  $-\log_{10} c$ , where  $c$  is the concentration of hydrogen ions in moles per cubic decimeter. A pH of below 7 indicates an acid solution; one above 7 indicates alkaline solution. More accurately, the pH depends not on the concentration of hydrogen ions but on their activity, which cannot be measured experimentally. pH stands for 'potential of hydrogen'. The scale was introduced by S.P. Sorensen in 1909.

**physical change**—tearing, ripping, folding, stomping, squashing, or any other random mutilation exacted on a compound that does not change its chemical nature or inherent characteristics.

**polymer**—a substance with long-chain molecules, made up of many small molecules called monomers. Substances such as cellulose and latex are examples of natural polymers, and many synthetic polymers are used in everyday life and in industry.

**precision** - Precision is how repeatable a measurement is. More precise measurements are reported with more significant figures.

**product** - A product is something made as a result of a chemical reaction

**rate determining step** - The rate determining step is the slowest step in any chemical reaction.

**rate law** - A rate law is a mathematical expression relating the speed of a chemical reaction as a function of concentration.

**reaction** - Chemistry - A change in which one or more chemical elements or compounds (the reactant) form new compounds (the products). All reactions are to some extent reversible; i.e., the products can also react to give the original

reactants. However, in many cases the extent of this back reaction is negligibly small, and the reaction is regarded as irreversible. Biology - Any change in behavior of an organism in response to a stimulus.

**redox reaction** - A redox reaction is a chemical reaction that involves oxidation and reduction.

**reversible reaction** - A reversible reaction is a chemical reaction which can go both ways: reactants make products and products make reactants.

**salt** - An ionic compound formed from reacting an acid and a base.

**solute** - The solute is the substance that gets dissolved in a solvent. Usually it refers to a solid that is dissolved in a liquid. If you are mixing two liquids, the solvent is the one that is present in a smaller amount.

**solution** - A homogenous mixture of a liquid (the solvent) with a gas or solid (the solute). In a solution, the molecules of the solute are discrete and mixed with the molecules of solvent. There is usually some interaction between the solvent and solute molecules. Two liquids that can mix on the molecular level are said to be miscible. In this case, the solvent is the major component and the solute the minor component.

**solvent** - This is the liquid that dissolves a solute in solution. Technically, you can dissolve gases into liquids or into other gases, too. When making a solution where both substances are in the same phase (e.g., liquid-liquid), the solvent is the largest component of the solution

**strong acid** - A strong acid is an acid that completely dissociates in water. An example of a strong acid is hydrochloric acid, HCl, which dissociates into  $H^+$  and  $Cl^-$  in water.

**sublimation** - Sublimation is when a solid changes directly into a gas. At atmospheric pressure, dry ice or solid carbon dioxide goes directly into carbon dioxide vapor, never becoming liquid carbon dioxide.

**synthesis** - Synthesis is making a larger molecule from two or more atoms or smaller molecules.

**system** - A system includes everything you are evaluating in a situation.

**temperature** - Temperature is a measure of the average kinetic energy of particles.

**thermometer**—a tool that measures the average amount of heat in a substance.

**unsaturated** - There are two common meanings for unsaturated in chemistry. The first refers to a chemical solution that does not contain all of the solute that can be dissolved in it. Unsaturated also refers to an organic compound which contains one or more double or triple carbon-carbon

**unshared electron pair** - An unshared electron pair or lone pair refers to two electrons that aren't participating in chemical bonding.

**valence electron** - The valence electrons are the atom's outermost electrons.

**variable**—something that can be changed

**wafting**—a technique used to safely sample the scent of something without taking a deep breath of it. Holding the object away from your face, wave your hand over it, blowing a few of the vapors toward your nose.

**Weight**— the force of gravity pulling on an object downward toward the Earth.

<http://chemistry.about.com/od/chemistryglossary/a/Chemistry-Vocabulary.htm>

[http://101science.com/chemistry\\_terms.htm](http://101science.com/chemistry_terms.htm)

*Jr. ChemHead*, B.K. Hixson, 2001, First Printing, Loose in the Lab, Inc. Sandy Utah, pp. 224-228.

*Science Fair Projects: Chemistry*. Bonnet, Bob and Keen, Dan. Sterling Publishing Co. Inc., New York, 2001, pp.88-92.

**Overview (for the teacher):** The unit provides students the opportunity to learn about chemistry through a variety of methods. Junior chemists will conduct experimentation, analyze experimental outcomes, record all observations accurately as they practice skills used by real chemists. The students will learn about facts and theories related to the field of chemistry as they understand the relationship of atoms, molecules, elements, compounds and mixtures. They will learn to write like a chemist using symbols to represent elements, compounds and chemical equations. The young chemists will be able to select and properly use appropriate lab equipment for conducting lab investigations as they practice lab safety measures which are in place. The students will research careers that make use of chemistry and create experiments within a selected career for an authentic audience.

**Pre-assessment:** The students will complete a Chemistry IQ game. This will be done individually. The students will read statements about chemistry facts and ideas. Each will decide if it is True or False. The student will mark the answer on the answer document. After all 20 questions have been read and answered by the students, the scoring will begin. As the teacher reads the question, the student will display either a "T" sign or an "F" sign. The teacher will state the correct answer with explanation about why this is the correct answer. The student will receive five points if he/she is correct and a minus five points if the answer is incorrect. The students will keep up with their scores. The previous exercise was done in ink so no one could change answers after they saw cards of other students. Students may add a "2" to their displayed signs. In this case if they are correct they would get ten points and if incorrect they would lose ten points. This is done for all 20 chemistry questions. Scores on the Chemistry IQ Game place the student as Chemistry Guru (90+), Chemistry Analyst (70-89), Chemistry Novice (50-69) and Chemistry Challenged (below 50).

### **Culminating Performance Task:**

It is time for Career Day at our school and the school counselor has heard that our class has been studying chemistry. She has asked if we could help her out with Career Day by speaking to the students about a career in Chemistry. After a class discussion, it was decided that we would help with Career Day but each student had an interest in a different kind of chemistry. It was decided that the students would become practicing chemists as they researched careers that involved chemistry, selected a career and created a chemical experiment/investigation that related to that career. The students are given the following lists of careers that involve chemistry: analytical chemistry, atmospheric chemistry, biochemistry, computational chemistry, electrochemistry, environmental chemistry, geochemistry, inorganic chemistry, materials science, medicinal chemistry, neurochemistry, nuclear chemistry, organic chemistry, polymer chemistry, physical chemistry, quantum chemistry, spectroscopy, stereochemistry, thermochemistry, and thermodynamics. They may select one of these for their topic or another related chemistry career not listed but of interest to the student (teacher approved, of course). The student must become the practicing professional in that field as he/she gains knowledge of the selected field of chemistry. He/She will research to find an appropriate experiment related to that field of study and will use his/her planning talent to plan the experiment. They will test the experiment along with developing a presentation to be presented to others. When students have completed their research and prepared their experiments, they will present their information along with performing their experiments at the CHEM CAREER FEST (formerly Career Day) to students throughout the school. Parents will be invited.

We are also going to take our expertise on the road, as we travel to the local high school and conduct our traveling CHEM CAREER FEST for the high school chemistry class. This time the students will be presenting one at the time whereas at the school-wide event, all exhibits were set up in the multi-purpose room and all presentations were occurring at the same time.

A rubric will be used for assessment of student presentation and experimental design.

TOPIC:  
Chemistry

Critical Content

### FACTS

A chemical is anything that has mass and takes up space (matter).

A chemical reaction is a chemical change.

Chemical changes are the basis of life and these changes are constantly occurring.

Chemical changes always produce new substances with new properties.

### SKILLS

Lab safety  
Lab techniques  
Measurement  
Written communication  
Following directions  
Research  
Classifying  
Analyzing  
Data interpretations  
Recording  
Reflection  
Representing compounds  
Writing/Balancing chemical equations  
Predictions  
Synthesizing  
Organizing  
Identifying variables

### CONCEPTS

Change  
Matter  
Properties  
Action/reaction  
System  
Substance  
Interaction  
Influence  
Rate of reaction  
Structure  
Similarities and differences  
Time  
Temperature  
Volume  
Heat  
Development

### **Essential Understandings**

Conducting investigations with precision can yield reliable data that leads to the development of accurate interpretations, analyses, and predictions related to matter.

The interaction of substances with varied properties promotes positive and negative change.

Volume, temperature, and surface area affect the rate of change of a reaction.

The interaction of different substances can change into new substances with different properties.

### **Essential Questions**

Why can conducting investigations with precision yield reliable data that leads to the development of accurate interpretations, analyses, and predictions related to matter?

How does the interaction of substances with varied properties promote positive and negative change?

How do volume, temperature, and surface area affect the rate of change of a reaction?

Why can the interaction of different substances change into new substances with different properties?

### **Culminating Performance Task**

It is time for Career Day at our school and the school counselor has heard that our class has been studying chemistry. She has asked if we could help her out with Career Day by speaking to the students about a career in Chemistry. After a class discussion, it was agreed upon that we would help with Career Day but each student had an interest in a different kind of chemistry. It was decided that the students would become practicing chemists as they researched careers that involved chemistry, selected a career and created a chemical experiment/investigation that related to that career. The students are given the following lists of careers that involve chemistry: analytical chemistry, atmospheric chemistry, biochemistry, computational chemistry, electrochemistry, environmental chemistry, geochemistry, inorganic chemistry, materials science, medicinal chemistry, neurochemistry, nuclear chemistry, organic chemistry, polymer chemistry, physical chemistry, quantum chemistry, spectroscopy, stereochemistry, thermochemistry, and thermodynamics. They may select one of these for their topic or another related chemistry career not listed but of interest to the student (teacher approved, of course). The student must become the practicing professional in that field as he/she gains knowledge of the selected field of chemistry. He/She will research to find an appropriate experiment related to that field of study and will use his/her planning talent to plan the experiment. They will test the experiment along with developing a presentation to be presented to others. When students have completed their research and prepared their experiments, they will present their information along with performing their experiments at the CHEM CAREER FEST (formerly Career Day) to students throughout the school. Parents will be invited.

We are also going to take our expertise on the road, as we travel to the local high school and conduct our traveling CHEM CAREER FEST for the high school chemistry class. This time the students will be presenting one at the time whereas at the school-wide event, all exhibits were set up in the multi-purpose room and all presentations were occurring at the same time.

A rubric will be used for assessment of student presentation and experimental design.

## **Affective Lessons**

In order to address social and emotional needs of gifted learners:

- Have the students describe what characteristics of a chemist do they possess (identity).
- The students compare themselves to a test tube in a personal analogy synectics lesson.

## **ALCCRS:**

### **Science**

- 5.1 Identify evidence of chemical changes through color, gas formation, solid formation, and temperature change.
- 5.2 Define mass, volume, and density.
- 8.1 Identify steps within the scientific process.
- 8.2 Describe the structure of atoms, including the location of protons, neutrons, and electrons
- 8.3 Determine the number of protons, neutrons, and electrons, and the mass of an element using the periodic table.
- 8.4 State the law of conservation of matter.
- 8.5 Differentiate between ionic and covalent bonds.
- 8.6 Define solution in terms of solute and solvent.
- 8.7 Describe states of matter based on kinetic energy of particles in matter.
- 9.1 Differentiate among pure substances, mixtures, elements, and compounds.
- 9.8 Distinguish among endothermic and exothermic physical and chemical changes.

### **Mathematics**

- 6.20 Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. [6-EE9]
- 6.25 Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers. [6-SP1]
- 6.29 Summarize numerical data sets in relation to their context.

### **English/Language Arts**

- 5.10 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. [RI.5.1]
- 5.11 Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text. [RI.5.2]
- 5.12 Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text. [RI.5.3]
- 5.13 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a *Grade 5 topic or subject area*. [RI.5.4]
- 5.16 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. [RI.5.7]
- 5.23 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. [RI.5.7]
- 5.28 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. [W.5.7]



- 5.30 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. [W.5.7]
- 5.31 Write routinely over extended time frames, including time for research, reflection, and revision, and shorter time frames such as a single sitting or a day or two for a range of discipline-specific tasks, purposes, and audiences. [W.5.10]
- 5.32 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *Grade 5 topics and texts*, building on others' ideas and expressing their own clearly. [SL.5.1]
- 5.40 Use knowledge of language and its conventions when writing, speaking, reading, or listening. [L.5.3]
- 6.20 By the end of the year, read and comprehend literary nonfiction in the Grades 6-8 text complexity band proficiently, with scaffolding as needed at the high end of the range. [RI.6.10]
- 6.27 Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate. [W.6.7]
- 6.28 Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources. [W.6.8]
- 6.42 Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression. [L.6.6]

### **Technology Education**

- 3-5.2 Use various technology applications, including word processing and multimedia software.
- 3-5.5 Practice safe use of technology systems and applications.
- 3-5.6 Describe social and ethical behaviors related to technology use.
- 3-5.8 Collect information from a variety of digital sources.
- 3-5.9 Use technology tools to organize, interpret, and display data.
- 3-5.11 Use digital tools to analyze authentic problems.
- 6-8.6 Select specific digital tools for completing curriculum-related tasks.
- 6-8.9 Practice responsible and legal use of technology systems and digital content.
- 6-8.11 Use digital tools and strategies to locate, collect, organize, evaluate, and synthesize information.

### **Career/Technical Education**

#### Career Cluster Explorations

- 7-8.3 Demonstrate oral presentation skills that sustain listeners' attention and interest including eye contact, clear enunciation, and use of visual aids.
- 7-8.7 Demonstrate positive work behaviors and personal qualities, including displaying a willingness to acquire new knowledge and skills, demonstrating integrity in a work situation, and indicating a willingness to follow rules and procedures.
- 7-8.12 Identify employment opportunities to match personal interests and aptitudes.

### **Health Science**

- 9-12.2 Exhibit appropriate safety procedure in the laboratory.
- 9-12.3 Explain concepts important to solution preparation.

### **GT Scope and Sequence**

- A: 1a, 1c, 1e, 2a, 2b, 2c, 2d, 2e, 2f, 2g, 3b, 3c, 4a, 4b
- B: 1b, 1c, 1d, 1e, 1i, 1k, 2b, 2c, 3a, 3b, 3c, 3d, 3e, 3f, 3g, 3i, 3j
- C: 1b, 1c, 2c, 3b, 4a, 5c
- D: 1a, 1b, 1c, 1f, 1i
- E: 1b, 1d, 1e, 2a, 2b, 2c, 3b, 3c, 3d
- F: 1a, 1b, 1d, 2a, 2b, 2c, 3b
- G: 1c, 3a
- H: 4c, 4d, 4e, 4g, 4h, 4i, 4j, 5a
- I: 1a, 1c, 1d, 1e, 1f, 2b, 2d, 3a, 3b, 3c, 5a, 6a, 6b, 6c, 7b
- J: 1a, 1b, 1c, 1d, 2a, 3b, 4c, 4d, 5c, 7a, 8b, 8c, 8d

**Content Knowledge/Standards****Concepts:** Change

**Lesson 1 (EU1):** Conducting investigations with precision can yield reliable data that leads to the development of accurate interpretations, analyses and predictions related to matter.

**EQ1:** Why does conducting investigations with precision yield reliable data that leads to the development of accurate interpretations, analyses and predictions related to matter?

**GT Scope & Sequence Outcomes:**

A: 1a, 1c, 1e, 2a, 2b, 2c, 2d, 3b, 3c, 4a, 4b

B: 1b, 1c, 1e, 1i, 2c, 3a, 3b, 3c, 3d, 3j

C: 1b, 2c, 5c

D: 1a, 1b, 1c, 1i

E: 1b, 2b, 3b, 3c,

F: 1a, 1b, 2a, 2c, 3a

G: 1c, 3a

H: 1b, 4c, 4d, 4e, 4g, 4h, 4i, 4j, 5a

I: 1a, 1c, 1d, 3b, 5a, 6a, 6b, 6c, 7b

J: 1a, 4c, 4d, 7a, 8b, 8c, 8d

**ALCCRS:****Science**

5.2 Define mass, volume, and density.

8.1 Identify steps within the scientific process.

**Mathematics**

6.25 Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers. [6-SP1]

6.29 Summarize numerical data sets in relation to their context.

**English/Language Arts**

5.13 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a *Grade 5 topic or subject area*. [RI.5.4]

5.31 Write routinely over extended time frames, including time for research, reflection, and revision, and shorter time frames such as a single sitting or a day or two for a range of discipline-specific tasks, purposes, and audiences. [W.5.10]

	<p>5.32 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on <i>Grade 5 topics and texts</i>, building on others' ideas and expressing their own clearly. [SL.5.1]</p> <p>6.27 Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate. [W.6.7]</p> <p>6.42 Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression. [L.6.6]</p> <p>Technology Education</p> <p>6-8.6 Select specific digital tools for completing curriculum-related tasks.</p> <p>6-8.9 Practice responsible and legal use of technology systems and digital content.</p> <p><b><u>Career/Technical Education</u></b></p> <p>Career Cluster Explorations</p> <p>7-8.7 Demonstrate positive work behaviors and personal qualities, including displaying a willingness to acquire new knowledge and skills, demonstrating integrity in a work situation, and indicating a willingness to follow rules and procedures.</p> <p><b><u>Health Science</u></b></p> <p>9-12.2 Exhibit appropriate safety procedure in the laboratory.</p>
<p><b>Assessment</b></p>	<p><b><u>Pre:</u></b> Chemistry IQ Game (This game gives a general overview of student's prior knowledge related to all of the essential understandings in this unit).</p> <p><b><u>Post:</u></b> Lab Journal Entries (These will be completed at the end of each session needed to complete all aspects of this lesson related to this essential understanding). A rubric for the necessary requirements for the Lab Journal has been given to the students.</p>
<p><b>Introduction</b></p>	<p><b>Overview of the Lesson:</b> The students will discuss lab safety and the importance of safety to both themselves and others who are working in the chemistry lab. The students will begin developing ideas about the responsibilities and characteristics of people who would decide to have a career in chemistry. It is important that students understand that chemists make use of the scientific method throughout their career as they create and evaluate organic and inorganic chemical products. Students practice measuring precisely and with the appropriate measuring devices as well as recording their data accurately. An understanding of how the relationship between conducting investigations with precision to obtain reliable data can lead to accurate interpretations, analyses and scientific predictions will begin to be developed in the young chemist. The students will practice skills of a practicing chemist as they write and record all information related to their investigations in a lab journal.</p>

**This unit includes:**

**Unit Pacing:** This unit will take approximately eight weeks to complete if you meet your gifted students once a week for 3-5 hours per week.

