Course: Physical Science

I. Grade Level/Unit Number: Physical Science / Unit 5

II: Unit Title: Chemical Interactions

III. Unit Length: 4 weeks

IV. Major Learning Outcomes:

- Define group (family) and period.
- Locate the following on the periodic table: alkali metals, alkaline earth metals, transition metals, halogens, noble gases, metals, nonmetals, metalloids.
- Compare and contrast the physical and chemical properties of metals, nonmetals, and metalloids. (Properties should include but not be limited to reactivity, physical state, melting and boiling point, ductility, malleability, conductivity, and luster.)
- Analyze the periodic trend for atomic radius (left to right and top to bottom on periodic table.
- Describe how ions form.
- Describe how ionic, covalent, and metallic bonds form and provide examples of substances that exhibit each type of bonding.
- Represent elements, ions, and simple compounds with electron dot diagrams.
- Predict an element's oxidation number based on its position in the periodic table and valence electrons, excluding the transition elements.
- Name and write formulas for simple binary compounds.
- Name and write formulas of compounds using polyatomic ions given in the Physical Science Reference Table.

Polyatomic Ions	
NH_4^+	Ammonium
$C_2H_3O_2^-$	Acetate
ClO_3^-	Chlorate
MnO_4^-	Permanganate
NO_3^-	Nitrate
OH^-	Hydroxide
CO_3^{2-}	Carbonate

CrO_4^{2-}	Chromate
SO_4^{2-}	Sulfate
PO_4^{3-}	Phosphate

- Identify the reactants and products of a simple chemical equation.
- Use coefficients to balance simple chemical equations.
- Recognize that chemical equations must be balanced because of the law of conservation of matter.
- Classify chemical reactions as one of four types: single replacement, double replacement, decomposition, and synthesis. (Neutralization reaction is a type of double replacement reaction. See 6.05)
- Observe a process and describe the indicator(s) of chemical change it exhibits.
- Differentiate between exothermic and endothermic reactions.
- (Color change is sometimes an indicator of chemical change- sometimes physical-discuss examples.)
- Give examples of solutions containing solutes and solvents of various phases such as alloys and carbonated drinks.
- Explain the polar nature of water (The phrase "like dissolves like" is often used to explain why substance dissolves another which is an over simplification of the process).
- Investigate the factors that affect the rate of solution of a solid including concentration, stirring, temperature, and surface area.
- Compare and contrast electrical conductivity of solutions containing ionic and covalent solutes.
- Interpret the solubility curves for solids (concentration vs. temperature). Investigate various concentrations unsaturated through supersaturated.
- Conduct an experiment to illustrate trends in solubility.
- Identify the acid, base, and salt in a neutralization reaction. (See 6.03)
- Compare and contrast the physical and chemical characteristics of acids, bases, and neutral substances.
- Develop an understanding of the concentration of ions in the organization of the pH scale.
- Investigate the pH of various substances using various indicators: litmus paper, phenolphthalein, and pH paper.

V. Content Objectives Included (with RBT Tags):

Objective Number	Objective	RBT Tag
6.02	Investigate and analyze the formation and nomenclature of simple inorganic compounds. • Ionic bonds (including oxidation numbers). • Covalent bonds. • Metallic bonds.	A3 B4 C2
6.03	Identify the reactants and products of chemical reactions and balance simple equations of various types: • Single replacement. • Double replacement. • Decomposition. • Synthesis.	A5 C3
6.04	Measure and analyze the indicators of chemical change including: • Development of a gas. • Formation of a precipitate. • Release/absorption of energy (heat or light).	C2 C3
6.05	Investigate and analyze the properties and composition of solutions: • Solubility curves. • Concentration. • Polarity. • pH scale. • Electrical conductivity.	A3 C2 C3
1.01	Identify questions and problems that can be answered through scientific investigations.	
1.02	Design and conduct scientific investigations to answer questions about the physical world. • Create testable hypotheses. • Identify variables. • Use a control or comparison group when appropriate. • Select and use appropriate measurement tools. • Collect and record data. • Organize data into charts and graphs. • Analyze and interpret data. • Communicate findings.	
1.03	Formulate and revise scientific explanations and models using logic and evidence to: • Explain observations. • Make inferences and predictions. • Explain the relationship between evidence and explanation.	
1.04	Apply safety procedures in the laboratory and in field	

	studies: • Recognize and avoid potential hazards. • Safely manipulate materials and equipment needed for scientific investigations.	
1.05	Analyze reports of scientific investigations of physical phenomena from an informed scientifically literate viewpoint including considerations of: • Appropriate sample. • Adequacy of experimental controls. • Replication of findings. • Alternative interpretations of the data.	

VI. English Language Development Objectives (ELD) Included: NC English Language Proficiency (ELP) Standard 4 (2008) for Limited English Proficiency Students (LEP)- English Language learners communicate information, ideas, and concepts necessary for academic success in the content area of science.

Suggestions for modified instruction and scaffolding for LEP students and/or students who need additional support are embedded in the unit plan and/or are added at the end of the corresponding section of the lessons. The amount of scaffolding needed will depend on the level of English proficiency of each LEP student. Therefore, novice level students will need more support with the language needed to understand and demonstrate the acquisition of concepts than intermediate or advanced students.