**Background Information for the teacher:**

This unit is highly motivating to students; however, it takes a great deal of preparation and time on the part of a teacher. The teacher should feel comfortable with facilitating scientific lab investigations with students. It is not important that the teacher have a degree in chemistry, but if the teacher's knowledge of chemical concepts and principles is limited then he/she may have to spend some time gaining the necessary knowledge in order to ensure that the conceptual knowledge gained by the student is accurate and correct. Since students' use of scientific materials is varied from prior grades, it is important to make sure that lab safety in the classroom is stressed throughout the entire unit. Practicing correct safety techniques and lab procedures will be used by the student throughout their educational growth. The steps of the scientific method include: identifying a problem or stating a purpose, forming a hypothesis, setting up an experiment to collect information, recording the results and coming to a conclusion as to whether or not the stated hypothesis was correct. Mass is measured in grams; volume in liters and/or milliliters, and length in centimeters and/or meters. Graduated cylinders, pipettes, and beakers can be used to measure volume. A balance scale can be used to measure mass while metric rulers can be used for measuring length. It is important for students to record data accurately so that interpretations of chemical investigations can be drawn.

**Definition:**

**accuracy** - Accuracy is a measure of how close a measured value is to its true value. For example, if an object is exactly a meter long and you measure it as 1.1 meters long, that is more accurate than if you measured it at 1.5 meters long.

**graphs**—quick, easy-to-view pictures of data. There are several kinds of graphs: pie, bar, line, best fit and pictorial.

**hypothesis**—a thoughtful, reasoned guess about something, based on what is known. A hypothesis must be proven by experimentation.

**Kelvin** - Kelvin is a unit of temperature. A Kelvin is equal in size to a degree Celsius, although Kelvin starts from absolute zero. Add 273.15 to a Celsius temperature to get the Kelvin value. Kelvin is *not* reported with a ° symbol. For example, you would simply write 300K not 300°K.

**mass**—how much “stuff” an object is made of. The more mass it has, the heavier it is. A ping-pong ball and a golf ball are about the same size and shape, but a golf ball has more mass.

**observation**—using your senses—smelling, touching, looking, listening and tasting—to study something closely, sometimes over a long period of time.

**precision** - Precision is how repeatable a measurement is. More precise measurements are reported with more significant figures.

**temperature** - Temperature is a measure of the average kinetic energy of particles.

**thermometer**—a tool that measures the average amount of heat in a substance.

**SQ:** What is safety?

What could happen as a result of not practicing safety?

What are some safety practices that are important?

How could we practice safety in the lab? Classroom?

**ACTIVITY:** Ask the students, “What is lab safety” and have them state their ideas. \*\* The students will view the following video on lab safety rules: <http://www.teachertube.com/video/science-lab-safety-rules-88281>.

Conduct a discussion with the class about the importance of lab safety. Ask the students, “What could happen as a result of not practicing safety in the chemistry lab?”

Have the students draw their ideas on art paper. Create a display in the classroom and entitle it “Do Not Let This Happen to You in the Lab!”

Ask the students, “What are some safety practices that are important in the lab/classroom?” and “How can we practice safety in the lab and classroom when doing lab experiments?” As a class generate a list of Lab Safety Rules that will be used throughout the unit for each lab experience. These will be written on a large poster and also on a flipchart for the Promethean Board for easy review of lab safety before each lab experience. The teacher will create a Lab Safety Contract using the student-generated rules for the students to sign and agree to follow. These will be reviewed at each lab session.

**SQ:** What is a chemist?

What are the responsibilities of a chemist?

What are the characteristics of a person who would choose a career in chemistry?

How are you like a chemist?

**ACTIVITY:** The teacher begins a discussion with the class about a chemist and asks the question, “What is a chemist?” The students are given time to respond and the teacher uses their responses to guide the discussion. Using a webbing graphic organizer, the students are asked to think about the responsibilities and characteristics of a chemist. Each is allowed to go to the whiteboard and write their ideas on the web. When finished, the teacher asks the student to Draw-A-Chemist using the descriptive ideas which they have written on the web. To conclude this activity, the teacher asks the students to think about how are they like a chemist. The students are challenged to add to their list of personal characteristics as they participate in the chemistry activities in the days ahead.

**SQ:** What is the scientific method?

**ACTIVITY:**

Ask “Who can explain the scientific method to the class?” As the students respond, the teacher is pre-assessing their prior knowledge about the scientific method and its use in conducting laboratory experiments.

The group will view the multi-media presentation [pa016.k12.sd.us/lab%20safety.ppt](http://pa016.k12.sd.us/lab%20safety.ppt).

The students will review the steps of the scientific method as a means to solve problems and answer questions. The teacher will present the steps of the scientific method using a prepared flipchart for the interactive whiteboard (if available, if not a transparency can be used).

Using a completed science investigation, the teacher will show how each step of the scientific method was applied to answer the scientific question and how conclusions were made. Student groups will be given a template of the steps of the scientific method. Each group will develop an inquiry question from a general list of problems provided by the teacher and design how they would carry out the investigation using the scientific method. Each group will present their plans to the entire class. Discussion will follow to decide if the plan will involve experimentation to find the answer.

It is important for students to understand that while answers can be found from research, the best kinds of problems for scientific investigation involve experimentation to find the answer to the problem.

**SQ:** What is measurement?

What are measuring tools used in the chemistry lab?

What are the metric units of measurement most commonly used in the chemistry lab?

**ACTIVITY:** The teacher will ask the students, “What is measurement?” As the teacher listens to the students’ responses, he/she will be able to determine their current knowledge about measurement. In the classroom, there is an Interest Development Center for students to observe the different measuring devices commonly used in a chemistry lab. The teacher will present each device to the students with an explanation about the use of each and its most commonly used material for measuring. Each measuring tool will be demonstrated by the teacher. Metric units of measurement of grams, centimeters, and milliliters (and their associated decimal measurements) will be discussed with the students. Throughout the room, stations have been set up for the students to visit. At each station is a material to be measured and measuring tools. Working individually, each student will visit the stations and decide which measuring tool would be used and complete the measurement of the given material. The student will record the correct measurement of the materials. When the students have visited all measuring stations, the class will compare their measurements. The teacher will check for accuracy in measurement.

**SQ:** What is data?

What is accurate and reliable data?

How can data be interpreted and analyzed?

How can data be used to make predictions?

How can obtaining data lead to further studies?

**ACTIVITY:**

The teacher will ask the students, “What is data?” and listen to their responses. The teacher will lead the class in a discussion about accurate and reliable data and why is it important to record data accurately? (The students in the class will conduct two activities which will allow them to record obtained data, combine this with classmates and look at how repeated experimentation yields more reliable data. The students will be using chemicals yet do not know chemical formulas at this point. The intent here is for the students to learn to record data accurately, make observations, analyze the data, and use it to make predictions).

First the students will participate in the “Two-colored Counters” Activity. They will determine the number of total outcomes for the events and how many different events can occur. This is the theoretical data. They will conduct the activity by tossing a single two-colored counter and

record which color appears on top. They will record this. They will do 50 tosses. When all students have finished their 50 tosses, each will write on a chart (paper or flipchart) their outcomes for red and yellow colors. These will be added to determine the total red tosses and the total yellow tosses. This is the experimental data. This can be compared to the theoretical data. The two may be similar or different. The class will repeat the activity and record the new data with the old data to yield more data points from which to work. This is repeated experimentation. The probability for the experimental data is calculated again and compared to the theoretical data. They should be more similar this time. Students should be led to discover that the more data points one has the more accurate the data is and that repeated experimentation can yield more accurate and reliable data.

Next, the students will participate in the “Mystery-Powder Investigation” where they will observe characteristics of given powders and record their observations. They will conduct some simple tests with each of the given powders and record their outcomes. Once the students have completed the analysis of all of the given powders and have recorded all information on their chart, they will receive their unknown mystery powder (s) vials which could contain either one or two different substances. The students will perform all of the tests used on the known powders to assist with the identification of the mystery powder(s). They will use the results written on the chart of the known powders to compare with results of the mystery powder. They will predict what they think their mystery powder is based on their observations and chemical test results. Students will write a justification as to why they identified their mystery powder in the way that they did.

### Mystery Powder Investigation

**Junior Chemist:** \_\_\_\_\_

**Date:** \_\_\_\_\_

**Instructions:** Observe and test each of the following substances and record these observations and outcomes on the chart. After you have completed the entire table, see your teacher for your Mystery Powder vial. Using the planning outline on the back of this sheet, develop a plan to identify your assigned Mystery Powder. Test the Mystery Powder using your plan. Please remember to record the number on your Mystery Powder vial on this sheet. The Mystery Powders are different—they may contain only one powder or they may contain a mixture of two or more different powders. Junior chemists begin your investigations. Remember that recording accurate data is important.

Powder	Description of powder (use a hand lens)	Test 1- Water	Test 2- Iodine	Test 3- Vinegar	Test 4- Heat
Baking soda					



<b>Plaster of Paris</b>					
<b>Cornstarch</b>					
<b>Sugar</b>					
<b>Salt</b>					
<b>Mystery Powder</b>					

**Mystery Powder Vial Number** \_\_\_\_\_

**State your hypothesis:**

**What substance(s) do you think are contained in your Mystery Powder vial?**

**What evidence did you obtain to assist you in your decision? Explain.**

**SQ:** What is a lab journal?

Why is a lab journal important to chemists?

**ACTIVITY:**

Ask “What is a lab journal?” The teacher explains that the use of a lab journal and the purpose of using one. Why is a lab journal important for a chemist to use? A lab journal allows the student a means to organize their chemistry experiment handouts where they have written their necessary responses as they make use of the scientific method for each lab experience. Students will create their lab journals to be used throughout this entire unit. (The lab journal entries will be used as an on-going assessment throughout the unit in order for the teacher to ensure that students are demonstrating understanding of the purpose of the lab experience).

**EQ:** Why does conducting investigations with precision yield reliable data that leads to the development of accurate interpretations, analyses and predictions related to matter?

**Debriefing Activity:**

The debriefing session will be conducted with the whole group. The teacher will ask students what they learned about lab safety. The teacher will listen to student responses and emphasize

	<p>the point that if safety practices are carried out properly that the conducting of lab experimentation will go smoother and results can be obtained.</p> <p>The teacher will ask a student to describe and explain the scientific method in his/her own words. What does a systematic approach to conducting chemical tests allow? The students should understand that the repeated use of a systematic approach like the scientific method can yield accurate and reliable results.</p> <p>The teacher will ask the students to name some tools for measuring in the chemistry lab. Describe what each is used to measure. What are the common metric units of measure used in the chemistry lab? Why is it important to measure chemical substances accurately? When substances are measured accurately, the outcomes of the tests can yield data that is both accurate and reliable.</p> <p>The students are asked to explain the term, “repeated experimentation” and how it can lead to more reliable data. The more data obtained the more reliable the results as the experimental data becomes similar to the theoretical data. Observations and testing of substances can lead to the identification of a substance along with determining its properties. Revisit the essential question to determine if the students understand that conducting investigations with precision can yield reliable data that leads to the development of correct interpretations and make predictions. Using data from experimentation can be used for further studies to add information to existing information to better understand scientific phenomenon.</p>
<p><b>Resources</b></p>	<p><b><u>Print:</u></b> Handouts for scientific method activity, measurement activity, two-colored counter and mystery powder investigation</p> <p><b><u>Non-Print:</u></b> computers with internet, art paper, thermometers, gram weights, balance scale, metric rulers, graduated cylinders, beakers, various items to measure, two-colored counters, baking soda, cornstarch, plaster of Paris, salt, sugar, iodine, vinegar, pipettes, hand lens, vials, safety goggles, lab aprons, eye-wash station</p>
<p><b>Extensions</b></p>	<p>The students may create a multi-media presentation or Podcast about lab safety.</p> <p>Using the internet and a tool like Skype/Face Time, the students can talk to a real chemist and interview the chemist to discover his/her job responsibilities. (Prepare interview questions prior to the interview).</p> <p>The two-colored counter activity may be extended to tossing two counters at a time which leads to a more in-depth understanding of repeated experimentation produces more reliable data. The outcomes are increased as well as calculation of the theoretical data involves more advanced use of fractions, decimals and per cents.</p>



**Content Knowledge/Standards****Concepts:** Change

**Lesson 2 (EU2):** The interaction of substances with varied properties promotes positive and negative change.

**EQ2:** How does the interaction of substances with varied properties promote positive and negative change?

**GT Scope & Sequence Outcomes:**

A: 1a, 1c, 2a,2b,2c,2d,2g,3c,4a,4b

B: 1b,1c,1d,1e,1i,1k, 2b,2c, 3a,3b,3c,3d,3f,3g,3i,3j

C: 1b, 1c, 2c, 3b, 4a, 5c

D: 1a,1b,1c, 1f, 1i

E: 1b, 1d,1e,2a,2b,2c,3b,3c,3d,

F: 1a, 1b,2a,2c,3b

G: 1c,3a

H: 4c, 4d, 4e, 4g, 4h, 4i, 4j, 5a

I: 1a, 1c,1d, 1e, 1f, 2b, 3a, 3b, 3c, 5a, 6a, 6b, 6c, 7b

J: 1a, 1b, 1c, 1d, 2a, 4c, 4d, 5c, 7a, 8b, 8c, 8d

**ALCCRS:****Science:**

5.1 Identify evidence of chemical changes through color, gas formation, solid formation, and temperature change.

8.2 Describe the structure of atoms, including the location of protons, neutrons, and electrons

8.3 Determine the number of protons, neutrons, and electrons, and the mass of an element using the periodic table.

8.4 State the law of conservation of matter.

8.5 Differentiate between ionic and covalent bonds

8.6 Define solution in terms of solute and solvent

8.7 Describe states of matter based on kinetic energy of particles in matter.

9.1 Differentiate among pure substances, mixtures, elements, and compounds.

9.8 Distinguish among endothermic and exothermic physical and chemical changes.

**English/Language Arts**

5.16 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. [RI.5.7]

- 5.23 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. [RI.5.7]  
investigation of different aspects of a topic. [W.5.7]
- 5.30 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. [W.5.7]
- 5.31 Write routinely over extended time frames, including time for research, reflection, and revision, and shorter time frames such as a single sitting or a day or two for a range of discipline-specific tasks, purposes, and audiences. [W.5.10]
- 5.32 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *Grade 5 topics and texts*, building on others' ideas and expressing their own clearly. [SL.5.1]
- 6.27 Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate. [W.6.7]
- 6.28 Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources. [W.6.8]
- 6.42 Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression. [L.6.6]

### **Technology Education**

- 3-5.2 Use various technology applications, including word processing and multimedia software.
- 3-5.5 Practice safe use of technology systems and applications.
- 3-5.6 Describe social and ethical behaviors related to technology use.
- 3-5.8 Collect information from a variety of digital sources.
- 3-5.9 Use technology tools to organize, interpret, and display data.
- 3-5.11 Use digital tools to analyze authentic problems.
- 6-8.6 Select specific digital tools for completing curriculum-related tasks.
- 6-8.9 Practice responsible and legal use of technology systems and digital content.
- 6-8.11 Use digital tools and strategies to locate, collect, organize, evaluate, and synthesize information.

### **Career/Technical Education**

#### Career Cluster Explorations

- 7-8.3 Demonstrate oral presentation skills that sustain listeners' attention and interest including eye contact, clear enunciation, and use of visual aids.
- 7-8.7 Demonstrate positive work behaviors and personal qualities, including displaying a willingness to acquire new knowledge and skills, demonstrating integrity in a work situation, and indicating a willingness to follow rules and procedures.

	<p><b><u>Health Science</u></b> 9-12.2Exhibit appropriate safety procedure in the laboratory.</p>
<b>Assessment</b>	<p><b><u>Pre:</u></b> Chemistry IQ Game (This game gives a general overview of student’s prior knowledge related to all of the essential understandings in this unit).</p> <p><b><u>Post:</u></b> Lab Journal Entries (These will be completed at the end of each session needed to complete all aspects of this lesson related to this essential understanding). A rubric for the necessary requirements for the Lab Journal has been given to the students.</p>
<b>Introduction</b>	<p><b><u>Overview of the lesson:</u></b> This lesson looks at the smallest unit of all matter that makes up all things. These atoms contain different numbers of protons, neutrons and electrons to create different elements which exist on the earth. These elements are arranged in order of their atomic number (protons) on the Periodic Table of Elements. These elements can form molecules of compounds. The compounds can be combined to form mixtures. A chemical equation can be written to represent the combination of elements and compounds and the new substances created by the chemical reaction. It is important to balance these. Substances can be classified acids, bases and neutrals using a variety of indicator materials to classify these. There can be negative and positive consequences of mixing reactants that yield new products. A variable is part of an experiment that can be changed. Reactions can be analyzed to determine what causes specific outcomes of mixing elements and compounds together to create new products.</p> <p><b><u>This lesson includes:</u></b></p> <p><b><u>Unit Pacing:</u></b> This unit will take approximately eight weeks to complete if you meet your gifted students once a week for 3-5 hours per week</p> <p><b><u>Background Information for the teacher:</u></b> The three states of matter are solids, liquids, and gases. All substances have physical and chemical properties and they may undergo physical and chemical changes. Atoms and molecules are two building blocks of matter. Atoms are made up of neutrons, protons and electrons. Elements are organized by increasing atomic number in the periodic table. Atoms combine in different ways to form covalent and ionic compounds. A chemical reaction is represented by a balanced chemical equation. An acid is a compound that releases hydrogen ions in water and a base is a compound that releases hydroxide ions in water. Litmus is a substance used to detect the presence of an acid or a base. The pH scale is a scale ranging from 1-14 used to indicate the strengths of acids and bases. An indicator is a substance that changes color at a certain range of pH values.</p>

**Definition:**

**acid** - There are several ways to define an atom, but they include any chemical that gives off protons or  $H^+$  in water. Acids have a pH less than 7. They turn the pH indicator phenolphthalein colorless and turn litmus paper red.

**alkali metal** - An alkali metal is a metal in Group I of the periodic table. Examples of alkali metals include lithium, sodium, and potassium.

**alkaline earth metal** - An alkaline earth metal is an element belonging to Group II of the periodic table. Examples of alkaline earth metals are magnesium and calcium.

**atom**-the smallest complete building block of the universe.

**base** - A base is a compound that produces  $OH^-$  ions or electrons in water or that accepts protons. An example of a common base is sodium hydroxide, NaOH.

**binary compound** - A binary compound is one made up of two elements.

**binding energy** - Binding energy is the energy that holds protons and neutrons together in the atomic nucleus.

**bond energy** - Bond energy is the amount of energy required to break one mole of chemical bonds.

**chemical change**-two or more chemicals combining to form a new compound with new characteristics. Indicators of this are a change in state, color, temperature, density, odor, or magnetism. This new compound also had a new boiling point, melting point, density, and so on. It's a complete makeover from a molecular point of view.

**chemical equation** - A chemical equation is a description of a chemical reaction, including what reacts, what is produced, and which direction(s) the reaction proceeds.

**chemical formulas**-a combination of letters and numbers representing molecules and atoms. Written as an equation showing the changes and new by-products. Shorthand for chemists.

**chemical property** - A chemical property is a property that can only be observed when a chemical change occurs. Flammability is an example of a chemical property, since you can't measure how flammable a substance is without igniting it (making/breaking chemical bonds).

**Chemical symbols**—one or two letter “abbreviations” that represent the elements. Elements are substances that cannot be chemically broken down into simpler basic substances.

**compound** - A substance formed by the combination of elements in fixed proportions. The formation of a compound involves a chemical reaction: i.e. there is a change in the configuration of the valence electrons of the atoms. Compounds, unlike mixtures, cannot be separated by physical means.

**covalent bond** - A covalent bond is a chemical bond formed when two atoms share two electrons.

**element** - A substance that cannot be decomposed into simpler substances. In an element, all the atoms have the same number of protons or electrons although the number of neutrons may vary. There are 92 naturally occurring elements.

**endothermic** - Endothermic describes a process that absorbs heat. Endothermic reactions feel cold.

**end point** - A known pH point of an acid and base interaction as shown by a chemical indicator change in color.

**exothermic** - Exothermic describes a process that gives off heat.

**family** - A family is a group of elements sharing similar properties. It is not necessarily the same thing as an element group. For example, the halogens or oxygen family consists of some different elements from the nonmetal group.

**Litmus paper**—a device used by chemists to measure the pH of a substance; that is, its acidity or alkalinity. It is a dye made from certain plants. A substance which is an acid will turn blue litmus paper red. Alkalines turn red litmus paper blue or deep violet. If the solution is neutral, it will not change the color of the paper. Litmus paper is inexpensive to buy.

**mixture** - A system of two or more distinct chemical substances. Homogeneous mixtures are those in which the atoms or molecules are interspersed, as in a mixture of gases or in a solution. Heterogeneous mixtures have distinguishable phases, e.g. a mixture of iron filings and sulphur. In a mixture there is no redistribution of valence electrons, and the components retain their individual chemical properties. Unlike compounds, mixtures can be separated by physical means (distillation, crystallization, etc).



**period** - A period is a row (left to right) of the periodic table.

**pH Scale** - A logarithmic scale (from 1 (acid) to 14 (base)) for expressing the acidity or alkalinity of a solution. To a first approximation, the pH of a solution can be defined as  $-\log_{10} c$ , where  $c$  is the concentration of hydrogen ions in moles per cubic decimeter. A pH of below 7 indicates an acid solution; one above 7 indicates alkaline solution. More accurately, the pH depends not on the concentration of hydrogen ions but on their activity, which cannot be measured experimentally. pH stands for 'potential of hydrogen'. The scale was introduced by S.P. Sorensen in 1909.

**physical change**—tearing, ripping, folding, stomping, squashing, or any other random mutilation exacted on a compound that does not change its chemical nature or inherent characteristics.

**product** - A product is something made as a result of a chemical reaction

**reaction** - Chemistry - A change in which one or more chemical elements or compounds (the reactant) form new compounds (the products). All reactions are to some extent reversible; i.e., the products can also react to give the original reactants. However, in many cases the extent of this back reaction is negligibly small, and the reaction is regarded as irreversible. Biology - Any change in behavior of an organism in response to a stimulus.

**redox reaction** - A redox reaction is a chemical reaction that involves oxidation and reduction.

**reversible reaction** - A reversible reaction is a chemical reaction which can go both ways: reactants make products and products make reactants.

**salt** - An ionic compound formed from reacting an acid and a base.

**strong acid** - A strong acid is an acid that completely dissociates in water. An example of a strong acid is hydrochloric acid, HCl, which dissociates into  $H^+$  and  $Cl^-$  in water.

**unsaturated** - There are two common meanings for unsaturated in chemistry. The first refers to a chemical solution that does not contain all of the solute that can be dissolved in it. Unsaturated also refers to an organic compound which contains one or more double or triple carbon-carbon

**unshared electron pair** - An unshared electron pair or lone pair refers to two electrons that aren't participating in chemical bonding.

	<p><b>valence electron</b> - The valence electrons are the atom's outermost electrons</p> <p><b>variable</b>—something that can be changed</p> <p><b>wafting</b>—a technique used to safely sample the scent of something without taking a deep breath of it. Holding the object away from your face, wave your hand over it, blowing a few of the vapors toward your nose.</p>
<p><b>Teaching Methods</b></p> <p><b>(You can have more than one SQ per activity)</b></p>	<p><b><u>SQ:</u></b> What is an atom?  What are the parts of an atom?  What are the characteristics of the different parts of an atom?  What is a molecule?</p> <p><b><u>ACTIVITY:</u></b>  Introduction: View video “What is an Atom: Basic for Kids”  <a href="https://www.youtube.com/watch?v=R1RMV5qhwyE">https://www.youtube.com/watch?v=R1RMV5qhwyE</a> (atoms)</p> <p>A molecule is the smallest part of anything that exists as a thing. Neither atoms nor molecules can be seen. The teacher says, “Imagine yourself shrinking way, way down until you become one. If you were a molecule of something on a tabletop, a salt crystal (one grain of salt) on the table would look like a mountain to you. If you were a molecule of water, you would be the last, littlest part of a drop. The last part to evaporate would be you. While molecules are small, the particles that make them up are even smaller. These parts are called atoms.</p> <p>Review visual aids in the classroom which contain diagrams of atoms and the parts of an atom. The teacher will discuss with the students characteristics of protons, neutrons and electrons. Everything on earth is made up of atoms. Each atom has a central point known as the nucleus which is made up of neutrons and protons. Protons have a positive electrical charge while neutrons have no charge and are said to be neutral. Spinning around the nucleus are very tiny particles called electrons which have a negative electrical charge. The positive and negative electrical charges between electrons and protons are what keep the atom together and whole. Think of the atom’s nucleus made of neutrons and protons as a ball with smaller balls (electrons) circling it.</p> <p>The students will make models of atoms using clay (even though none of these particles are as dense as clay—it will serve as a means to help students understand this difficult idea).  “Atomic Orbit” found in <i>Simple Chemistry Experiments with Everyday Materials</i></p> <p><b><u>SQ:</u></b> What is a solid?  What is a liquid?  What is a gas?</p> <p><b><u>ACTIVITY:</u></b>  Students use productive thinking to think of many, different and unusual examples of matter. Each will share his/her ideas as the teacher writes these on the board (or flipchart). The teacher encourages the students to add to the examples to make the list better. (SAVE FOR LATER) The students will view the video on solids, liquids and gases at :</p>

<http://www.sciencekids.co.nz/videos/chemistry/solidliquidgassong.html>

The teacher will conduct a demonstration to demonstrate solids, liquids and gases. The teacher will present ice and discuss with the class what makes it a solid. Next the ice will melt and move to another state of matter. Again the students will discuss with the class what makes this a liquid. The melted ice water will be placed in a pot on a heat element and allowed to boil. The students observe the steam as it comes out of the pot as a gas. Students discuss the characteristics of a gas.

Students get up and model these with their bodies.

The students will return to their productive thinking list of examples of matter and classify each as solid, liquid or gas.

**SQ:**

What is an element?

What is a compound?

What is a symbol?

How are the characteristics of elements different?

What is the periodic table?

How can elements be combined to form compounds?

How can compounds be combined to form new substances?

**ACTIVITY:**

The students are introduced to elements and compounds as they view the video at:

<http://www.sciencekids.co.nz/videos/chemistry/elementsong.html>. The students will make paper models of elements to better understand that the configuration of the elements is different and the number of protons determines the differences in elements.

Next, the students will view another more complex video that gives a more in-depth explanation of elements. The video can be view at: <https://www.youtube.com/watch?v=cV4jJZCIMPo>. The students will use structured note-taking as they view the video. The class will discuss what they heard and learned during the video.

The students will be given a chocolate chip cookie and told to take out all of the chocolate chips. They are to count the number of intact chocolate chips (not very small pieces) and record on the lab sheet "Cookies as Elements". This number of chocolate chips represents protons (+). Using the Periodic Table of Elements, name your element based on the number of protons found in the cookie. (Save this handout to be completed later)

The students will view this video about the organization and use of the Periodic Table of Elements at: <https://www.youtube.com/watch?v=fLSfgNxoVGk>.

The teacher will use a classroom display of a large periodic table to practice with students how to find information about the different elements listed on it. Each student is given a personal copy of a Periodic Table to use throughout the unit. After discussing a few elements and answering questions about characteristics of selected elements, the students go back to their "Cookies as Elements" handout to use the Periodic Table to answer the remaining questions about their "cookie element."

The students will continue to get practice with identifying elements using symbols by completing handouts that allow for naming elements represented by symbols and using element names to write symbols.

As students come to class each day, there will be a selected “Element of the Day” posted on the board with some information. The students are asked to use productive thinking to create a list of the many, varied and unusual ways that the “Element of the Day” can be used.

There are several interest development centers in the classroom for students to visit: 1) An element kit with actual elements in labelled ampules is available for students to view and 2) a game about elements.

The students will conduct a research project on elements. The students will use a decision making matrix to determine which element(s) to research. They must establish criteria questions to use on the matrix. Once the element for research has been determined, students will use *Inspiration* software to brainstorm what information they will present in the finished product. The students will use the software to turn the graphic web design into an outline. Both should be printed. Students will take notes from every resource used for information and document this for the bibliography. Students may use websites from the Internet, chemical resource books, chemistry textbooks, and other reliable resources. The students may choose to create a newsletter, a multi-media presentation, a Podcast, a book or brochure for their finished product. (If students have other ideas, they may discuss and get approval from the teacher). Students must use their planning talent to create a plan before starting on their selected product. There are some specific information (given to the student) that must be included in the final product. A deadline is given for the product which will allow for the students to plan and use their time wisely in order to create a wonderful finished product.

As time allows throughout the unit, the students will create two different types of “Element Bingo” cards— one that has only selected symbols from selected elements and the other has names of elements. When they play the game, the caller will call out the name of elements and the player(s) will mark the symbol on the card if that element’s symbol is there. For the other card type, the caller will call the symbol and the player(s) will mark the element name if located on the card.

Another good resource for information on the use of elements and the periodic table can be found at: <http://www.webelements.com/> (interactive periodic table).

**SQ:** What is a mixture?

**ACTIVITY:**

A mixture is what you get when you combine two substances in such a way that no chemical reaction occurs between the components and you can separate them again.

Using internet, students find examples of 10 different mixtures composed of common substances. Each will make one of the mixtures. The class will make a class list of these mixtures.

**SQ:** What is a chemical equation?

How can I represent the interaction of these substances in an equation?

**ACTIVITY:**

The teacher asks, “What is a chemical equation?” As the students respond, the teacher is assessing their prior knowledge of this. The teacher explains that a chemical equation describes a chemical reaction. A chemical equation includes symbols, formulas, numbers, and an arrow. The arrow means produces or yields. Original substances are written to the left of the arrow and products (new substances) are written to the right. Examples of simple chemical equations are presented to the class. (The teacher will determine the quantity and complexity of these equations as this is a new concept and skill for the students). It may be necessary to review the differences between atoms and molecules because this distinction is essential in order to balance chemical equations. The teacher will lead the class in balancing simple chemical equations. Students will be divided into groups and given chemical equations to balance. Groups will select a spokesperson that will present the completed balanced equation to the group and explain how they approached the process. Discuss with the group the importance and necessity of balancing chemical equations in order to maintain the Law of Conservation of Mass.

(This practice will be on-going throughout the unit—either in the form of a practice sheet or as a game).

**SQ:** What is an acid?

What is a base?

What is a neutral substance?

What is the pH scale?

How can a substance be classified as an acid or base?

Why is it important to distinguish substances as acidic, basic or neutral?

**ACTIVITY:**

Students taste a piece of citrus fruit (make sure do not have allergies) and are asked to describe how the fruit tastes. Point out to the students that certain molecules and atoms are responsible for the taste. These are referred to as acids. Using large poster photos of other acids, the teacher presents other examples of acids. Substances are classified as either as acid, a base or a neutral. An acid is a compound that releases hydrogen ions in water. Hydrogen ions ( $H^+$ ) are released—the more hydrogen ions released the stronger the acid. A base is a compound that contains a hydroxide (OH) ion. Examples of bases are presented to the students using photos on large poster boards. These are placed on a bulletin board for future reference for students. The students will view the following: <http://www.kidsknowit.com/interactive-educational-movies/free-online-movies.php?movie=Acids%20And%20Bases> and take the quiz at the end of the video. Another video can be viewed at: <http://studyjams.scholastic.com/studyjams/jams/science/matter/acids-and-bases.htm> and students will answer the questions after viewing this.

A visual aid is displayed in the classroom which shows the pH scale and pictures of various items and their related pH number from 1-14. Students begin to recognize substances that are acidic and those that are basic as well as neutral substances. The teacher leads the class in a discussion about the negative and positive effects of both acids and bases. Using some of the ideas from the videos and student’s knowledge of these substances, a list of positive and negative ideas about these substances can be generated and placed on a flipchart for future use.

The students are ready to begin experimenting to classify substances as acid, base or neutral. They will make cabbage juice by placing red cabbage leaves in warm water and watching as the extraction of the color takes place (I do this first thing in the morning with the students so they can observe until time for the testing to occur—beware it is not a good smell in the room). The experimental design is developed with the problem being “how to classify the tested substances as acid, base or neutral using the cabbage juice, litmus paper and pH paper.” The students are introduced to the use litmus paper in classifying substances as acid, base or neutral. The teacher uses a variety of substances in a teacher demonstration to show what happens when blue litmus paper is dipped into an acid solution. The blue litmus paper turns red. This substance would be classified as an acid. If blue litmus paper is placed in a basic (alkaline) solution it will remain blue. If red litmus paper is placed into a basic (alkaline) solution, it will turn blue thus indicating a base. If red litmus paper is placed in an acid, it will remain red. No color change will occur on either the red or blue litmus paper if it is a neutral substance with a pH of 7. Students are reviewed on the ranges on the pH scale of acids and bases. The students will also use pH paper in their classification of various substances. The teacher demonstrates how to use the pH paper. The strip is dipped into the tested substance and a color change will occur on the strip within 30 seconds. There is a color chart which correlates with each number 1-14 on the pH scale. The students will compare the color on the pH paper strip to the chart to determine the pH of the tested substance. The students will use micro-chemistry plates to distribute their tested substances. A small sample of each solution is placed in each well. The teacher goes around the room to make sure that students are placing four small amounts of each tested substance in the wells. They will add cabbage juice to one well and record their observations on the “Acid/Base Lab” Lab sheet. Next each student will dip the blue litmus paper in the second well and record results then the red litmus paper will be dipped into the third well and results recorded. Finally, the students will test the solutions with pH paper. After they have tested all of the ten solutions, they will look at their recorded data and classify each solution as an acid, base or neutral substance. After this has been completed, the students will share their findings and justify to the class why they classified the substances as they did. It will be apparent to the teacher who conducted the lab and recorded observations accurately. The teacher will ask, “Why is it important to know if a substance is an acid, base or neutral?”