VII. Materials/Equipment Needed:

Activity	Materials
Find Your Partner	Note cards Yarn
Candy Chemistry	Toothpicks Soft candies of different colors
Nuts and Bolts of Chemical Reactions	Assortment of bolts Nuts Washers Lock washers Wing nuts Paper
Types of Chemical reactions(from Physical Science Support Document)	Goggles Well plates Iron Zinc

	Copper Magnesium Aluminum HCl Silver (I) Nitrate Potassium iodide Distilled water Graduated cylinder Beakers
Fizzie Lab Part I	Goggles Baking soda Calcium chloride Water Plastic petri dishes Stirring rods Paper towels Matches Wooden splints
Fizzie Lab Part II	Goggles Petri dishes w/ compounds from Part I Water Vinegar Stirring rods Paper towels Matches Wooden splints
Solutions	Beakers Water Salt Sand Goggles
Coffee Filter Lab	Coffee filters Crayons Water soluble markers Water Petri dishes
Rate of Solution	Goggles Beakers or clear plastic cups Sugar granules Sugar cubes Stirring rods Hot plate Stopwatch or timer
Let There be Light	Electrical conductivity apparatus Beakers Water

	Various materials to test in solution → (salt, sugar, baking soda, vinegar, dilute HCl) Water Stirring rods Paper towels Goggles
Tang® Lab	Tang® Plastic spoons Plastic cups Drinking water Paper towels
Taste Bud Teasers	Soap Lemon Pecan pulp Vinegar
Acids, Bases,pH Scale	Smal plastic containers (weigh boats) pH (hydrion) paper Litmus paper 10 sample substances Goggles

VIII. Detailed Content Description:

Please see the detailed content description for each objective in the Physical Science Support document. The link to this downloadable document is in the Physical Science Standard Course of Study at:

http://www.ncpublicschools.org/curriculum/science/scos/2004/26physical

IX. Unit Notes:

Overview of Unit Five:

In this unit students expand their knowledge of matter by examining interactions that can occur in matter. After reviewing atomic structure, students learn about oxidation numbers and why atoms combine. Bonding types are examined and oxidation numbers are used to determine chemical formulas. Students then proceed to naming inorganic compounds. Once they master this, students move on to the writing and balancing of the different types of chemical equations which illustrate how the compounds form. Solutions are made and solubility investigated as yet another means by which one type of mater interacts with another.

In each unit, Goal 1 objectives which relate to the process of scientific investigation are included. In each of the units, students will be practicing the

processes of science: observing, hypothesizing, collecting data, analyzing, and concluding. **Goal 1 objectives are an *integral* part of *each of the other goals*.** In order to measure and investigate scientific phenomena, students must be given the opportunity to design and conduct their own investigations in a safe laboratory. Investigations may also be conducted using simulations.

The unit guide below contains the activities that are suggested to meet the Standard Course of Study (SCOS) Goals for Unit Five. The guide includes activities, teacher notes on how to implement the activities, and resources relating to the activities which include language objectives for ESL (English as a Second Language) students. Teachers should also consult the Department of Public Instruction website for English as a Second Language at: http://www.ncpublicschools.org/curriculum/esl/ to find additional resources. If a teacher follows this curriculum, (s)he will have addressed the goals and objectives of the SCOS. However, teachers may want to substitute other activities that teach the same concept. Teachers should also provide guided and independent practice from other sources.

It is understood that the days required to complete this unit are approximate. Depending on your students, you may need to divide the unit into smaller subunits. It is also understood that if you choose to use this guide, you will make adjustments as needed for your own teaching style and your individual class needs.

Only the subject content objectives are listed each day as the operational science objectives are repeated daily.

Tables and diagrams are suggestions that may be modified as desired.

Reference Tables:
The North Carolina Physical Science Reference Tables were developed to provide essential information that should be used on a regular basis by students, therefore eliminating the need for memorization. It is suggested that a copy be provided to each student on the first day of instruction. A copy of the reference tables can be downloaded at the following URL:

http://www.ncpublicschools.org/docs/accountability/testing/eoc/PhysicalScience/physicalsciencereferencetable.pdf

Essential Questions:

Essential questions for this unit are embedded throughout the unit. Essential questions are those questions that lead to student understanding. Students should be able to answer these questions at the end of an activity. Teachers are advised to post these questions in a prominent place in the classroom. The questions can be answered in a journal format as closure.

Safety:

Students should wear chemical splash goggles during any lab activity involving chemicals. This includes household substances. **It is extremely important for the safety and success of your students that you do ALL activities and labs prior to assigning them to students.** At the beginning of each lab, the teacher should address any specific safety concerns relating to the activity.

Modified Activities for LEP Students:
Those activities marked with a flag (🏳) have a modified version or notes designed to assist teachers in supporting students who are English language learners. Teachers should also consult the Department of Public Instruction website for English as a Second Language at:
http://www.ncpublicschools.org/curriculum/esl/ to find additional resources.

Computer Based Activities:
Several of the recommended activities are computer based and require students to visit various internet sites and view animations of various biological processes. These animations require various players and plug-ins which may or may not already be installed on your computers. Additionally some districts have firewalls that block downloading these types of files. Before assigning these activities to students it is essential for the teacher to try them on the computers that the students will use and to consult with the technology or media specialist if there are issues. These animations also have sound. Teachers may wish to provide headphones if possible.

Suggested Websites:
Below is a list of suggested websites for various topics discussed in Unit Five.

How to name binary molecular compounds
http://www.800mainstreet.com/5/0005-0010-naming.htm

An internet site which includes “Balancing Activity,” “Balancing Equations,” “Reaction Types,” worksheets, video clip, labs, and links
http://www.nclark.net/ChemicalReactions

Other sites:
http://richardbowles.tripod.com/chemistry/balance.htm#part1
http://dbhs.wvusd.k12.ca.us/webdocs/Equations/Balance-Equation.html
http://www.middleschoolscience.com/balance.html

For balancing chemical equations activities, worksheets, reaction types, puzzles, "Cartoon Chemistry" worksheets, etc.
http://www.nclark.net/ChemicalReactions

For a Balancing Chemical Equation Activity
http://www.middleschoolscience.com

For Balancing Equations
Interactive On-line Game
http://funbasedlearning.com/chemistry/chemBalancer/default.htm

http://funbasedlearning.com/chemistry/chembalancer/worksheet.htm

Video demo of precipitate reaction
http://www.nitrogenorder.org/experiment/dblreplace.shtml

Video of a supersaturated demonstration
http://www.mefeedia.com/entry/rapid-crystallization-supersaturated-solution-demo/8129986/

X. Global Content: Aligned with 21st Skills:

NC SCS Physical Science	21st Century Skills	Activity
	Communication Skills	
Goal 1	Conveying thought or opinions effectively	• What is bonding? • Find Your Partner(s) Activity • Nuts and bolts activity • Fizzie lab • Rate of solution lab • Let there be light activity • Acid/bases pH lab
Goal 1	When presenting information, distinguishing between relevant and irrelevant information	• What is bonding? • Find Your Partner(s) Activity • Nuts and bolts activity • Fizzie lab • Rate of solution lab • Let there be light activity • Acid/bases pH lab
Goals 1-6	Explaining a concept to others	• What is bonding? • Find Your Partner(s) Activity • Nuts and bolts activity • Fizzie lab • Rate of solution lab • Let there be light activity • Acid/bases pH lab
	Interviewing others or being interviewed	• Find Your Partner(s) Activity
	Computer Knowledge	

Goals 1-6, esp. Goal 1	Using word-processing and database programs	• Writing Chemical Formulas-Binary Molecular • Balancing Chemical Equation Activity
Goals 1-6, esp. Goal 1	Developing visual aides for presentations	• Balancing Chemical Equation Activity
Goal 1	Using a computer for communication	• Writing Chemical Formulas-Binary Molecular • Balancing Chemical Equation Activity
	Learning new software programs	• Balancing Chemical Equation Activity
	Employability Skills	
Goals 1-6	Assuming responsibility for own learning	All activities
Goals 1-6, esp. Goal 1, 2.02, Goal 3, Goal 4, 5.03, 6.02, 6.05	Persisting until job is completed	All activities
Goals 1-6	Working independently	• What is bonding? • Writing Chemical Formulas-Binary Molecular • Candy chemistry • Balancing Chemical Equation Activity • Coffee filter lab
	Developing career interest/goals	
Goal 1	Responding to criticism or questions	
	Information-retrieval Skills	
Goal 1	Searching for information via the computer	• Various online extensions as related to the web sites given in suggested web sites • Candy chemistry • Balancing Chemical Equation Activity
Goal 1	Searching for print information	
	Searching for information using community members	
	Language Skills - Reading	
Goal 1-6	Following written directions	Most of the activities can be presented as opportunities for students to follow written directions. The teacher will have to work with most students to develop this skill over time. The following activities are well suited to developing skills in following directions:

		• What is an ionic compound? • Balancing Chemical Equation Activity
Goals 1-6	Identifying cause and effect relationships	• What is an ionic compound? • Find Your Partner(s) Activity • Balancing Chemical Equation Activity
Goals 1-6	Summarizing main points after reading	• Balancing Chemical Equation Activity
Goal 1	Locating and choosing appropriate reference materials	• Balancing Chemical Equation Activity
Goals 1-6	Reading for personal learning	• Balancing Chemical Equation Activity
	Language Skill - Writing	
Goals 1-6	Using language accurately	All activities
Goals 1-6	Organizing and relating ideas when writing	All activities
Goals 1-6, esp. Goal 1	Proofing and Editing	
Goals 1-6, esp. Goal 1	Synthesizing information from several sources	• Find Your Partner(s) Activity
Goal 1	Documenting sources	
	Developing an outline	
1.04	Writing to persuade or justify a position	
	Creating memos, letters, other forms of correspondence	
	Teamwork	
Goal 1, 2.02, Goal 3, Goal 4, 5.03, 6.02, 6.05	Taking initiative	• What is an ionic compound? • What is bonding? • Find Your Partner(s) Activity • Writing Chemical Formulas-Binary Molecular • Candy chemistry • Nuts and bolts activity • Balancing Chemical Equation Activity • Fizzie lab • Coffee filter lab • Let there be light activity • Tang® lab • Acid/bases pH lab
Goal 1, 2.02, Goal 3, Goal 4, 5.03, 6.02, 6.05	Working on a team	Most of the activities are designed to be done and discussed in teams. The following activities are well suited to developing team interdependence skills:

		• What is an ionic compound? • Find Your Partner(s) Activity • Writing Chemical Formulas-Binary Molecular • Candy chemistry • Nuts and bolts activity • Balancing Chemical Equation Activity • Fizzie lab • Let there be light activity • Tang® lab • Acid/bases pH lab
	Thinking/Problem-Solving Skills	
Goals 1-6	Identifying key problems or questions	• What is an ionic compound? • Find Your Partner(s) Activity • Writing Chemical Formulas-Binary Molecular • Candy chemistry • Nuts and bolts activity • Fizzie lab • Coffee filter lab • Let there be light activity • Tang® lab • Acid/bases pH lab
Goals 1-6	Evaluating results	• What is an ionic compound? • What is bonding? • Find Your Partner(s) Activity • Writing Chemical Formulas-Binary Molecular • Candy chemistry • Nuts and bolts activity • Fizzie lab • Coffee filter lab • Let there be light activity • Tang® lab • Acid/bases pH lab
Goals 1-4, 5.02, 5.03, Goal 6	Developing strategies to address problems	• What is an ionic compound? • Find Your Partner(s) Activity • Writing Chemical Formulas-Binary Molecular • Candy chemistry • Nuts and bolts activity • Coffee filter lab • Let there be light activity • Tang® lab • Acid/bases pH lab
Goal 1, 2.02, Goal	Developing an action plan or	• What is an ionic compound?