The teacher asks the students to use productive thinking as they think of many, varied and unusual products in their home which could be tested for acidity, alkalinity and neutral. Write these ideas on a sheet of paper. Try to think of things no one else would think of.” Students are given some litmus strips to take home and test a minimum of three products on their list and record results. They will report to the class the next day their findings.

As a follow-up and to further give students experience with identifying acids, bases, and neutrals.

<http://www.lawrencehallofscience.org/kidsite/portfolio/alien-juice-bar/>

**SQ:** What is a physical change?

What is a chemical change?

What is an endothermic reaction?

What is an exothermic reaction?

How can one distinguish physical and chemical changes?

**ACTIVITY:**

The students will view the following;

<http://studyjams.scholastic.com/studyjams/jams/science/matter/changes-of-matter.htm>

As a group, the students will answer the questions to the quiz that accompanies the video on physical and chemical changes.

The students will conduct a mini-experiment which will allow them to be exposed to both physical and chemical changes. Pairs of students will be given egg shells to examine and write their observations. Each group breaks off two pieces from the egg shell and writes their observations of the broken egg shell pieces. How were these observations similar to the first written responses and how were they different? Next the students will add one drop of vinegar to a piece of egg shell. What happened? (It should bubble). The pairs will share with the entire class. The teacher will ask, "How was the first experiment different from the second?" and listen to responses. The teacher will further explain and give examples of physical and chemical changes. The teacher will ask which demonstrated a physical change and which demonstrated a chemical change. Why were the broken egg shells an example of a physical change? Why was the addition of vinegar to the egg shells a chemical change? Address any misconceptions at this time.

The students will conduct several lab experiments in the activity "Are You Ready for a Change?" where they visit ten stations set up in the classroom. Each station has a set of directions for the students to follow (depending on the size of your group this can be done in pairs or individually). After the students conduct the experiment at each station, they record their observations, classify what occurs as either a physical or a chemical change and justify why they classified this in such a manner. They will answer some follow-up questions related to the investigation. When all have visited all stations, the group will reconvene and debrief the activity. At the different stations where a chemical reaction took place; there was either be a color change, a precipitant formed, a gas formed or a temperature change to indicate that a chemical change occurred. The teacher will listen that the students use those terms when classifying chemical changes. In stations 9-10, students should make the observation that the Ziploc bags used to conduct the experiment either turned cold or warm to the touch. This should be recorded on their observations for these stations. The teacher will ask the students why some bags were warm and other cold. The teacher will listen to the student responses. There was a temperature change associated with both of these reactions that indicated a chemical change occurred. In the bag that got warm, the change is referred to as exothermic because heat is given off (excited) to the surroundings. In the case of the bag that got cold, the change would be referred to as endothermic because the system absorbed heat (heat entered the bag) from the surroundings so it felt colder. The characteristic of an exothermic reaction is that heat energy is released and the heat can be felt. A reaction in which heat energy is absorbed is called an endothermic reaction and feels cool because heat energy from your hand is absorbed by the reaction.

Other than those experiences in class with physical and chemical changes, each student will give five examples of physical and chemical changes that can occur in daily lives and nature. They must justify their classification of their examples.

**SQ:** What is a variable?

How can I determine causative agents in a chemical reaction?

Why do I need to only have one variable in the analysis of causative agents?  
Why did this reaction create a different substance?  
How do color, temperature, odor and formation of new substances indicate chemical changes?  
Why would some interactions result in positive changes?  
Why would some interactions result in negative changes?  
Why is it necessary to understand the interaction of different substances before testing?

**ACTIVITY:**

The students will conduct a series of lab experiments from the GEMS unit “Chemical Reactions.”  
**REVIEW ALL LAB SAFETY RULES WITH THE STUDENTS ESPECIALLY RELATED TO THE USE OF CHEMICALS IN THE LABORATORY!!** Conduct a quick demonstration about the ease of getting a chemical powder on one’s hand and how quickly it could contaminate other things touched. The teacher will ask the students to use productive thinking to think of the many, varied and unusual happenings when two chemicals are mixed together. Record these ideas on a flipchart. During the upcoming lab, you will combine three chemicals one by one and you need to decide at each step whether or not you observe any of the things that are listed on the board.

Prepared student trays with measuring devices, zip lock bags and chemicals are passed out to the student groups. Students examine the chemicals and write their observations on the “Chemical Reactions” handout. Following the procedure, student groups will mix the chemicals and record all observations. Discuss what observations and conclusions the groups made. Ask the students, “What caused the heat that was produced in this experiment?” Could it be one, two or all three of the chemicals in this experiment? The students have to discover which chemical caused the heat. Ask the students, “What is a variable?” Explain that a variable is something that can be changed in an experiment. An independent variable is the variable that is changed in a scientific experiment. Independent variables are the variables that the experimenter changes to test their dependent variable. The students need to discover what chemical caused the heat to be produced in the previous experiment. The students are asked, “How could they find out what caused the heat?” What could the variable be? The variable should be one of the three chemicals used in the previous experiment. The students will use their planning talent to develop an experimental plan that will determine which reactant is responsible for the production of heat in the previous chemical reaction experiment. Begin by writing a description of your experimental plan followed by listing all materials and equipment needed to carry out the plan. Next, number the steps necessary to complete the experimental plan along with any problems that you might have with your plan. Finally, after you have conducted your plan, you will need to write any improvements to your plan in different colored ink. Each group will conduct their experiment using their experimental design and describe what happened. Each will draw conclusions about their own outcomes. In a whole group discussion, groups will present the chemical which was the variable in the experiment and the outcome of not using that chemical in the experiment. The class will discuss whether their experiments produced heat and what their variable was. After reviewing all data from each group, the class should be able to determine what caused the heat in the experiment. The teacher asks, “Is this an endothermic or an exothermic chemical reaction?” (All materials from this experiment will be placed in Lab Journal)



The teacher will say, “The previous experiment demonstrated an exothermic chemical reaction. You will use your communication talent to develop a network of ideas in the form of a comic strip, using many, varied and complete thoughts that depict what occurred in the experiment and what you discovered. You will use the strips of paper provided for the comic strip, which will be used to teach other students about chemical reactions, reactants and products. Be sure that the comic strip shows what occurred in the experiment as well as what you learned from the experience, I will be looking for correct use of chemistry vocabulary.”

The students will use the computer and open a document (“Are You Learning Anything About Chemistry?”) uploaded by the teacher to respond to some questions. They are to print this out when completed and place in their Lab Journal.

Debrief with students as they discuss why some interactions might result in positive changes while others might result in negative changes. What are some examples in real life of mixing chemicals that could result in positive changes? (New drugs for various diseases, new products that help mankind, etc.) What are some examples in real life of mixing chemicals that could result in negative changes? (chemicals that are used in warfare that would endanger human life, radioactive materials, explosions, etc.) Why would it be important to be able to predict what products would be produced from the interaction of different chemicals? This is done by writing a chemical equation and provides chemists with an idea of what outcomes to expect.

#### SYNECTICS (DIRECT ANALOGY)

Teacher Talk: “We have been conducting a variety of chemical experiments using equipment like a real chemist used in his/her chemistry lab. We have noted the occurrences of physical and chemical changes through our experimentation while differentiating exothermic and endothermic reactions. In our classroom chemistry lab, we have practiced lab safety, recorded results of our investigations, developed experimental plans and interpreted the Periodic Table of Elements. Today, you will use your knowledge of chemical investigations to make comparisons between a chemist’s lab and other things.”

“A direct analogy is the comparison of one thing to another. An example might be: A graduated cylinder is like a **thermometer** because **it always measures up**. I would like for you to practice with the following analogy: **Safety goggles** are like \_\_\_\_\_ because they give protection.” (This statement will be written on the board or flipchart). I will write the responses from the students on the board or flipchart.

Now that you have warmed up, you will complete the analogies on the handout that deals with the aspects of a chemist’s lab. (Use the Synectics Direct Analogy Handout for this activity-Handout packet at the end of unit).

**EQ:**How does the interaction of substances with varied properties promote positive and negative change?

#### **Debriefing Activity:**

(Students have participated in many activities as they develop an understanding of this essential understanding and it has been lengthy). As the class reflects upon this essential question, the teacher will first ask the students to talk about the activities and what they learned. If the students do not mention

	<p>major ideas practiced, the teacher will assist them with the discussion of those. The essential question will be stated and student responses will be written on the board (or flipchart). Interaction of substances (reactants) is a big idea as well as the understanding of varied properties. Examples of positive and negative changes caused by the interaction of different substances will be given by the students. The teacher will clarify at this time any misunderstandings that might be apparent from the class discussion.</p>
<p><b>Resources</b></p>	<p><b>Print:</b> Visual Aids for atoms, Periodic Table and pH scale; <i>Simple Chemistry Experiments with Everyday Materials</i>, <i>Chemical Reactions</i>, Atom Paper Model Template, Elements Structured Note-taking Handout, “Cookies as Elements” recording handout; individual copies of Periodic Table; chemical equations practice sheets</p> <p><b>Non-Print:</b> Computer with Internet, clay, ice, pot, burner, chocolate chip cookies, element kit, element game, <i>Inspiration</i> software, element bingo cards, student’s lab journal, poster board, orange, litmus paper, pH paper, various acid and basic solutions, egg shells, vinegar, pipettes, graduated cylinder, Ziploc bags, phenol red, calcium chloride</p>
<p><b>Extensions</b></p>	<ol style="list-style-type: none"> <li>1. The students can investigate other natural pH indicators (they used cabbage juice in lesson) and create their own experiments that determine if substances are acidic or alkaline. Students will conduct their planned experiment to determine if their data compares with known acids and bases. Write a summary of their findings.</li> <li>2. Students can use reference materials to investigate the medical uses of elements such as lithium, potassium and calcium. The students present their findings to their classmates. Their presentation may take the form of a multi-media presentation, a flipchart and/or a pod cast.</li> <li>3. Using the background gained from the Chemical Reaction lab, the students can further investigate other liquids which might react with calcium chloride to produce heat. They will develop an experimental design which will guide the investigation. They will create a chart of those liquids which demonstrate an exothermic reaction and those that do not.</li> <li>4. Students can take water samples from all water fountains located in the school and test the pH. The students can plan how they are going to do this and gather their needed materials. Students must ensure that the collection method is standardized throughout. The students can write a letter to the school principal noting the outcome of their testing. If problems are detected, then they must present the principal with a plan to solve the problem.</li> </ol>

**Content Knowledge/Standards****Concepts:** Change

**Lesson 3 (EU3):** Volume, temperature and surface area affect the rate of change of a reaction.

**EQ3:** How do volume, temperature and time affect the rate of change of a reaction?

**GT Scope & Sequence Outcomes:**

A: 1a, 1c, 2a, 2b, 2c, 2d, 3b, 4a,4b

B: 1b, 1c,1d, 1e,1i,2c,3a,3b,3c,3d,3j

C: 1b,1c,2c,3b,4a,5c

D: 1a,1b,1c, 1f,1i

E: 1b,2b,2c,5d,6,7

F: 1a, 1b, 2a

H: 2c,3c,4a,4c,4e, 4g, 4i,

I: 1a, 1c,1d, 1e, 2b,3b, 3c, 3e, 5c,6a,6b,6c,7b

J: 1a, 2a,3b,4c,4d,7a, 8b, 8c, 8d

**ALCCRS:****Science**

5.1 Identify evidence of chemical changes through color, gas formation, solid formation, and temperature change.

8.1 Identify steps within the scientific process.

8.6 Define solution in terms of solute and solvent

8.7 Describe states of matter based on kinetic energy of particles in matter.

**English/Language Arts**

6.27 Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate. [W.6.7]

6.42 Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression. [L.6.6]

**Technology Education**

6-8.11 Use digital tools and strategies to locate, collect, organize, evaluate, and synthesize information

	<p><b><u>Career/Technical Education</u></b>  Career Cluster Explorations  7-8.7 Demonstrate positive work behaviors and personal qualities, including displaying a willingness to acquire new knowledge and skills, demonstrating integrity in a work situation, and indicating a willingness to follow rules and procedures.</p> <p><b><u>Health Science</u></b>  9-12.2 Exhibit appropriate safety procedure in the laboratory.  9-12.3 Explain concepts important to solution preparation.</p>
<b>Assessment</b>	<p><b><u>Pre:</u></b> Chemistry IQ Game (This game gives a general overview of student's prior knowledge related to all of the essential understandings in this unit).</p> <p><b><u>Post:</u></b> Lab Journal Entries (These will be completed at the end of each session needed to complete all aspects of this lesson related to this essential understanding). A rubric for the necessary requirements for the Lab Journal has been given to the students.</p>
<b>Introduction</b>	<p><b>Overview of the lesson:</b> The students will conduct a series of experiments to determine what factors affect the rate of a chemical reaction. The students will vary the temperature and record the time that it takes for the chemical reaction to stop. Changing the surface area of a given solid will show how surface area affects the speed of the chemical reaction. This will be recorded. Varying concentrations of a given solution will be tested to determine how concentration of solutions affects the rate of a chemical reaction. Each of the experiments are timed and recorded. The students will interpret the data and write these interpretations on their lab sheet which will be placed in their Lab Journals at the completion of the lab.</p> <p><b>This lesson includes:</b></p> <p><b>Unit Pacing:</b> This unit will take approximately eight weeks to complete if you meet your gifted students once a week for 3-5 hours per week.</p> <p><b>Background Information for the teacher:</b> The rate of a reaction increases as the temperature increases. Molecules at a higher temperature are moving faster, on the average, and thus have a higher kinetic energy (energy of motion). The higher the kinetic energy, the faster the molecules will react with one another. Surface area is the amount of the substance that is exposed. The larger the surface area the quicker the reaction will proceed. A larger surface area corresponds with having more available places for the reaction to occur. The concentration of reactants also affects the rate of a chemical reaction. The students are conducting experiments that demonstrate how temperature, surface area and concentration affect the rate of reactions. Nature of reactants, catalysts, and agitation are three other factors that affect the rate of reactions.</p>

**Definition:**

**chemical change**-two or more chemicals combining to form a new compound with new characteristics. Indicators of this are a change in state, color, temperature, density, odor, or magnetism. This new compound also had a new boiling point, melting point, density, and so on. It's a complete makeover from a molecular point of view.

**dilution** - Dilution is when solvent is added to a solution, making it less concentrated.

**end point** - A known pH point of an acid and base interaction as shown by a chemical indicator change in color.

**equilibrium** - Equilibrium occurs in reversible reactions when the forward rate of the reaction is the same as the reverse rate of the reaction.

**hypothesis**—a thoughtful, reasoned guess about something, based on what is known. A hypothesis must be proven by experimentation.

**observation**—using your senses—smelling, touching, looking, listening and tasting—to study something closely, sometimes over a long period of time.

**precision** - Precision is how repeatable a measurement is. More precise measurements are reported with more significant figures.

**product** - A product is something made as a result of a chemical reaction.

**rate determining step** - The rate determining step is the slowest step in any chemical reaction.

**rate law** - A rate law is a mathematical expression relating the speed of a chemical reaction as a function of concentration.

**reaction** - Chemistry - A change in which one or more chemical elements or compounds (the reactant) form new compounds (the products). All reactions are to some extent reversible; i.e., the products can also react to give the original reactants. However, in many cases the extent of this back reaction is negligibly small, and the reaction is regarded as irreversible. Biology - Any change in behavior of an organism in response to a stimulus.

**solute** - The solute is the substance that gets dissolved in a solvent. Usually it refers to a solid that is dissolved in a liquid. If you are mixing two liquids, the solvent is the one that is present in a smaller amount.

**solution** - A homogenous mixture of a liquid (the solvent) with a gas or solid (the solute). In a solution, the molecules of the solute are discrete and mixed with the molecules of solvent. There is usually some

	<p>interaction between the solvent and solute molecules. Two liquids that can mix on the molecular level are said to be miscible. In this case, the solvent is the major component and the solute the minor component.</p> <p><b>solvent</b> - This is the liquid that dissolves a solute in solution. Technically, you can dissolve gases into liquids or into other gases, too. When making a solution where both substances are in the same phase (e.g., liquid-liquid), the solvent is the largest component of the solution.</p> <p><b>temperature</b> - Temperature is a measure of the average kinetic energy of particles.</p> <p><b>Thermometer</b> - a tool that measures the average amount of heat in a substance.</p>
<p><b>Teaching Methods</b></p> <p><b>(You can have more than one SQ per activity)</b></p>	<p><b>SQ:</b> What is volume? How is volume measured? How does volume of a substance affect the rate of change of a reaction?</p> <p><b>ACTIVITY:</b> The teacher asks, “What is volume?” Students respond to the question. The teacher defines volume as the amount of space, measured, in cubic units, that an object or substance occupies. “What are some ways that volume can be measured?” The students respond with some names of measuring devices used for measuring volume. These might include but not limited to a beaker, a graduated cylinder, a measuring cup, a pipette, and a measuring spoon. (Students have previously used all of these at the beginning of the unit when learning to use scientific equipment correctly). “What are the metric units associated with volume?” “What are the standard units of measurement associated with volume?” The students will conduct an experiment, “How much vinegar?” to explore the relationship of volume to the rate of a reaction.</p> <p>In this experiment, vinegar and baking soda will be used to produce bubbles. The same amount of baking soda will be used, but the volume (amount) of vinegar will be changed. The students will follow the directions with the lab as they place different amounts (1 tsp., 2 tsp., and 4 tsp.) of vinegar into each of 3 cups. Add ¼ cup of water to each cup. Add a teaspoon of baking soda to each cup at the same time. Which reaction occurred first and went the fastest? Students will record their observations on their lab write-up sheets for Lab Journal and answer questions related to the experiment. After all have completed the lab and written responses, the teacher asks, “How does volume of a substance affect the rate of change in the reaction?” Student respond orally and teacher clarifies any misconceptions during this lab debriefing time. The teacher asks, “Was this a chemical reaction?” Listen to student responses. “If so, what is your evidence?” The volume of a substance does affect the rate of change in the reaction. Ask students, “How could the chemist use this information in his/her experimental design when trying to mix chemicals to create a new product?”</p> <p><b>SQ:</b> What does equilibrate mean?</p>

Why is it important to allow materials to equilibrate before beginning an actual experiment?