3, Goal 4, 5.03, 6.02, 6.05	timeline	• What is bonding? • Find Your Partner(s) Activity • Writing Chemical Formulas-Binary Molecular • Candy chemistry • Nuts and bolts activity • Coffee filter lab • Let there be light activity • Acid/bases pH lab

Chemical Interactions
Day 1

Objective 6.02 – Investigate and analyze the formation and nomenclature of simple inorganic compounds: ionic bonds (including oxidation numbers), covalent bonds, metallic bonds

Essential Question: What is an ionic compound?

<u>ENGAGE</u>
Engage students by relating to knowledge of atomic structure and Bohr model diagrams. You can diagram an atomic model and then ask students to predict how to draw a model for a compound. (The topic of compound was introduced in Unit 4.) Relate the difference between organic and inorganic compounds.

<u>EXPLORE</u>
Students will explore what ions are as well as the difference between positive and negative ions.

<u>Ionic Compounds</u>
In order for students to write formulas and names of ionic compounds, they must first understand how ions are formed.
Review the term ion and explain how ions are formed.

Choose a simple ionic inorganic compound with which the students are familiar, such as sodium chloride. To discuss how and why the two combine, remind students of the numbers of valence electrons in the various columns on the Periodic Table. Ask how many valence electrons in sodium and have one student stand up on one side of the room to represent one valence electron. Ask how many valence electrons in chlorine and have seven students stand up on the other side of the room to represent the seven valence electrons. Then ask students what they remember about the valence electrons in noble gases. They should remember that they have eight (except in helium), and that these elements are extremely stable because of this. Tell students that atoms of elements become chemically stable by achieving a “full” valence level of eight as there is a mutual attraction between protons in one atom for the electrons of

another. (Here again, students should know by now the number of valence electrons in each level.) Now ask students the easiest way for the standing students to make a complete valence level of eight. They quickly see that the easiest way to do this is for the one “valence electron” to move over to the seven. Ask students if the sodium and chlorine are still atoms. They should recognize that they are not atoms but are ions because you have just changed the number of electrons. (The number of protons and electrons are not equal as in atoms.)

From the visual just modeled, they should see that the metal, sodium, lost an electron, forming a positive one ion. The ionic charge is positive one as is the oxidation number, or combining ability. You can show this mathematically on the board if needed. Next show that the nonmetal lost an electron forming a positive ion. The ionic charge of chlorine is negative one as is the oxidation number. When one atom has this much attraction for the electrons of another, there is a transfer of electrons.

Go over with students how to name ions; positive ions are the name of the element plus ion (ex. Na^{+1} is named sodium ion). Negative ions are named differently- the name ends in -ide (ex. Cl^{-1} is named chloride ion). Inform students that positive ions are called cations (pronounced cat-ions) and negative ions are called anions (pronounced an-ions).

A chart for practicing the names and formulas of ions is below.
Add as many as necessary until you feel your students have mastered the information.

This would be a good time to review Bohr models and then have students draw

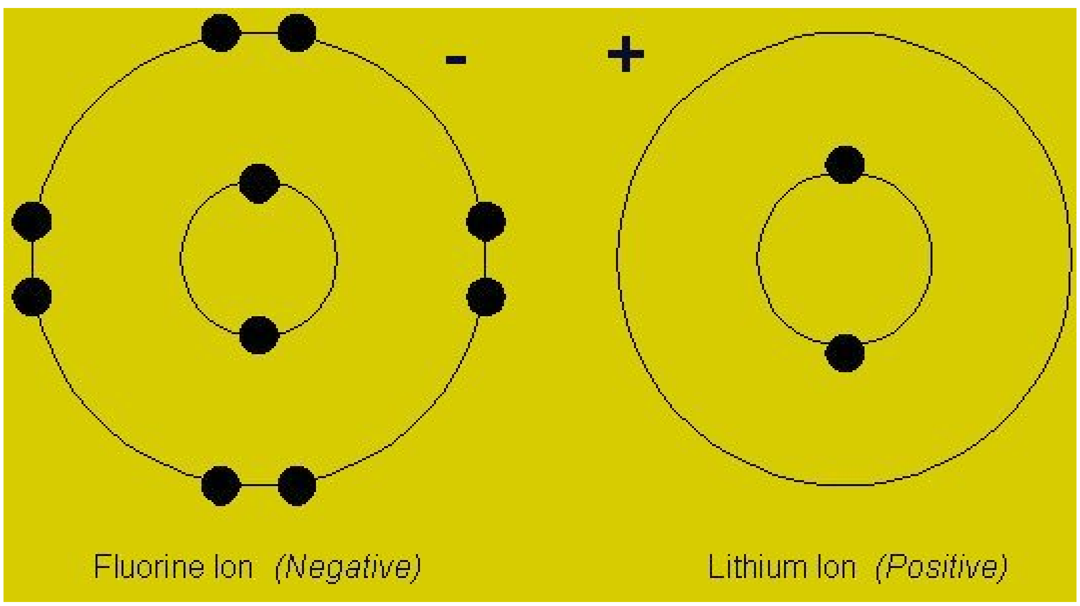
Element name	Ion name	# valence electrons	# electrons lost or gained	Oxidation #	Formula	Anion or Cation?
Calcium	Calcium ion	2	2 lost	2+	Ca^{+2}	
Nitrogen	Nitride ion	5	3 gained	3-	N^{-3}	
	Potassium Ion			1+		
					O^{-2}	
Fluorine						
	Aluminum ion					
Barium						
	Lithium ion					
					Mg^{+2}	
	Sulfide ion					

and identify Bohr models of ions.

ION PRACTICE
Complete the chart using your knowledge of ions and how they are formed.

Element name	Ion name	# valence electrons	# electrons lost or gained	Oxidation #	Formula	Anion or Cation?
Calcium	Calcium ion	2	2 lost	2+	Ca^{+2}	***Cation***
Nitrogen	Nitride ion	5	3 gained	3-	N^{-3}	***Anion***
Potassium	Potassium Ion	***1***	***1 lost***	1+	***K^{+1}***	***Anion***
Oxygen	***Oxide ion***	***6***	***2 gained***	***2--***	O^{-2}	***Anion***
Fluorine	***Fluoride ion***	***7***	***1 gained***	***1-***	***F^{-1}***	***Anion***
Aluminum	Aluminum ion	***3***	***3 lost***	***3+***	***Al^{+3}***	***Cation***
Barium	***Barium ion***	***2***	***2 lost***	***2+***	***Ba^{+2}***	***Cation***
Lithium	Lithium ion	***1***	***1 lost***	***1+***	***Li^{+1}***	***Cation***
Magnesium	***Magnesium ion***	***2***	***2 lost***	***2+***	Mg^{+2}	***Cation***
Sulfur	Sulfide ion	***6***	***2 gained***	***2-***	***S^{-2}***	***Anion***

Key:



http://www.chelationtherapyonline.com/technical/images/chembond_atom2.jpg

You can also include electron dot diagrams of ions.

Chemical Interactions
Day 2

Objective 6.02 – Investigate and analyze the formation and nomenclature of simple inorganic compounds: ionic bonds (including oxidation numbers), covalent bonds, metallic bonds

Essential Question: What is bonding?

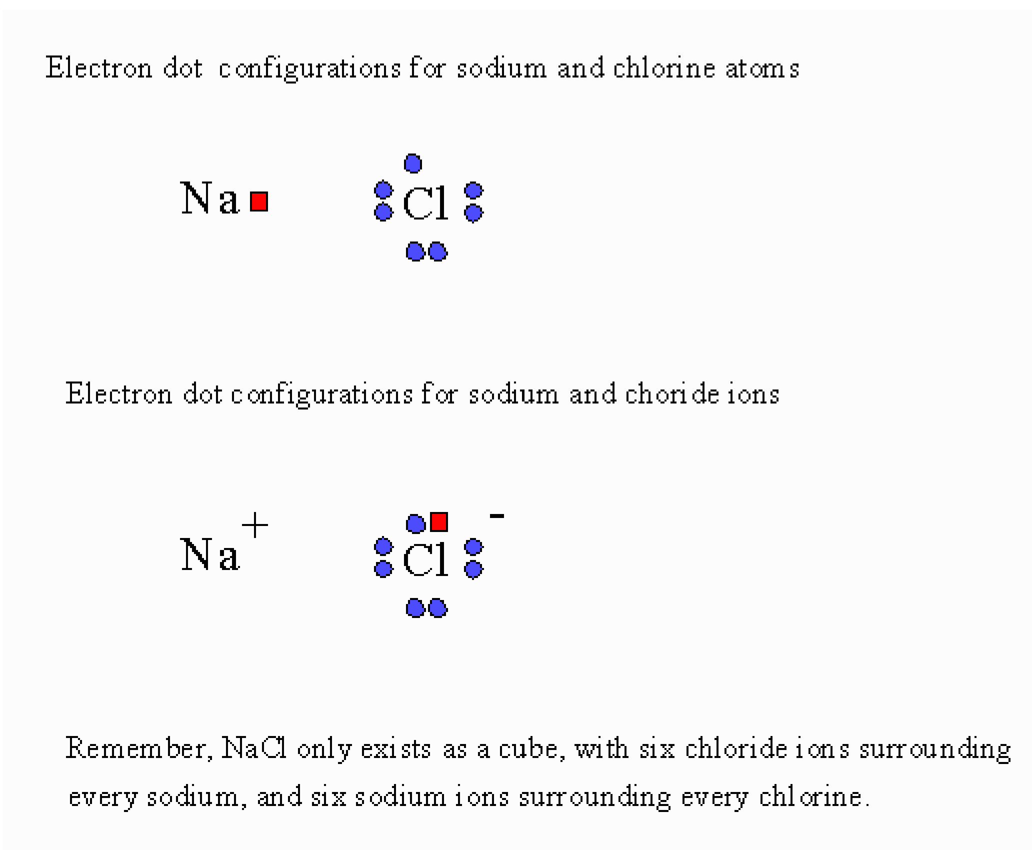
EXPLORE
The purpose of the next two activities is to allow students to explore how chemical bonding occurs as they apply previous knowledge of charges.

EXPLAIN
Students will demonstrate understanding by explaining the different types of bonds to their peers with dot diagrams.

Ionic Bonding
Start by asking students what they know about opposite charges. They should remember that they attract. This represents an ionic bond, which is electrostatic, in an ionic compound.

Have students predict the types of elements that will combine to form ionic bonds.
(metal & nonmetal)

Have students draw electron dot diagrams to represent an ionic bond.



http://wwwchem.csustan.edu/chem3070/images/nacl.gif

Covalent Bonding

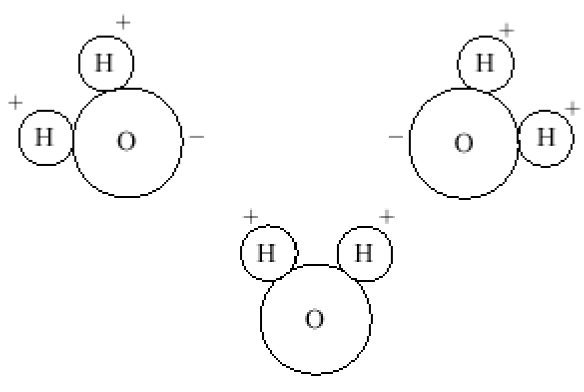
Next model a covalent bond using the hydrogen molecule. Again refer students to the Periodic Table to find the number of valence electrons for hydrogen and have two students go to opposite sides of the room to model these. Since hydrogen just has the first energy level, remind students that it is full with only two electrons. When you ask the easiest way to combine electrons to fill the energy level, they should see that it is just as easy to move one as the other. When this happens, the electrons are not transferred, but are shared.