How does temperature affect the rate of change of a reaction?

**ACTIVITY:**

The students will be participating in two experiments that demonstrate how temperature affects the rate of change in a chemical reaction. The first is "Light stick Kinetics" and the other is "Bubble Rate." "Light stick Kinetics" will be done first because this experiment will have to be observed over a period of time. The teacher presents some chemical background information to the students about the light sticks. The reaction that occurs within the light stick when the ampule is broken is a chemiluminescence reaction. The light stick contains dilute hydrogen peroxide in a phthalic ester solvent, which is held in a thin glass ampule. This ampule is surrounded by sodium containing phenyl oxalate and a fluorescent dye. When the ampule is broken, the peroxide and the phenyl oxalate ester react. During the course of the reaction, an intermediate is produced which transfers energy to the dye molecule. Visible light is emitted when the excited dye returns to the ground state.

Each student will test a light stick. Half of the class will place their light sticks in warm water and the other half will place their light sticks in a cold solution of water. (Temperatures are recorded at the beginning of the lab). Students are to make and record observations for the next hour. The light sticks need to equilibrate in the solution before breaking the ampules. "What does equilibrate mean?" Listen to student responses. The teacher explains that a balance is needed for the reactants used in a chemical reaction. (Simply the light stick has to get use to either the cold or hot water). This should not take but a few minutes. The teacher asks, "What is it important to allow materials to equilibrate before beginning an actual experiment?" The students record their observations at specified intervals ending after one hour.

While the students are observing this reaction over time, they will conduct "Bubble Rate." This involves the amount of time that it takes for an Alka-Seltzer tablet to disappear when dropped in water. Water will be ice cold, room temperature and hot. The students will fill 3 cups one-half full of water. (One for ice cold, one for hot water and one for room temperature water). Record the water temperature of each cup. Using a timing device, the students will record in seconds the amount of time that it takes for the Alka-Seltzer to completely disappear. Drop the Alka-Seltzer in the cups at the exact same time and record the length of time it takes for the tablet to completely dissolve. Students record their data onto a flipchart chart so that the entire class can see the data from all groups. A student volunteer will summarize the class data. The teacher will ask, "How does temperature affect the rate of change of a chemical reaction?" The final reading will be taken on the light stick. Again, students will present their data to the entire class. (All the sticks will glow, but the ones in the warmer water will glow before those in the cold water). The data will show that the time is shorter for the light sticks in the warm water and longer for those which started in the cold water. The teacher will again ask, "How does temperature affect the rate of change of a chemical reaction?" The students should be able to conclude that in both experiments that the rate of change in a chemical reaction increases as the temperature increases. Molecules at a higher temperature are moving faster, on the average, and thus have a higher kinetic energy level (energy of motion). The greater this energy, the more rapidly the molecules can react with one another.

**SQ:** What is surface area?

How does surface area affect the rate of change of a reaction?

**ACTIVITY:**

The teacher asks, "What is surface area?" Listen to the student responses. Students should realize that surface area is the amount of the substance that is exposed (seen). Have the students predict whether they think that a substance that covers the entire surface or one that covers only one-half the surface (same amount of substance) will react faster. Record predictions. The teacher note that when dissolving sugar in water that a sugar cube dissolves much slower than granulated sugar because the granulated sugar has more of its surface exposed to the water.

The students will conduct the lab, "Surface Area and Reaction Rate." Ask the student how they think the rate of the reaction can be increased when using an Alka-Seltzer tablet in water. Listen to all suggestions. Students are given a copy of the lab procedure. The student groups will fill petri dishes about  $\frac{1}{2}$  full with water. Each group of three students is given 3 ( $\frac{1}{2}$ ) pieces of Alka-Seltzer. One of the Alka-Seltzer pieces is broken into very fine pieces and the other piece is broken into larger pieces (about 3-4). One piece is not broken at all. All samples should be placed on a piece of paper to make it easier to pour into the petri dishes. At the same time, the three samples are added to the 3 petri dishes. Record the amount of time in seconds that it took for each reaction to completely stop reacting (no more bubbling). The groups will present their findings to the entire class. Was their data similar for each type of sample? The students will answer questions related to the lab and place these in their Lab Journals.

Ask the students, "How does the surface area affect the rate of change of a reaction. Students should be able to state that the more surface area a substance covers that the quicker the reaction.

**SYNECTICS (PERSONAL ANALOGY)**

Academic Context: The students have been studying about the evidence of change as related to Chemistry. They have practiced differentiating physical and chemical changes as well as exothermic and endothermic reactions in the classroom chemistry lab. The students have developed and implemented experimental plans to determine which reactants of a chemical reaction cause certain outcomes. They have compared the rate of different chemical reactions that combine a solid and liquid to form a gas. The students have investigated the Periodic Table of Elements as they named elements, wrote symbols, created models, viewed pure elements and discovered element uses. They have used natural indicators, litmus paper, and pH paper to classify substances as acids, bases and neutrals. The students have tested known powders using several reagents, noted results and developed plans for identifying an unknown mixture of powders. Students have designed experimental plans that utilize the idea of a variable. They have determined how temperature, surface area and concentration affect the rate of chemical reactions. Throughout these past few weeks, many experiments have been conducted that use lab equipment, demand safety, require recording of observations and give students the opportunity to work like practicing chemists.

Content Objective: Students will develop a broader concept of a chemist's lab using previously acquired knowledge as a foundation. The students will demonstrate understanding of possible occurrences of chemical reactions with a chemistry lab. Empathetic feelings will be developed as students become the test tube.



	<p>Teacher Talk: “We have been conducting a variety of chemical experiments using equipment like a real chemist uses in his/her own chemistry lab. We have noted the occurrences of physical and chemical changes through our experimentation while differentiating exothermic and endothermic reactions. In our classroom chemistry lab, we have practiced lab safety, recorded results of our investigations, developed experimental plans and interpreted the Periodic Table of Elements. Today, you will become the test tube in a chemistry lab. As you are sitting in the test tube rack on the shelf, you feel the warm grasp of a human hand. What is about to happen? Will you get hot? Will you feel cold? Will you get broken? Will others be there? Are you excited? Do you feel scared? What will you be used for? Will you contain an exciting discovery? Think about these and other questions as you write your story. <b>BE THE TEST TUBE!</b>”(It may be helpful before getting to this point in the assignment to brainstorm several scenarios for test tubes in order to spur creativity and flexibility in the responses from students). (Handout for this in packet at the end of unit).</p> <p><b><u>EQ:</u></b> How do temperature, surface area and volume of a substance affect the rate of change of a reaction?</p> <p><b><u>Debriefing Activity:</u></b></p> <p>In debriefing after all of these lab experiments, the teacher will ask the students to summarize how volume, temperature and surface area affect the rate of change of a chemical reaction. Students should be able to this based on the scaffolding and lab experiences. Students are then asked to write in their Lab Journals an answer to this question, “Why would it be important to be aware of volume, temperature and surface area when creating an experimental design?” The teacher will read responses and write a note to each student clarifying their understanding, if needed. Any misconceptions that are characteristic of the entire class can be done in a mini-lesson during the next class session.</p>
<p><b>Resources</b></p>	<p><b><u>Print:</u></b> Lab Write-up Handouts</p> <p><b><u>Non-Print:</u></b> vinegar, baking soda, measuring devices (teaspoon, graduated cylinders, thermometers), Alka-Seltzer, petri dishes, light sticks, heating element, ice cubes, cups, Lab Journals</p>
<p><b>Extensions</b></p>	<p>At this point in the unit, the students have had a great deal of experience with chemicals other than the chemicals used to determine how surface area, concentration and temperature affect the rate of a reaction. The students can design their own tests for determining how surface area, concentration and temperature affect the rate of a reaction and use chemicals other than those tested in the original experiments. The students will develop a method of recording their data and drawing conclusions. Essentially, this will be repeated experimentation to further validate the outcomes of the original experiments.</p>

**Content Knowledge/Standards****Concepts:** Change

**Lesson 4 (EU4):** The interaction of different substances can change into new substances with different properties.

**EQ4:** Why can the interaction of different substances change into new substances with different properties?

**GT Scope & Sequence Outcomes:**

A: 1c, 1e, 2b, 2c, 2d, 2e, 3b, 3c, 4a, 4b

B: 1b, 1c, 1e, 1g, 1i, 2b, 2c, 3a, 3b, 3c, 3g, 3j

C: 1b, 2c, 3c, 3d, 4a, 5a

D: 1a, 1b, 1c, 1i

E: 2a, 2c, 3c

F: 1a, 1b, 2a, 3b

H: 4c, 4e, 4g, 4j, 5a

I: 1a, 1c, 1d, 3b, 6a, 6c, 7b

J: 1a, 4c, 4d, 8b, 8c, 8d

**ALCCRS:****Science**

9-12.2 Describe the structure of carbon chains, branched chains, and rings.

9-12.5 Use the kinetic theory to explain states of matter, phase changes, solubility, and chemical reactions

**Reading/Language Arts**

5.12 Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text.

[RI.5.3]

5.13 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a *Grade 5 topic or subject area*. [RI.5.4]

.31 Write routinely over extended time frames, including time for research, reflection, and revision, and shorter time frames such as a single sitting or a day or two for a range of discipline-specific tasks, purposes, and audiences. [W.5.10]

5.32 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *Grade 5 topics and texts*, building on others' ideas and expressing their own clearly. [SL.5.1]

**Career/Technical Education**

	<p>Career Cluster Explorations 7-8.7 Demonstrate positive work behaviors and personal qualities, including displaying a willingness to acquire new knowledge and skills, demonstrating integrity in a work situation, and indicating a willingness to follow rules and procedures.</p> <p><b><u>Health Science</u></b> 9-12.2 Exhibit appropriate safety procedure in the laboratory.</p>
<b>Assessment</b>	<p>Pre: Chemistry IQ Game (This game gives a general overview of student’s prior knowledge related to all of the essential understandings in this unit).</p> <p>Post: Lab Journal Entries (These will be completed at the end of each session needed to complete all aspects of this lesson related to this essential understanding). A rubric for the necessary requirements for the Lab Journal has been given to the students.</p>
<b>Introduction</b>	<p><b>Overview of the lesson:</b> The students will conduct three lab experiments with two substances which they made. Both substances are made up of different reactants. The substances have different properties which will be tested in each of the three lab experiments. The substances will be evaluated for resiliency, viscosity and fluidity. Using a bracket (similar to a sports bracket), the students will eliminate one of the substances as they conduct the experiments and record the outcomes. The students will be asked to extend their thinking as they use their data to connect the properties of these substances to existing materials.</p> <p><b>This lesson includes:</b></p> <p><b>Unit Pacing:</b> This unit will take approximately eight weeks to complete if you meet your gifted students once a week for 3-5 hours per week.</p> <p><b>Background Information for the teacher:</b> Colloids are substances that can have the characteristics of both a solid and a liquid. While the substances, Glurch and Oobleck, used in this experiment have very different properties, they are classified as polymers. Even though these substances seem unrelated, their molecular structures have similarities. Polymers are sometimes called “giant molecules” because they can consist of hundreds of small repeating molecules connected in a long chain. The arrangement of polymer chains and the different molecules in the chain influences the properties that the material demonstrates. The two liquid substances which combine to make Glurch are very different from the resulting product. Chemicals in the starch connect the polymer chains in the glue in a direction like rungs on a ladder. This process, called crosslinking, is used to change the properties of polymers. Many polymers solutions and molten polymers are non-Newtonian fluids. Oobleck is a non-Newtonian fluid. A non-Newtonian fluid</p>

	<p>has a non-linear relationship between the shear stress and the strain rate which can be time-dependent. A constant coefficient of viscosity cannot be defined.</p> <p><b>Definition:</b>  <b>colloid</b>—a solid, liquid, or gas dispersed into a second solid, liquid, or gas but not chemically connected to that other compound. Styrofoam is one of the most famous examples. Air is trapped in spaces created when polystyrene plastic is extracted from a mold. The air is still air, the polystyrene is still polystyrene. They just happen to like to hang out together.</p> <p><b>observation</b>—using your senses—smelling, touching, looking, listening and tasting—to study something closely, sometimes over a long period of time.</p> <p><b>polymer</b>—a substance with long-chain molecules, made up of many small molecules called monomers. Substances such as cellulose and latex are examples of natural polymers, and many synthetic polymers are used in everyday life and in industry.</p> <p><b>product</b> - A product is something made as a result of a chemical reaction</p> <p><b>synthesis</b> - Synthesis is making a larger molecule from two or more atoms or smaller molecules.</p>
<p><b>Teaching Methods</b></p> <p><i>(You can have more than one SQ per activity)</i></p>	<p><b><u>SQ:</u></b> What is a colloid?  What is a polymer?  Are all colloids polymers? Are all polymers colloids?</p> <p><b><u>ACTIVITY:</u></b>  The teacher will pass around the room examples of colloids. Each student will observe the physical characteristics of these colloid substances. The teacher will ask the class to give many, varied single words to describe the substance. (This could be done as a Word Wall or Padlet if needed technology available). Students will say their ideas while the teacher writes these in a list on the board or flipchart. (Students enter themselves if using technology). What do these substances seem to have in common? The teacher asks the students, “What is a colloid?” and listens to the responses. If students know this then, the teacher will reinforce their understanding and ask why they think the previously observed substances are colloids. If students do not know what a colloid is, then the teacher will explain that colloids are substances which have properties of both solid and liquid states of matter. Depending on the proportions of the ingredients, one may be more or less solid or liquid. In a colloid, one substance is suspended within another. The suspended material is made of particles so small they don’t sink to the bottom of the second substance. Other common colloidal substances include fog, smoke, meringue, protoplasm, homogenized milk, synthetic rubber and mayonnaise. The teacher will ask, “Why do you think the substances that you just observed are colloids?”</p>

Polymers are substances with long-chain molecules. Students will make the colloid, Oobleck, for this lab. Oobleck is a polymer and a non-Newtonian fluid. Glurch is also a polymer with a different molecular arrangement of polymer chains. Both Oobleck and Glurch are polymers with different properties.

Using two polymers which students will make before the lab, the students will use experimental design skills to test different properties of resiliency, viscosity, and fluidity of these two substances. The lab, “Glurch vs Oobleck: A Tournament of Properties” is about to get underway.

**SQ:** How can different substances be combined to create polymers with different properties?

**ACTIVITY:**

The teacher will ask, “How can different substances be combined to create polymers with different properties?” Student groups will measure, mix and create the colloid substances, Glurch and Oobleck. Each group will make Glurch using 45 ml of liquid laundry starch, 25 ml of white school glue and a pinch of salt. Look at the different substances that are combined together and then observe the product that results from combining these two substances. Have students describe the resulting product. Two liquids were mixed together to form this colloid substance with characteristics of both a solid and a liquid. Next the groups will mix together 50 g of cornstarch and 25 ml of water (a solid and a liquid) to produce another colloidal substance known in the science world as Oobleck. Observe the newly formed substance and describe it. How is it similar to the Glurch? How is it different? Student groups should have an assigned reporter who will report the ideas of the group. Student groups will begin the evaluation of different properties of these colloids once the teacher checks to ensure that the substances are made properly. (On occasion, some students have not made these correctly and that could affect the outcome of the testing). The groups will make use of the scientific method. The problem is stated and each group will write a hypothesis, describe and create their procedure(s) for testing and record results. All groups are given the directions and the tournament brackets for recording the outcomes of their testing. After each property is tested, the student groups are given different scenarios and based on their outcomes will answer the questions and explain why they made the choices they did. These scenarios will give them the opportunity to extend their newly acquired knowledge about each colloidal property to a real situation.

**SQ:** What is resiliency?

**ACTIVITY:**

The teacher will ask, “What is resiliency?” A resilient substance will bounce or stretch due to the arrangement of its molecules in its chemical structure. If a polymer is more resilient then that substance will bounce higher or stretch longer.

**SQ:** How can the resiliency of new substances (polymers) be tested?

**ACTIVITY:**

It is the responsibility of the group to develop a procedure for testing the resiliency of Glurch and Oobleck. The group's recorder will write the steps of the procedure on the lab journal handout. The group will test Glurch and Oobleck for resiliency following their procedure.

**SQ:** Which of the new substances was the most resilient?

**ACTIVITY:**

Record all results on the "Tournament of Properties" bracket sheet. Which substance was the most resilient or demonstrated the greatest elasticity?

**SQ:** Why would the most resilient substance be considered for a trampoline surface?

**ACTIVITY:**

After discussion of the student responses to given scenarios, the teacher will ask, "Why would the most resilient substance be considered for a trampoline surface?" Students will need to justify their responses.

**SQ:** What is viscosity?

**ACTIVITY:**

The teacher will ask, "What is viscosity?" A viscid substance is sticky will pick up newsprint as well as glue two pieces of paper together more strongly. If a colloid is more viscid then that substance will be sticky, pick up newsprint or glue two pieces of paper together more strongly.