H. .H = H:H H_2

You can include other diatomic gases here as examples of nonpolar covalent bonds with equal sharing of valence electrons.

Use the water molecule as an example of a polar covalent bond where electrons are unequally shared. This forms a dipole or polar molecule.

Water shows particularly good examples of polar covalent bonds. The oxygen nucleus has stronger attraction for electrons than hydrogen. Note the negative charge on the oxygen end of the molecule as its nucleus attracts the hydrogen electrons, but does not completely pull them away. As a result, the positive hydrogen nuclei “stick out” on the other side, thus the tem “dipole”.

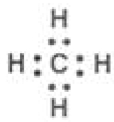


http://abbysenior.com/biology/cell_c5.gif

Have students predict what type of elements form covalent bonds. (Be sure to note that covalent bonds contain only nonmetals).

Another visual that can be used to understand the formation of covalent bonds is the electron dot diagram. For example, show the carbon with four unpaired electrons and the hydrogen with one unpaired electron. It is easy to look at this

and see that four hydrogen atoms will be needed to complete the valence level of carbon.



http://www.chemcool.com/regents/chemicalbonding/aim3_files/image002.jpg

Metallic Bonding
Choose a metal that has just one valence electron such as silver. Using the students as valence electrons, show that each valence electron is lost from one atom forming a positive one ion. This positive ion then attracts a valence electron from another atom, to form another positive ion, and on; the students end up moving around the room. This illustrates how valence electrons of metals form a common electron cloud or sea of electrons.
It is important that students understand the properties of metals that are due to the metallic bond, or sea of electrons, such as conductivity, ductility, and malleability.

ELABORATE
Students demonstrate understanding as they explain bonding to their neighbor; they can write a paragraph, they can make a small booklet or poster, etc.

Have students perform some sort of activity to reinforce what they have learned about chemical bonds. They can turn and explain the types of bonds to their neighbor, they can write a paragraph, they can make a small booklet or poster, etc. With the booklet or poster, have students include all three types of bonds with definitions and examples that show diagrams and names.

EVALUATE
Use the following practice sheet or board review to evaluate knowledge of bonding types.

Bonding Types Practice
Predict the type of bonding present in each of the following: ionic, covalent, or metallic. For covalent bonds, would the bonds be polar or nonpolar?

1. CH_4
2. KBr
3. O_2
4. Ag
5. $CaCl_2$
6. AlF_3

7. Na_2S
8. SiO_2
9. Mn
10. ZnI_2

Key:
1. covalent (polar), 2. ionic, 3. covalent (nonpolar), 4. metallic, 5. ionic, 6. ionic, 7. ionic, 8. covalent (polar), 9. metallic, 10. ionic

Chemical Interactions
Day 3

Objective 6.02 – Investigate and analyze the formation and nomenclature of simple inorganic compounds: ionic bonds (including oxidation numbers), covalent bonds, metallic bonds

Engage
To help students understand how ions combine to form compounds, it is helpful to represent them visually as people represent different types of ions.

Explore
Students explore as they predict and practice writing chemical formulas (Find Your Partner(s) Activity) based on their observations of combinations of people.

Introduce the term binary compound- an element composed of 2 different elements.

Go over what a binary ionic compound will be- ask students to predict what type of elements will combine to form a binary ionic compound (metal & nonmetal).

Find Your Partner(s) Activity

Purpose:
To help students see how elements combine to form binary ionic chemical compounds and to write the formulas for these compounds.

Materials:
Note cards with a variety of ion formulas on them (make sure there are enough “matching” cards to make several different compounds). Note cards can be held or you can use yarn to make them into necklaces.

Give each student a note card. Ask for a volunteer to move to the front of the room and have all others stand on the other side. Ask students to pick another student to “match up” with the student if the front of the room. If they don’t pick someone whose card balances out the other person- lead them to recognize this.

Once they pick a correct ion- have the 2 students stand together- ask the other students why they work and then what the formula would be. For example- one student might have a card with Na^{+1} and another may have a card with Cl^{-1}, once they "match up" students will realize they balance out each other and therefore the formula will be NaCl- one of each.

Next pick a student who has a card with a +2 charge and ask the students to pick out 2 other students to "match up", remind students that there can only be 2 different elements. For example – the first student might be Mg^{+2}- the students can then pick 2 Cl^{-1} or 2 F^{-1}, etc. Have the 3 stand in the front and once again ask if/why the compound is balanced and what the formula would be- they determine this by counting the number of each type of ion- ex. $MgCl_2$.

Repeat until you feel students understand that compounds must be electrically neutral and the subscript is the number of each ion needed to make the compound neutral.

Once students understand that subscripts are used to balance oxidation numbers in order for a compound to be electrically neutral, you can show how to determine the formula for a compound at this point using the "criss-cross" method. Put the ion charge, or oxidation number, for each element as a superscript to the right of the element symbol.

$$Na^{+1}\ Cl^{-1} = NaCl$$

Take the absolute values of the two numbers and switch them to the lower right side of the opposite symbols to become the subscripts in the formula, however, subscripts of one are understood and not shown.
You can follow the same procedure but with another example, maybe magnesium chloride, to show subscripts (other than the understood one) in the chemical formulas.

$$Mg^{+2}\ Cl^{-1} = MgCl_2$$

EXPLAIN

Learning how to name molecular compounds requires the students to learn the prefixes. Students then practice by explaining examples to demonstrate their understanding.