**SQ:** How can the viscosity of new substances (colloids) be tested?

**ACTIVITY:**

It is the responsibility of the group to develop a procedure for testing the viscosity of Glurch and Oobleck. The group's recorder will write the steps of the procedure on the lab journal handout. The group will test Glurch and Oobleck for viscosity following their procedure.

**SQ:** Which of the new substances was the most viscid?

**ACTIVITY:**

Record all results on the "Tournament of Properties" bracket sheet. Which substance was the most viscid or demonstrated the greatest stickiness?

**SQ:** Why would the most viscid substance be a better substitute for thumbtacks?

**ACTIVITY:**

Which substance, Glurch or Oobleck,, would make a better substitute for thumbtacks? Listen to the students' responses. Ask, "How could you prove this?" List their ideas.

**SQ:** What is fluidity?

**ACTIVITY:**

The teacher asks, “What is fluidity?” A substance that exhibits fluidity will flow or squeeze between one’s fingers easily. A substance is more fluid when it flows or squeezes between one’s fingers more easily. Student groups will have to determine whether Glurch or Oobleck is more fluid.

**SQ:** How can the fluidity of new substances (colloids) be tested?

**ACTIVITY:**

It is the responsibility of the group to develop a procedure for testing the fluidity of Glurch and Oobleck. The group’s recorder will write the steps of the procedure on the lab journal handout. The group will test Glurch and Oobleck for fluidity following their procedure.

**SQ:** Which of the new substances was the most fluid?

**ACTIVITY:**

Record all results on the “Tournament of Properties” bracket sheet. Which substance was the most fluid or demonstrated the ability to flow?

**SQ:** Why would it be important to know which substance is the most fluid?

**ACTIVITY:**

The teacher will discuss with the class the follow-up questions with the lab. The teacher will ask, “If both substances were poured, which would fill a container first?” “How do you know?” The class will discuss their ideas and it will be determined if a consensus from the group can be reached. Next, the teacher will ask, “Which of these substances would be better measured in milligrams than milliliters?” “Why?” Of course, the less fluid substance would be better measured in milligrams. The teacher will ask, “Why would it be important to know which substance is the most fluid?”

### **SYNECTICS (COMPRESSED CONFLICTS)**

Academic Context: The students have been studying about the evidence of change as related to Chemistry. They have practiced differentiating physical and chemical changes as well as exothermic and endothermic reactions in the classroom chemistry lab. The students have developed and implemented experimental plans to determine which reactants of a chemical reaction cause certain outcomes. They have compared the rate of different chemical reactions that combine a solid and liquid to produce a gas. The students have investigated the Periodic Table of Elements as they named elements, wrote symbols, created models, reviewed pure elements and discovered element uses. They have used natural indicators, litmus paper, and pH paper to classify substances as acids, bases, and neutrals. The students have tested known powders using several reagents, noted results, and developed plans for identifying an unknown mixture of powders. Students have designed experimental plans that utilized the idea of a variable. Throughout the past several weeks, many experiments have been conducted that use lab equipment, demand safety, require recording of observations and give students the opportunity to work like real chemists in the classroom chemistry lab.

**Content Objective:** Students develop a broader concept of a chemist's lab using previously acquired knowledge as a foundation. The students will evaluate comparisons of compressed conflicts as they relate to events that can occur in a chemistry lab.

**Process Objective:** Compressed Conflict

**Teacher Talk:** "We have been conducting a variety of chemical experiments using equipment like a real chemist uses in his/her own chemistry lab. We have noted the occurrences of physical and chemical changes through our experimentation while differentiating exothermic and endothermic reactions. In our classroom chemistry lab, we have practiced lab safety, recorded results of our investigations, developed experimental plans and interpreted the Periodic Table of Elements. Today, I would like you to use a form of Synectics called compressed conflict to make comparisons of events that can occur in a chemistry lab. A compressed conflict is a comparison that describes something with words that are opposite. Let's do an example together. Unknown discovery—This describes an event that occurs in a chemistry lab. It is known if it is discovered while "unknown" implies something not yet discovered. Doesn't an "unknown discovery" exist in a chemistry lab? Look at the list of compressed conflicts on the handout. Try to think of why these words are good comparisons for events that occur in a chemistry lab. Write your interpretation of the comparisons as related to the chemistry lab. The students will be asked to explain their interpretations of the relationships demonstrated in the given compressed conflicts. The students are asked to create their own compressed conflict comparison using other events that could occur in a chemistry lab. (Handout can be found in the Handout packet with this unit).

**EQ:** Why does the interaction of different substances result in new substances with different properties?

**Debriefing Activity:**

The teacher will revisit the questions that followed the testing of each characteristic (resiliency, fluidity, and viscosity) of Oobleck and Glurch. The first one discussed with the entire class will be, "Why would the most resilient substance be considered for a trampoline surface?" Students will respond and justify their answers. At this point, the teacher can determine if student understanding has occurred and further explain any needed information before moving to the next characteristic. The teacher will ask the students, "Why would the most viscous substance be a better substitute for thumbtacks?" The students would explain what viscosity is and will state reasons for selecting either Oobleck or Glurch to be used as thumbtacks. The final questions will be, "Which of these substances can be poured and which would be better to measure in milliliters?" The description of a fluid substance will be discussed with the class. Students will answer the questions along with why they are giving these answers. The teacher will answer any questions to close the discussion. If we tested cornstarch and water separately, would they exhibit the same properties as the Oobleck? Did the interaction of cornstarch and water change into a new substance with different properties unlike those of cornstarch and water? Have the students explain their thinking. Did the reaction of glue and liquid starch change into a new substance that was different from the reactants used to make Glurch? Have the students explain their thinking. Repeat the essential question and have students state this in their own words.

**Print:** Printed directions for making Oobleck and Glurch and conducting the investigation; large bracket poster board



<b>Resources</b>	<b><u>Non-Print:</u></b> cornstarch, water, liquid starch, school glue, measuring devices, timer, newsprint
<b>Extensions</b>	<p>The students have created two different polymers (Glurch and Oobleck) from different materials to form two new substances. (Polymer chemistry is used often in schools to promote observation and description of macroscopic features of substances as well as physical and chemical reactions). Students are given the challenge to research other recipes for different polymers that can be made with easily obtainable materials and create these. They may test for fluidity, resiliency and viscosity. These test results may be compared to the outcomes of the Glurch/Oobleck experiments.</p> <p>After considering all the attributes of Oobleck, students can make a list of all the possible uses of Oobleck.</p> <p>Polymers are either synthetic or natural. The students can research to discover examples of both synthetic and natural polymers. They can further research to find out how the synthetic polymers are made. The students can explain how natural polymers are processed to make useful products. They can present their finding in a digital multi-media format of their chose.</p>

## Resources

### Chemistry Concept Base Unit

Smith, A., Clarke, P., and Henderson, C. (2001). The Usborne Internet-Linked Library of Science Mixtures and Compounds. London: Usborne Publishing Ltd.

Barber, Jacqueline. (2001). Chemical Reactions. Berkley, CA: The Regents of the University of California.

Abby, Theodore S. (2001). Elements and the Periodic Table. United States of America: Carson-Dellosa Publishing Company, Inc.

Hixson, B.K. (2001). Jr. Chemhead. Sandy, Utah: Loose in the Lab, Inc.

Louis B. Loeschnig.(1994). Simple Chemistry Experiments with Everyday Materials. New York: Sterling Publishing Co. Inc.

Erickson, Lynn H. (2002). Concept-Based Curriculum and Instruction. Thousand Oaks, CA: Corwin Press, Inc.

2002 Alabama Operation Chemistry/Physics Summer Institute for Middle School Science Teachers

## Rules for the Chemistry IQ Quiz (Pre/Post Assessment)

This will be done individually.

1. Each question is presented on the overhead projector and/or flipchart one at a time. Students will decide if the statement is true or false.
2. The student will hold up a T sign for true and F sign for false. He/She may hold up a Double Down sign if this strategy is chosen for this question. All sheets must be raised at the same time to discourage some students from waiting to see what others have decided.
3. Students will keep track of their scores and the teacher will also record point totals on the board.
4. Each person will get 5 points for each correct answer. Each person will lose 5 points for each incorrect answer.
5. Each person can choose Double Down on any question up to a total of five questions. If the student answers correctly, he/she receives 10 points; if the student answers incorrectly, he/she loses 10 points from his/her current score. Students use this tactic on questions they are most confident about answering correctly.
6. A total of 125 points is a perfect score. To earn this score, each student must answer all questions correctly and double-down correctly on five questions.
7. A person achieves a score of 100+ is rated as a Chemistry Guru. Any student who achieves a score of 80-99 is rated as a Chemistry Analyst. A Chemistry Novice is one who achieves a score between 60 and 79. Anyone scoring below 60 is rated as Chemistry Challenged.

Score sheets are turned into the teacher. These will be used to compare pre/post assessment scores at the end of the unit.

NOTE TO TEACHER: You can use index cards to make the T, F and Double cards. Each student will need one T card, one F card and one Double card. I also make them use colored pencils to ensure that they do not change/erase their original answers.

## Chemistry IQ Score Sheet

Directions: Circle either T or F. Calculate the score for each question. Total at the end. You may use Double Down only 5 times.

1. True or False	Score	(-5 or +5) (double down -10 or +10)	_____
2. True or False	Score	(-5 or +5) (double down -10 or +10)	_____
3. True or False	Score	(-5 or +5) (double down -10 or +10)	_____
4. True or False	Score	(-5 or +5) (double down -10 or +10)	_____
5. True or False	Score	(-5 or +5) (double down -10 or +10)	_____
6. True or False	Score	(-5 or +5) (double down -10 or +10)	_____
7. True or False	Score	(-5 or +5) (double down -10 or +10)	_____
8. True or False	Score	(-5 or +5) (double down -10 or +10)	_____
9. True or False	Score	(-5 or +5) (double down -10 or +10)	_____
10. True or False	Score	(-5 or +5) (double down -10 or +10)	_____
11. True or False	Score	(-5 or +5) (double down -10 or +10)	_____
12. True or False	Score	(-5 or +5) (double down -10 or +10)	_____
13. True or False	Score	(-5 or +5) (double down -10 or +10)	_____
14. True or False	Score	(-5 or +5) (double down -10 or +10)	_____
15. True or False	Score	(-5 or +5) (double down -10 or +10)	_____
16. True or False	Score	(-5 or +5) (double down -10 or +10)	_____
17. True or False	Score	(-5 or +5) (double down -10 or +10)	_____
18. True or False	Score	(-5 or +5) (double down -10 or +10)	_____
19. True or False	Score	(-5 or +5) (double down -10 or +10)	_____
20. True or False	Score	(-5 or +5) (double down -10 or +10)	_____

Total Score \_\_\_\_\_

4-6<sup>31</sup>

### PRE/POST ASSESSMENT CHEMISTRY IQ QUIZ

- T or F 1. Solids, liquids, and gases are three states of matter that exist naturally on earth.
- T or F 2. Molecules of solids can slide past one another because they are held together loosely and can flow.
- T or F 3. Sharpening a pencil results in a physical change.
- T or F 4. The composition of water changes when it exists as a solid, liquid or gas.
- T or F 5. A physical change occurs when the iron part of a bicycle reacts with air and water to form rust.
- T or F 6. Digestion of food is an example of a chemical change that takes place inside the body.
- T or F 7. Atoms are made of neutrons, protons, and electrons; all of which are located in the nucleus of the atom.
- T or F 8. The protons, neutrons, and electrons of an atom all have positive charges.
- T or F 9. Water is a compound made of two hydrogen atoms and one atom of oxygen.
- T or F 10. When a proton is added to the atom of an element, it becomes a new element.
- T or F 11. The mass number of an atom is the sum of its protons and neutrons.
- T or F 12. Element names are represented by symbols.
- T or F 13. The modern periodic table arranges known elements in order of increasing mass.
- T or F 14. All 109 elements listed on the periodic table occur naturally on earth.
- T or F 15. Heating sugar causes a chemical change.
- T or F 16. Ice cream is a compound made of ice, milk fat, flavorings, and air.
- T or F 17. A solution is made when a mixture of a solid is dissolved in a liquid.
- T or F 18. Compounds and mixtures are the same.
- T or F 19. Litmus paper is used to detect whether a substance is an acid or base.
- T or F 20. The pH of a substance can never change.

PRE/POST ASSESSMENT

CHEMISTRY IQ QUIZ

ANSWERS

1). T

2). F

3). T

4). F

5). F

6). T

7). F

8). F

9). T

10). T

11). T

12). T

13). F

14). F

15). T

16). T

17). T

18). F

19). T

20). F

**One Counter Toss**

Totals

Red											
Yellow											

**One Counter Toss**

Totals

Red											
Yellow											

## Two Counter Toss

Totals

Red and yellow											
Two yellow											
Two red											

## Two Counter Toss

Totals

Red and yellow											
Two yellow											
Two red											

Adapted from 1998 Alabama Quantitative Literacy Workshop



## Mystery Powder Investigation

Junior Chemist: \_\_\_\_\_

Date: \_\_\_\_\_

### Instructions:

Observe and test each of the following substances and record these observations and outcomes on the chart. After you have completed the entire table, see your teacher for your Mystery Powder vial. Using the planning outline on the back of this sheet, develop a plan to identify your assigned Mystery Powder. Test the Mystery Powder using your plan. Please remember to record the number on your Mystery Powder vial on this sheet. The Mystery Powders are different—they may contain only one powder or they may contain a mixture of two or more different powders. Junior chemists begin your investigations. Remember that recording accurate data is important.

Powder	Description of powder (use a hand lens)	Test 1- Water	Test 2- Iodine	Test 3- Vinegar	Test 4- Heat
Baking soda					
Plaster of Paris					
Cornstarch					
Sugar					
Salt					
Mystery Powder					

Mystery Powder Vial Number \_\_\_\_\_

State your hypothesis:

What substance(s) do you think are contained in your Mystery Powder vial?

What evidence did you obtain to assist you in your decision? Explain.

## PLANNING GUIDE

TITLE: MYSTERY POWDERS

1. Write a description of your experimental plan for the identification of the “Mystery Powder.”
  
2. List all of the materials and equipment you will need to carry out the plan.
  
3. List the steps for carrying out your plan in sequential order.
  1. Gather materials and equipment
  2. \_\_\_\_\_
  3. \_\_\_\_\_
  4. \_\_\_\_\_
  5. \_\_\_\_\_
  6. \_\_\_\_\_
  7. Clean Up
  
4. Write any problems you might have with your plan.
  
  
5. Make changes on your planning worksheet in a different color to show ways to improve the plan. Write these changes in a different ink color.

## Are You Ready For a Change?

Junior Chemist: \_\_\_\_\_ Date: \_\_\_\_\_

Change Number	Observations	Physical or Chemical	Why do you think so?
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

### Questions:

1. For all of the changes that you classified as physical, what evidence did you have?
2. For all of the changes that you classified as chemical, what evidence did you have?
3. What changes felt cold? Is this endothermic or exothermic? \_\_\_\_\_

In this activity, we will attempt to distinguish between physical changes and chemical changes. Be looking for ways to tell whether or not a chemical reaction has occurred. (ACS 4th, 5th, 6th, 7th, 8th)

## Reactions - Chemical or Physical?

### Concept

Physical reactions change the form or the state of matter of materials without changing the composition or basic properties of those materials. Chemical reactions produce new substances with compositions and properties that are different from those of the starting materials.

### Objectives

After completing this exercise, students should be able to:

- Explain the difference between a physical and chemical change.
- Observe a reaction and classify it as a physical or chemical reaction
- List evidences that a chemical reaction has occurred

### Materials Needed

candle  
matches  
play dough  
aluminum foil  
alum  
paper  
scissors (optional)  
colored drink powders  
water  
wax  
hot plates  
red cabbage or phenol red

vinegar  
baking soda  
rubbing alcohol  
5 plastic cups  
graduated cylinder  
teaspoon  
chalk  
3 ziploc bags  
calcium chloride (hardware store)  
ammonium nitrate (fertilizer)  
ammonia  
sugar

### Procedure

Follow the directions to carry out the ten reactions listed below. Record your observations about each reaction in the data table as you proceed. Keep your safety glasses on at all times and be careful when using a flame. If you have long hair, make sure it is tied back.

#### Change 1: Burning matches and a candle.

Strike a match and observe what happens as it burns. Then use the match to light a candle and observe the candle as it burns (You can support the candle in play dough).

#### Change 2: Melting and freezing wax

Pour a few drops of the molten candle wax on a piece of aluminum foil and let it solidify.

#### Change 3: Tearing or cutting paper.

Tear a piece of paper into many small pieces. You could also use scissors to cut the paper.

#### Change 4: Breaking chalk

Drop a piece of chalk onto a hard surface.

#### Change 5: Alum and ammonia

Dissolve a half teaspoon of alum (potassium aluminum sulfate) in about 30 mL of water and stir until you have a colorless liquid. Slowly pour 10 mL of household ammonia (ammonium hydroxide solution) into the alum solution. Mix well and observe for several minutes.

**Change 6: Vinegar and Ammonia (with indicators—phenol or red cabbage leaves)**

Pour about 1 ml phenol solution into each of three cups. Add 1 ml vinegar to one of the cups. Add about 1 ml of ammonia to another cup. Repeat with red cabbage leaves. Tear a red cabbage leaf into dime-sized pieces and cover with rubbing alcohol. Let stand for a few minutes. Use this in place of the phenol. Add about 1 ml of cabbage solution to each of three cups. Add 1 ml of vinegar to one of the cups. Add about 1 ml of ammonia to another.

**Change 7: Vinegar and baking soda**

Put three heaping teaspoons of baking soda (sodium hydrogen carbonate) into a clean ziplock bag. Then pour in 20 ml of vinegar (acetic acid solution) and observe the results.

**Change 8: Dissolving a powder I**

Add a few teaspoons of a colored powdered drink mix to a clear cup half-filled with water. Stir. The solid dissolves.

**Change 9: Dissolving a powder II**

Pour 10 ml of water into a ziplock bag and add 2 teaspoons of calcium chloride. Seal the bag. Mix the contents. Feel the sides of the bag.

**Change 10: Dissolving a powder III**

Pour 10 ml of water into a ziplock bag and add 2 teaspoons of ammonium nitrate. Seal the bag and mix the contents. Feel the sides of the bag.

Change #	Observations	Physical or Chemical Change?	Why do you think so?
1	wax melts, wick burns, heat	chemical	candle wax and wick disappeared, heat released; new materials (gas) formed
2	wax melts and then freezes back	physical	properties don't change; substance is same
3	paper now in small pieces	physical	substance is same
4	chalk broke into smaller pieces	physical	substance is same
5	a solid falls out of the solution	chemical	new material (solid) formed
6	the solutions are different colors	chemical	color changes, thus new substance must be formed
7	bubbles (a gas) form; cold	chemical	solid disappears, new material (gas) formed
8	solid dissolves in the water	physical	properties don't change; substance is same
9	bag feels warm	chemical	heat released, exothermic
10	bag feels cold	chemical	heat absorbed, endothermic

### Questions

1. For all of the reactions that you classified as physical, what evidence did you have? The properties of the materials remained the same, so they were the same materials in a different form or state.

2. For all of the reactions that you classified as chemical, what evidence did you have? Properties changed, thus new materials were formed.

3. How could you recover the sugar or powdered drink mix in Change #8? The original solid could be recovered by evaporating the water by heating the mixture.

## **Are You Learning Anything About Chemistry?**

**Name:** \_\_\_\_\_

**Date:** \_\_\_\_\_

**Type your responses on to the document. Print out a copy and place in your Junior Chemist Lab Write-Up Journal.**

- 1. What is a physical change?**
- 2. What is a chemical change?**
- 3. Distinguish between physical changes and chemical changes.**
- 4. How can you tell if a physical change has taken place?**
- 5. How do you know that a chemical change has occurred?**
- 6. List some common examples of chemical changes that you encounter every day?**
- 7. How can you tell if a chemical reaction is endothermic or exothermic?**
- 8. Tell me anything else that you have learned so far in this Chemistry Unit.**

## Planning Guide

Title: Determining the Heat-Caus ingReactant

1. Write a description of your group's experimental plan that will determine which reactant(s) are responsible for the production of heat in the previous chemical reaction experiment.

2. List the materials and equipment needed to carry out your experimental plan.

_____	_____
_____	_____
_____	_____

3. List the steps for carrying out your experimental plan. Number the steps in order.

Gather materials.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Clean Up!

4. List any problems that you might have with your plan.

**\*\* 5. Write any improvements made on your plan using a different colored ink pen.\*\***

*Use with GEMS "Chemical Reactions" book*



## Experiment Write-Up

Title: \_\_\_\_\_

Junior Chemist: \_\_\_\_\_

State the Purpose:

Make a prediction (hypothesis) of the outcome:

List the materials:

List any manipulated and control variables:

List the Steps (procedure) you will follow during the experiment:

Record your observations. Include a table or graph to display your results (if applicable):

State your conclusions:

After you have typed in your results on to the form, print a copy to place in your Junior Chemist Lab Write Up Journal.

## COOKIES AS ELEMENTS

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Examine your cookie and answer the following questions. You will need the Periodic Table to identify your element.

1. How many "protons" (chocolate chips) do you see on top of your cookie?

\_\_\_\_\_ p<sup>+</sup>

2. Using the Periodic Table, what is the name of this element? \_\_\_\_\_

3. Write the symbol for this element. \_\_\_\_\_

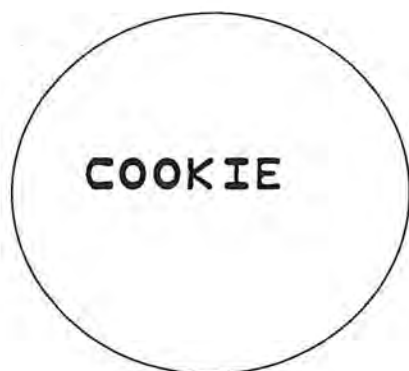
4. How many electrons are in your element? \_\_\_\_\_

5. What is the "atomic mass"-mass number of your element? \_\_\_\_\_

6. How many neutrons are in this element? \_\_\_\_\_

7. What is the element's atomic number?

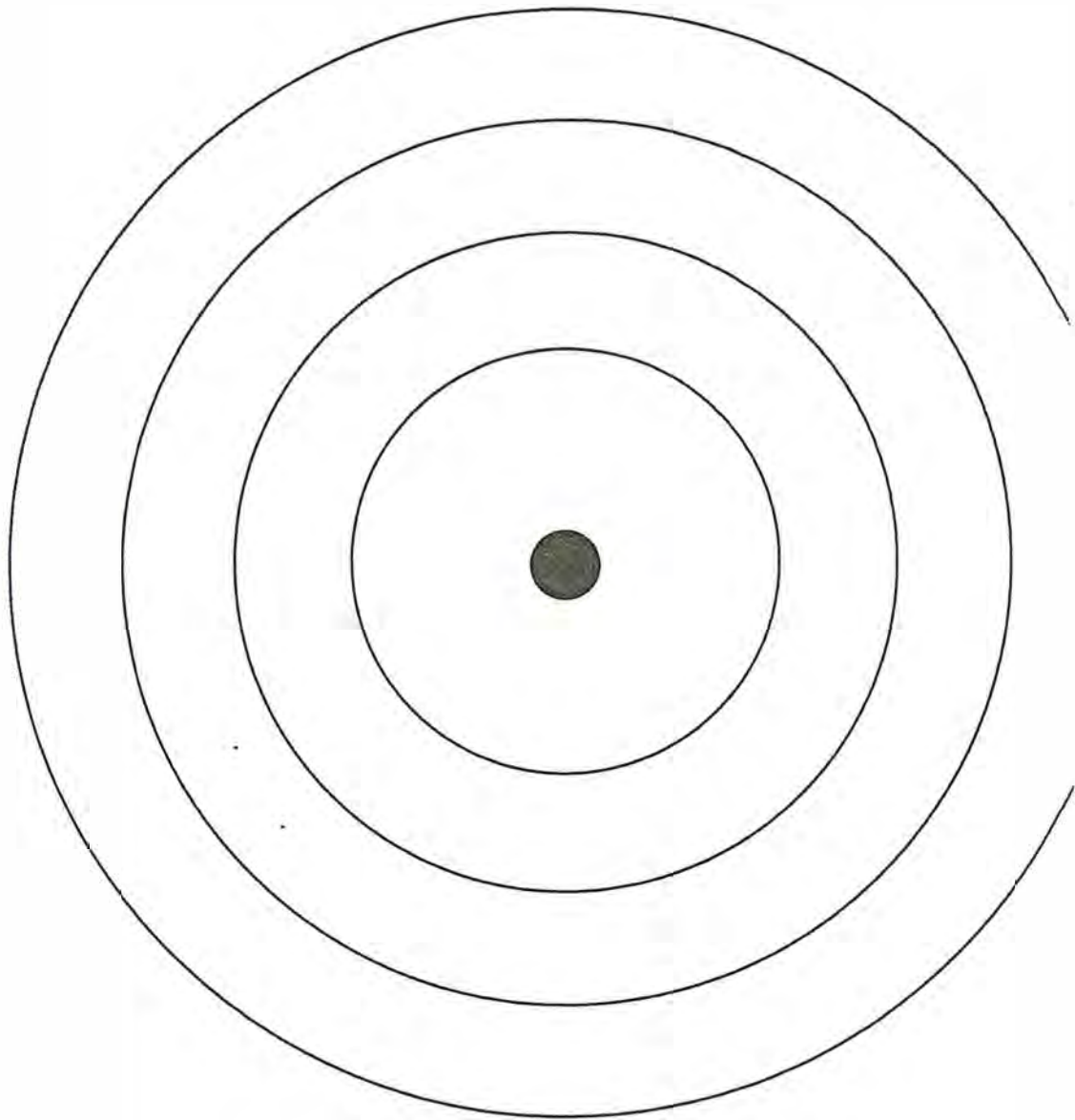
Draw A Model of Your Element



You may now eat and enjoy your cookie.

# Atomic Structure


---



Element \_\_\_\_\_

# ELEMENT BINGO!

Learn the symbols of the elements by playing Element Bingo! Fill in the card below with the symbols of your favorite elements. When your teacher calls out the NAME of the element, cross out the symbol on your card. When you have a row crossed out, call Element Bingo!

**Variation:** Try playing Blackout Bingo by crossing out the entire card.

**Note to Teacher:** You may wish to have students play Element Bingo with a copy of the periodic chart before them as a guide. After the students have learned the symbols, they can play Element Bingo without the aid of a periodic table.

## Talents Unlimited

### Decision Making Activity

Antoine Lavoisier has often been referred to as the “Father of Modern Chemistry.” Use the decision making talent to select another chemist whom you decide could be worthy of this title also.

#### 1. Alternatives

Jons Jakob Berzelius	Hippolyte Mege-Mouriez	Alexander Butlerov
Hideki Yukawa	Sir Humphrey Davy	Democritus
Friedreich Kekule	John Dalton	Dmitri Mendleyev
Fritz Haber	Joseph Priestly	Karl Scheele
Charles M. Hall	Paul L. T. Heroult	Michael Faraday

#### 2. Criteria

- Was his/her discovery important to the field of chemistry?
- Is his/her discovery still used today?
- Can I find more information about him/her?
- Am I interested in what this person did with chemistry?
- \_\_\_\_\_

#### 3. Weighing

Use the criteria questions to weigh the merits of each alternative.

#### 4. Decision

Indicate your choice here: \_\_\_\_\_

#### 5. Reasons

Give many, different reasons to support your decision.

---

---

---

---

### Famous Chemists' Trivia

**Jons Jakob Berzelius (1779-1848)** Used the idea of letters to represent chemical atoms and used the idea of numbers to show the number of atoms in each chemical

**Hippolyte Mege-Mouriez** created a way to make margarine from beef fat.

**Alexander Butlerov(1828-1886)** found that formaldehyde could be treated to make a type of sugar called glucose.

**Hideki Yukawa (1907-1981)** discovered what some of the tiny bits of atoms are made of.

**Sir Humphrey Davy (1778-1829)** discovered many new chemicals. Laughing gas was one of them (nitrous oxide). Designed a miner's lamp to be used by miners in the mines.

**Democritus (c. 460-370 BC)** suggested the existence of atoms.

**Friedreich Kekule (1829-1896)** figured out that atoms can join together more easily than others to make new chemicals and opened up a wide new field for chemistry. This was a result of a dream! Discovered benzene was a ring of atoms and is used in the development of new chemical dyes and thousands of other useful substances.

**John Dalton (1766-1844)** Based on his discovery using the break down of water, he called these substances "elements" and said that each was a type of atom.

**Dmitri Mendeleev (1834-1907)** discovered the Periodic Table by writing elements on cards and arranging them as in his favorite card game—Concentration. Element 101 is named after him—mendelevium.

**Fritz Haber (1868-1934)** invented a way to make the chemical "ammonia" which is used to make cheap fertilizers that help plants grow and also explosives used in WW I.

**Joseph Priestly (1733-1804)** isolated the gases oxygen and carbon dioxide. He invented fizzy drinks.

**Karl Scheele (1746-1786)** discovered new chemicals such as oxygen, chlorine and nitrogen but due to a publishing mix-up the book describing his discoveries wasn't printed for 28 years. In the mean time, other chemists discovered the same chemicals. Later, he died after being poisoned by a chemical he discovered and never got credit for.

**Charles M. Hall (1863-1914)** and **Paul L.T. Heroult (1863-1914)** discovered how to make cheap aluminum—about the same time in different chemistry labs.

**Michael Faraday (1791-1867)** investigated the process of electrolysis using different chemicals. Basically, you mix compounds with water and run electricity through the solution.

Any others that interest you...

# DECISION MAKING MATRIX

Use this chart to help you as you weight the alternatives for a decision. Start with your first criteria question. Answer the question for each of your alternative, using the rating scale at the bottom to assign weights. Then, answer the second criteria question for each alternative, again assigning weights. Continue in the same way until you have answered all criteria questions for each alternative. Examine the ratings and use them to make a final decision which can be defended with many, different reasons.

<b>ALTERNATIVES</b>	<b>CRITERIA</b>						
	Was his/her discovery important to the field of chemistry?	Is his/her discovery still used today?	Can I find more information about him/her?	Am I interested in what this person did with chemistry?			

Rating scale:      1                  2                  3                  4                  5  
poor excellent

**Circle the best alternative; write many, different REASONS.**

---

---

---

---

---

---

---

---

### Acid/Base Lab

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Substance	Cabbage Juice Color Change	Blue Litmus	Pink Litmus	pH paper	Classification as Acid/Base/Neutral Substance
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

Place solutions in the assigned well. Record the name of the solution on the Acid/Base Lab handout. Test each solution with the indicator solution, litmus paper and pH paper. Record your observations. Using your obtained data, classify each solution as an acid, base (alkaline) or neutral substance.

- 1A and 3 A vinegar
- 1B and 3 B sodium bicarbonate solution
- 1C and 3 C washing soda solution
- 1D and 3D tap water
- 1E and 3E aspirin solution
- 1F and 3F lemon juice
- 2A and 4A ammonia solution
- 2B and 4B hydrogen peroxide
- 2C and 4C rubbing alcohol
- 2D and 4D shampoo solution

*(Used with "microchemistry" plates)*

Solutions in wells 1A-2D will be tested with the cabbage juice indicator solution. Solutions in wells 3A-4D will be tested with indicator strips (Litmus & pH)



<b>Level</b>	<b>Scientific Procedures and Reasoning</b>	<b>Strategies</b>	<b>Scientific Communication/Using Data</b>	<b>Scientific Concepts and Related Content</b>
<b>Practitioner</b>	Effectively used some appropriate tools and technologies (e.g., rulers, pH paper, hand lens, computer, reference materials, etc.) to gather and analyze data, with only minor errors.	<p>Used a strategy that led to completion of the investigation/task.</p> <p>Recorded all data.</p> <p>Used effective scientific reasoning.</p> <p>Framed or used testable questions, conducted experiment, and supported results with data.</p>	<p>A clear explanation was presented.</p> <p>Effectively used scientific representations and notations to organize and display information.</p> <p>Appropriately used data to support conclusions.</p>	<p>Appropriately used scientific terminology.</p> <p>Provided evidence of understanding of relevant scientific concepts, principles or theories (big ideas).</p> <p>Evidence of understanding observable characteristics and properties of objects, organisms, and/or materials used.</p>
<b>Expert</b>	Accurately and proficiently used all appropriate tools and technologies (e.g., rulers, pH paper, hand lens, computer, reference materials, etc.) to gather and analyze data.	<p>Used a sophisticated strategy and revised strategy where appropriate to complete the task.</p> <p>Employed refined and complex reasoning and demonstrated understanding of cause and effect.</p> <p>Applied scientific method accurately: (framed testable questions, designed experiment, gathered and recorded data, analyzed data, and verified results).</p>	<p>Provided clear, effective explanation detailing how the task was carried out. The reader does not need to infer how and why decisions were made.</p> <p>Precisely and appropriately used multiple scientific representations and notations to organize and display information.</p> <p>Interpretation of data supported conclusions, and raised new questions or was applied to new contexts.</p> <p>Disagreements with data resolved when appropriate.</p>	<p>Precisely and appropriately used scientific terminology.</p> <p>Provided evidence of in-depth, sophisticated understanding of relevant scientific concepts, principles or theories (big ideas).</p> <p>Revised prior misconceptions when appropriate.</p> <p>Observable characteristics and properties of objects, organisms, and/or materials used went beyond the task investigation to make other connections or extend thinking.</p>

<b>Level</b>	<b>Scientific Procedures and Reasoning</b>	<b>Strategies</b>	<b>Scientific Communication/Using Data</b>	<b>Scientific Concepts and Related Content</b>
<b>Novice</b>	Did not use appropriate scientific tools or technologies (e.g., rulers, pH paper, hand lens, computer, reference materials, etc.) to gather data (via measuring and observing).	<p>No evidence of a strategy or procedure, or used a strategy that did not bring about successful completion of task investigation.</p> <p>No evidence of scientific reasoning used.</p> <p>There were so many errors in the process of investigation that the task could not be completed.</p>	<p>No explanation, or the explanation could not be understood, or was unrelated to the task investigation.</p> <p>Did not use, or inappropriately used scientific representations and notation (e.g. symbols, diagrams, graphs, tables, etc.).</p> <p>No conclusion stated, or no data recorded.</p>	<p>No use, or mostly inappropriate use, of scientific terminology.</p> <p>No mention or inappropriate references to relevant scientific concepts, principles, or theories (big ideas).</p> <p>Some evidence of understanding observable characteristics and properties of objects, organisms, and/or materials used.</p>
<b>Apprentice</b>	Attempted to use appropriate tools and technologies (e.g., rulers, pH paper, hand lens, computer, reference materials, etc.) to gather data (via measuring and observing) but some information was inaccurate or incomplete.	<p>Used a strategy that was somewhat useful, leading to partial completion of the task/investigation.</p> <p>Some evidence of scientific reasoning used.</p> <p>Attempted but could not completely carry out testing a question, recording all data and stating conclusions.</p>	<p>An incomplete explanation or explanation not clearly presented (e.g., out of sequence, missing step).</p> <p>Attempted to use appropriate scientific representations and notations, but were incomplete (e.g., no labels on chart).</p> <p>Conclusions not supported or were only partly supported by data.</p>	<p>Used some relevant scientific terminology.</p> <p>Minimal reference to relevant scientific concepts, principles, or theories (big ideas).</p> <p>Evidence of understanding observable characteristics and properties of objects, organisms, and/or materials used.</p>

**Synthetics**  
**Lesson Plans**  
**Becky Sands**  
**“Will It Explode?”**  
**SEW 2003**  
**June 24, 2003**

**Grade Level:** 4<sup>th</sup> and 5<sup>th</sup> grades

**Academic Context:** The students have been studying about the evidence of change as related to Chemistry. They have practiced differentiating physical and chemical changes as well as exothermic and endothermic reactions in the classroom chemistry lab. The students have developed and implemented experimental plans to determine which reactants of a chemical reaction cause certain outcomes. They have compared the rate of different chemical reactions that combine a solid and liquid to produce a gas. The students have investigated the Periodic Table of Elements as they named elements, wrote symbols, created models, viewed pure elements and discovered element uses. They have used natural indicators, litmus paper, and pH paper to classify substances as acids, bases and neutrals. The students have tested known powders using several reagents, noted results, and developed plans for identifying an unknown mixture of powders. Students have designed experimental plans that utilized the idea of a variable. Throughout the past few weeks, many experiments have been conducted that use lab equipment, demand safety, require recording of observations and give students the opportunity to work like real chemists in the classroom chemistry lab.