Writing Chemical Formulas-Binary Molecular

Review the term binary with students and then introduce the term molecular compound- a compound composed of two nonmetals.

Review the Greek prefixes with students. (Chart follows.)

Number	Prefix
1	mono-
2	di-
3	tri-
4	tetra-
5	penta-
6	hexa-
7	hepta
8	octa-
9	nona-
10	deca-

Formula-Say out loud “carbon dioxide” and ask student to tell you the formula- they will quickly yell out CO_2-ask student what that means- they might need to see it written at this point- then they should realize that the prefix gives the number of each atom-the subscript.

Continue with several other examples such as sulfur hexafluoride (SF_6), dinitrogen tetrafluoride (N_2F_4)

Naming Binary Molecular Compounds
Review the term binary molecular and the Greek prefixes. Do a couple of formulas for review.

Ask students to predict the name of CO- most will know it- if not, lead them to the answer. Continue with another example such as P_2O_5 or SF_6.

Ask students to come up with a “rule” for naming molecular compounds- most will realize they turn the subscript into the prefix. Make sure that they realize the exception that the prefix mono- is not traditionally used for the first element in the compound—example: CO_2 is carbon dioxide, not monocarbon dioxide.

ELABORATE
For elaboration have students go to a website (such as the one listed below) which describes how to name binary molecular compounds.

http://www.800mainstreet.com/5/0005-0010-naming.htm

ELABORATE
Students elaborate on naming compounds as they practice writing binary molecular formulas and complete a review worksheet on naming compounds and writing binary molecular formulas. This activity follows:

Learning Guide—Molecular Compounds

For each formula given, write the name of the compound. For each compound names given, write the formula.

Formula	***Compound Name***
SO_2	
	Carbon monoxide
N_2O_5	
	Carbon tetrafluoride
SF_2	
	Diphosphorus pentoxide
PCl_5	
	Disulfur dichloride
P_4O_{10}	
	Carbon disulfide

Key:
sulfur dioxide, CO, dinitrogen pentoxide, CF_4, sulfur difluoride, P_2O_5, phosphorus pentachloride, S_2Cl_2, tetraphosphorus decoxide, CS_2

Chemical Interactions
Day 4

Objective 6.02 – Investigate and analyze the formation and nomenclature of simple inorganic compounds: ionic bonds (including oxidation numbers), covalent bonds, metallic bonds

Naming Binary Ionic Compounds

Review what binary ionic compounds are and how to write formulas for binary ionic compounds. Then review naming of ions.

Ask students the name for NaCl- most will know the answers is sodium chloride- if not lead them to this. Ask them to predict the name of CaO using the same format as the name for NaCl.

Explain that ionic compounds are named by giving the names of the individual ions.

EXPLAIN

As students recognize different types of compounds and can write formulas and names for the different types, it is necessary for them to be able to explain how they derive their answers.

Go over several more examples with them to help them understand and to realize that the subscripts are not used in naming.

Examples- $CaCl_2$ (calcium chloride), Al_2S_3 (aluminum sulfide) K_2S (potassium oxide)

EXPLORE
Students need a lot of practice, in pairs or alone, so allow them to explore new examples to ensure they understand compounds.

ELABORATE
Use a practice sheet (provided below) at this point to evaluate and practice writing binary formulas and naming binary compounds.

Binary Formulas Practice
For each formula given, write the name of the compound. For each compound names given, write the formula.

Formula	Compound Name
KI	
	Calcium chloride
Ag_2S	
	Barium bromide
Al_2O_3	
	Magnesium fluoride
NaI	
	Lithium iodide
BaF_2	
	Strontium oxide

Key:
potassium iodide, $CaCl_2$, silver sulfide, $BaBr_2$, aluminum oxide, MgF_2, sodium iodide, LiF, barium fluoride, SrO

EVALUATE
Spot check selected items on the practice sheet.

Ternary Compounds
(Ionic compounds containing at least one polyatomic ion.)

ENGAGE
Engage by referring back to ionic bonding and review the term *ion*. Then ask students what they think a "polyatomic" ion is.

Normally at least one student in each class will know that poly- means "many." A polyatomic ion is made of a *group of (or many) atoms that are covalently bonded*

to form a single ion. Either show students a list of polyatomic ions or refer them to a reference table in the text.

OPTIONAL: Show them that the ion charge is for the entire polyatomic ion, not just the last element.

$(P^{+5}O^{-2}_4)^{-3}$ phosphate

The positive five added to the negative eight (4 X –2) equals a net charge of negative three for the polyatomic ion.

EXPLORE

Give students a combination of a metal and a polyatomic ion and ask them to predict the correct formula of the ternary compound based on what they already know.

(Criss-cross the absolute values of the oxidation numbers.)

K^{+1} OH^{-1} = KOH potassium hydroxide

Mg^{+2} OH^{-1} = $Mg(OH)_2$ magnesium hydroxide

Make sure students understand the need for the parenthesis with a polyatomic ion that requires a subscript. Without the parenthesis, it looks as if you would have just one oxygen atom and two hydrogen atoms instead of two hydroxide ions. If they have not realized it yet, be sure to point out that the subscript outside the parenthesis multiplies everything inside the parenthesis. In practice, you may find it helpful to always include the parenthesis, but then drop it if no additional subscript is needed outside the parenthesis.