**Content Objective:** Students will develop a broader concept of a chemist’s lab using previously acquired knowledge as a foundation. The students will make use of simple comparisons as they respond to direct analogies related to a chemist’s lab.

**Process Objective:** Direct Analogy

**Teacher Talk:** “We have been conducting a variety of chemical experiments using equipment like a real chemist uses in his/her own chemistry lab. We have noted the occurrences of physical and chemical changes through our experimentation while differentiating exothermic and endothermic reactions. In our classroom chemistry lab, we have practiced lab safety, recorded results of our investigations, developed experimental plans and interpreted the Periodic Table of Elements. Today, you will use your knowledge of chemical investigations to make comparisons between a chemist’s lab and other things.”

“A direct analogy is the comparison of one thing to another. An example might be: A graduated cylinder is like **thermometer** because **it always measures up**. I would like for you to practice with the following analogy:

Safety goggles are like \_\_\_\_\_ because they give protection. (This statement will be written on the board). I will write your responses on the board.

Now that you have warmed up, you will complete the analogies on the handout that deals with aspects of a chemist’s lab.

**Synecotics Lesson**  
**Direct Analogy**

**Name:** \_\_\_\_\_ **Date:** \_\_\_\_\_

**Directions:** The purpose of Synectics is to help one express his/her feelings and ideas. Use your knowledge of chemical investigations to complete the following comparisons to a chemist's lab.

**Activity A**

A chemist's lab is like \_\_\_\_\_ because unusual odors can be present.

A chemist's lab is like \_\_\_\_\_ because answers to questions are there.

A chemist's lab is like \_\_\_\_\_ because it provides adventures into the unknown.

A chemist's lab is like \_\_\_\_\_ because fragile glassware is handled.

**Activity B**

A chemist's lab is like a rainbow because \_\_\_\_\_  
\_\_\_\_\_.

A chemist's lab is like a school cafeteria because \_\_\_\_\_  
\_\_\_\_\_.

A chemist's lab is like a hospital because \_\_\_\_\_  
\_\_\_\_\_.

A chemist's lab is like a thunderstorm because \_\_\_\_\_  
\_\_\_\_\_.

**Activity C**

A chemist's lab is like \_\_\_\_\_ because \_\_\_\_\_  
\_\_\_\_\_.

A chemist's lab is like \_\_\_\_\_ because \_\_\_\_\_  
\_\_\_\_\_.

## **Synectics Personal Analogy**

**Grade level:** 4<sup>th</sup>-5<sup>th</sup>

**Academic Context:** The students have been studying about the evidence of change as related to Chemistry. They have practiced differentiating physical and chemical changes as well as exothermic and endothermic reactions in the classroom chemistry lab. The students have developed and implemented experimental plans to determine which reactants of a chemical reaction cause certain outcomes. They have compared the rate of different chemical reactions that combine a solid and liquid to produce a gas. The students have investigated the Periodic Table of Elements as they named elements, wrote symbols, created models, viewed pure elements and discovered element uses. They have used natural indicators, litmus paper, and pH paper to classify substances as acids, bases and neutrals. The students have tested known powders using several reagents, noted results, and developed plans for identifying an unknown mixture of powders. Students have designed experimental plans that utilized the idea of a variable. Throughout the past few weeks, many experiments have been conducted that use lab equipment, demand safety, require recording of observations and give students the opportunity to work like real chemists in the classroom chemistry lab.

**Content Objective:** Students will develop a broader concept of a chemist's lab using previously acquired knowledge as a foundation. The students will demonstrate understanding of possible occurrences of chemical reactions within a chemistry lab. Empathetic feelings will be developed as students become the test tube.

**Process Objective:** Personal Analogy

**Teacher Talk:** "We have been conducting a variety of chemical experiments using equipment like a real chemist uses in his/her own chemistry lab. We have noted the occurrences of physical and chemical changes through our experimentation while differentiating exothermic and endothermic reactions. In our classroom chemistry lab, we have practiced lab safety, recorded results of our investigations, developed experimental plans and interpreted the Periodic Table of Elements. Today, you will become the test tube in a chemistry lab. As you are sitting in the test tube rack on the shelf, you feel the warm grasp of a human hand. What is about to happen? Will you get hot? Will you feel cold? Will you get broken? Will others be there? Are you excited? Do you feel scared? What will you be used for? Will you contain an exciting discovery? Think about these and other questions as you write your story. **BE THE TEST TUBE!**"



## **Synectics Compressed Conflict**

**Grade Level:** 4<sup>th</sup> and 5<sup>th</sup> grades

**Academic Context:** The students have been studying about the evidence of change as related to Chemistry. They have practiced differentiating physical and chemical changes as well as exothermic and endothermic reactions in the classroom chemistry lab. The students have developed and implemented experimental plans to determine which reactants of a chemical reaction cause certain outcomes. They have compared the rate of different chemical reactions that combine a solid and liquid to produce a gas. The students have investigated the Periodic Table of Elements as they named elements, wrote symbols, created models, viewed pure elements and discovered element uses. They have used natural indicators, litmus paper, and pH paper to classify substances as acids, bases and neutrals. The students have tested known powders using several reagents, noted results, and developed plans for identifying an unknown mixture of powders. Students have designed experimental plans that utilized the idea of a variable. Throughout the past few weeks, many experiments have been conducted that use lab equipment, demand safety, require recording of observations and give students the opportunity to work like real chemists in the classroom chemistry lab.

**Content Objective:** Students will develop a broader concept of a chemist's lab using previously acquired knowledge as a foundation. The students will evaluate comparisons of compressed conflicts as they relate to events that can occur in a chemistry lab.

**Process Objective:** Compressed Conflict

**Teacher Talk:** "We have been conducting a variety of chemical experiments using equipment like a real chemist uses in his/her own chemistry lab. We have noted the occurrences of physical and chemical changes through our experimentation while differentiating exothermic and endothermic reactions. In our classroom chemistry lab, we have practiced lab safety, recorded results of our investigations, developed experimental plans and interpreted the Periodic Table of Elements. Today, I would like you to use a form of Synectics called compressed conflict to make comparisons of events that can occur in a chemistry lab. A compressed conflict is a comparison that describes something with words that are opposite. Let's do an example together. Unknown discovery—This describes an event that occurs in a chemistry lab. It is known if it is discovered while 'unknown' implies something not yet discovered. Doesn't an 'unknown discovery' exist in a chemistry lab? Look at the list of compressed conflicts on the handout. Try to think of why these words are good comparisons for events that occur in a chemistry lab. Write your interpretation of the comparisons as related to a chemistry lab."

**Synectics**  
**Compressed Conflict**

**Name:** \_\_\_\_\_ **Date:** \_\_\_\_\_

Read each set of compressed conflicts. Try to think of why these words are good comparisons for events that occur in a chemistry lab. Write your interpretation of the comparisons as related to a chemistry lab.

<u>Compressed Conflicts</u>	<u>Interpretation</u>
1. <b>silent blast</b>	_____ _____ _____ _____
2. <b>burning cold</b>	_____ _____ _____ _____
3. <b>odorless smell</b>	_____ _____ _____ _____
4. <b>structured chaos</b>	_____ _____ _____ _____
5. <b>enlightening failures</b>	_____ _____ _____ _____

**Think of other events that could occur in a chemistry lab and create your own compressed conflict comparison.** \_\_\_\_\_





## Rates of Reactions Lab

Name \_\_\_\_\_

Date: \_\_\_\_\_

### Lightstick Kinetics

The reaction is a chemiluminescence reaction, and like most reactions, its rate is temperature dependent. The lightstick contains dilute hydrogen peroxide in a phthalic ester solvent, which is held in a thin glass ampule. This ampule is surrounded by sodium containing phenyl oxalate and a fluorescent dye. When the ampule is broken, the peroxide and the phenyl oxalate ester react. During the course of the reaction, an intermediate is produced which transfers energy to the dye molecule. Visible light is emitted when the excited dye returns to the ground state.

Each student will test a light stick. Half of the students will place their light sticks in warm water and the other half will place their light sticks in a cold solution of water. Make and record observations during class. Allow the light sticks to equilibrate in the solution before breaking the ampule.

What is the effect of heat/cold on the brightness of the light stick?

Why do you think this occurred?

### Bubble Rate

We are interested in studying the effect that temperature has on the rate of reaction. The reaction that we will use to study this is the disappearance of an Alka-Seltzer tablet when it is dropped in water. We will use water that is ice cold, room temperature and hot.

State hypothesis:

Materials: 3 cups, ice water, warm water, room temperature water, Alka-Seltzer tablets.

Procedure:

Fill 3 cups one-half full of water. (One for ice water, one for hot water and one for RT water).

Measure the temperature of the water in each cup.

Look at the clock (or use your watch)

Drop the Alka Seltzer in the waters at the same time. Record the length of time it takes for the tablet to completely dissolve.

Sample	Temperature (Celsius)	Time to disappear (seconds)
Ice Water		
Room Temp Water		
Warm water		

Questions:

1. State the relationship between temperature of the water and the disappearance of the Alka Seltzer tablet.
2. Was this a chemical change? What is your evidence?

### Surface Area and Reaction Rate

Reactions proceed at different rates depending on many factors. One thing that you can do to increase the rate of reaction is to create more surface area.

Materials: 3 petri dishes, Alka seltzer tablets, water

Procedure: Fill petri dishes half full of water.

Break 2 Alka Seltzer tablets in half. Match pieces as evenly as possible.

Break one of the pieces into fine pieces. Break a second half into chunks.

Transfer each of the 3 samples onto a piece of paper to make it easy to dump them into the petri dishes. At the same time add the three samples to the three petri dishes. Note the amount of time need for each sample to quit reacting.

Questions:

1. How did you tell when each reaction was complete?
2. Which of the three samples took the longest time to finish reacting?
3. Why do you think the whole half took the longest amount of time to react?
4. Describe in your own words what surface area is.
5. What effect does surface area seem to have on the rate of reaction?

### How Much Vinegar?

We are interested in studying the effect that concentration of a solution has on the rate of a reaction. We shall use the formation of bubbles when vinegar is added to baking soda. We will use the same amount of baking soda and vinegar, but the concentration of the vinegar will be changed.

Materials: 3 cups, teaspoons, water, baking soda, vinegar

Procedure: Pour 1 tsp of vinegar into the first cup, two tsp. in the second cup, and four teaspoons in the third cup. Add  $\frac{1}{4}$  cup of water to each cup.

At the same time, a tsp of baking soda will be added to the vinegar. Record observations.

Sample	Vinegar Amount	Observations
	One teaspoon	
	Two teaspoons	
	Three teaspoons	

Questions:

1. State the relationship between concentration of the vinegar and the appearance of the reaction.
2. Was this a chemical reaction? What is your evidence?

## Glurch vs. Oobleck: A Tournament of Properties

Name: \_\_\_\_\_ Date: \_\_\_\_\_

**Purpose:** The purpose of this activity is to present the participants with directions for making two interesting substances and a method of teaching experimental design skills through testing of the properties of resiliency, viscosity, and fluidity.

### Essential Elements:

- Identify and manipulate the conditions of investigations
- Define and apply terms operationally
- Form generalized statements

### Materials:

Paper cups  
Graduated Cylinders  
Small containers for water and finished products  
Woodsticks  
Newspaper

**Glurch:** 45 ml liquid laundry starch  
25 ml white glue  
pinch of salt

Dissolve salt in starch. Place in a paper cup. Add the white glue and stir about 30 beats. Reach in and squeeze out the excess starch until the substance becomes doughy. Remove from the cup and knead some more. If the Glurch is runny, add a few grains more of salt.

**Oobleck:** cornstarch (about 50 ml)  
About 25 ml of water

Place water in paper cup. Add a little cornstarch at a time to the water while stirring. When you can't stir anymore, remove the mixture from the cup and knead. Add a few more drops of water if the Oobleck is crumbly.

**Background Information:** Both Glurch and Oobleck are colloids, substances which have properties of both solid and liquid states of matter. Depending on the proportions of the ingredients you use, the Glurch or Oobleck may be more or less solid or liquid. In a colloid, one substance is suspended within another. The suspended material is made of particles so small they don't sink to the bottom of the second substance. Other common colloidal substances include fog, smoke, meringue, protoplasm, homogenized milk, synthetic rubber and mayonnaise.

### Group Members have Designated Jobs:

**Principal Investigator:** assigns jobs (stirring, bouncing, etc) and makes sure that EVERYONE is involved. S/He checks results, also, and is the one who may communicate directly with the teacher.

**Materials Manager:** picks up and returns the materials and equipment

**Maintenance Director:** in charge of clean-up and should spread newspaper before the group begins. S/He may enlist cleaning help from other group members.

**Recorder:** designs the data collection chart and records all information on the chart. Makes sure that everyone has recorded observations on their lab write up sheets

**Reporter:** part of the debriefing activity with lab. S/He reports all findings to the other groups and class members.

## Experiment #1—Resiliency/Elasticity of Glurch & Oobleck

Problem: Which Substance is more resilient or elastic?

Definition: More resilient means that it will bounce higher or stretch longer.

Hypothesis:

Materials: You'll need the Oobleck and Glurch you made.

Procedure: What did you do to test the substances? Write it below.

Results: What did your tests show you? Which substance is more resilient?

If you fell from a 3-story indo, would your rather fall into a vat filled with glurch or a vat of oobleck? Why?

With which substance, Glurch or Oobleck, do you think you could blow a bigger bubble? Why?

## Experiment #2: Viscidity/Stickiness of Glurch and Oobleck

Problem: Which substance is more sticky, Glurch or Oobleck?

Definition: More sticky means that it will pick up newsprint or will glue two pieces of paper together more strongly.

Hypothesis: Which do you think will be more sticky? Why?

Materials: You will need the Oobleck and Glurch you made.

Procedure: What did you do to test your substances? Write it below.

Results: What happened and which did you find has the greatest viscosity?

Which substance, Glurch or Oobleck, would make a better substitute for thumbtacks? How could you prove this?

Which substance might make a louder noise when pulled up from a surface? How would you prove it?

### Experiment #3: Fluidity of Glurch and Oobleck

Problem: Which substance, Glurch or Oobleck is more fluid?

Definition: More fluid means that it flows or squeezes between your fingers more easily.

Hypothesis: Which do you think is more fluid? Why?

Materials: You will need the Oobleck and Glurch the you made.

Procedure: What did you do to test your substance? Write it below.

Results: What happened? Write your results below.

If both substances were poured, which would fill a container first? How do you know?

Which substance would be better measured in mg than in ml? Why?

# A Tournament of Properties

PROPERTY

MATERIALS

OPERATIONAL  
DEFINITIONS

CONCLUSION

RESILIENCY  
(ELASTICITY)

GLURCH

OUBLECK

GLURCH

OUBLECK

will bounce higher

will stretch longer

Is more resilient

VISCIDITY  
(STICKINESS)

GLURCH

OUBLECK

GLURCH

OUBLECK

picks up more  
newsprint

glues 2 pieces of paper  
together more strongly

Is more viscid

FLUIDITY  
(ABILITY TO FLOW)

GLURCH

OUBLECK

GLURCH

OUBLECK

flows faster

squeezes through  
fingers more easily  
when pinched

Is more fluid



## TO MAKE GLURCH:

1. Place 45 mL laundry starch in paper cup.
2. Add a pinch of salt and stir with a woodstick.
3. Add 25 mL white glue and stir about 30 beats.
4. Reach in and squeeze out the extra starch until the substance becomes doughy.
5. Remove from cup and knead some more.
6. If the Glurch is runny, add a little salt.

## TO MAKE OOBLECK:

1. **Place** 25 mL water in a paper cup.
2. Measure out about 50 mL cornstarch.
3. Stir a little cornstarch at a time into the water, until you can't stir anymore.
4. Remove the mixture from the cup and knead.
5. If the Oobleck is too crumbly, add a few drops of water.