EXPLAIN

Give students a formula of a ternary compound and ask them to predict and explain the name based on how they named binary ionic compounds. For example:

$Al_2(SO_4)_3$- Aluminum sulfate.

Be sure to emphasize that they do not change the ending of the Polyatomic Ion.

ELABORATE

Do several more for practice. Use a practice sheet at this point to elaborate and to practice writing ternary formulas and naming ternary compounds. This practice sheet follows:

PRACTICE Sheet: Ternary Compounds

For each formula given, write the name of the compound. For each compound names given, write the formula.

Formula	Compound Name
NH_4F	
	Barium hydroxide
Na_2SO_4	
	Lithium acetate
$KMnO_4$	
	Calcium carbonate
Al_3PO_4	
	Magnesium chlorate
$(NH_4)_2CrO_4$	
	Strontium nitrate

Key:
Ammonium fluoride, $Ba(OH)_2$, sodium sulfate, $LiC_2H_3O_2$, potassium permanganate, $CaCO_3$, aluminum phosphate, $Mg(ClO_3)_2$, ammonium chromate, $Sr(NO_3)_2$

Chemical Interactions
Day 5-Review

Objective 6.02 – Investigate and analyze the formation and nomenclature of simple inorganic compounds: ionic bonds (including oxidation numbers), covalent bonds, metallic bonds

EVALUATE

Have students construct a summary foldable including identifying bonds, naming and writing formulas and names of: ions, binary compounds and compounds with polyatomic ions.

Day 6

6.03 Identify the reactants and products of chemical reactions and balance simple equations of various types:

- Single replacement.
- Double replacement.
- Decomposition.
- Synthesis.

Essential Question: What are chemical reactions?

ENGAGE

This lab (Candy Chemistry) engages students by helping them visualize what happens in a chemical reaction as they manipulate soft candies to form to separate from “molecules”.

Candy Chemistry

This lab is used to help students visualize what happens in a chemical reaction as well as to introduce and explain chemical equations. (It can also be used to reinforce dot-diagrams and to introduce the Law of Conservation of Matter.) Depending on the level of your students, you can represent one or more equations together or you can give the unbalanced equations and ask the students to find a way to use the materials to represent the equations.

Safety: Instruct students to be careful using toothpicks.

Materials: toothpicks, soft candies of different colors that you can stick toothpicks into to represent atoms and bonds.

Choose any chemical equations that you feel your students can represent. For example, the following three equations might be used:

$$2H_2 + O_2 \rightarrow 2H_2O$$

$$3H_2 + N_2 \rightarrow 2NH_3$$

$$4Al + 3O_2 \rightarrow 2Al_2O_3$$

DO NOT GIVE THE STUDENTS THE BALANCED EQUATIONS AS THIS DEFEATS THE PURPOSE!!

The balanced equations are given here so that you can select the numbers and colors of candy pieces needed.

Based on the equations above, each group will need:

- 4 pieces of one type or color of candy – aluminum
- 6 pieces of another type or color of candy – oxygen
- 6 pieces of another type or color of candy – hydrogen
- 2 pieces of another type or color of candy – nitrogen

As an example, you could represent the $2H_2 + O_2 \rightarrow 2H_2O$ equation together.

When the students are given toothpicks and the candy list above, ask them how they can make a model of H_2, a hydrogen molecule. For example, if purple jelly

beans are listed as hydrogen, they should understand that putting two purple jelly beans together with a toothpick makes one H_2. Then ask students to make a model of O_2, an oxygen molecule, using the color of candy indicated. Next ask students for the chemical formula of water. (H_2O) Students should remember that this means one water molecule is made of two atoms of hydrogen and one atom of oxygen.

Ask the students how they can use the models they just made to make a model of H_2O. They will most likely see that they have to take the first two apart and rearrange them to make one H_2O. If they did not mention the fact that they had to use energy to take the models apart and then again to put the H_2O together, be sure to add this. By now they will have noticed that they have one piece of candy representing one oxygen atom left over. (If not, ask questions about this.)

Use this as an introduction to the concept of balancing. For example, how can this oxygen atom become part of a water molecule just as the other one did? This can only happen if another hydrogen molecule is present, so have the students make another H_2. Once this is done, students use more energy to break the old bonds and to make another H_2O molecule.

Go back over this together, possibly having the students start over with two H_2 molecules and one O_2 molecule this time. Point out that these are “reactants” in a chemical change (reaction) because they react with each other, and that chemical equations are used to represent chemical reactions. Have them write the reactants on their paper with an addition sign in between. You could also have a student come up and write this on the board or whiteboard. Be sure to put a coefficient of **2** in front of the H_2 to show that two molecules were used. (This could be a good time to explain the difference between the coefficient and the subscript.) Now have the students take the molecules apart. Don’t forget to explain that this action is shown as an arrow (yields) in the equation. Next have the students put the “atoms” of hydrogen and oxygen together as two water molecules, **2**H_2O. These molecules are produced so they are shown on the right side of the equation as “products.” Again, ask a student to show this in the equation on the board.

Remind students that subscripts in a given formula cannot be changed, so coefficients are needed to make sure that all the atoms that react together are used in the products. This is where you talk about the equation being “balanced” because atoms that are in the reactants cannot be destroyed and that atoms in the products cannot be created from nothing – the Law of Conservation if Matter. To reinforce dot-diagrams you could have the students draw these to represent the reactions as well.

EXPLORE

The students should explore and proceed with the other two equations above.

You can have students write the equations and draw dot-diagrams and/or pictures on paper and check them as a grade.

ELABORATE

Balancing equations is an important concept that is a true hands-on, one-at-a-time practice. Allowing students to elaborate on the concept of the conservation of matter with balancing equations is crucial.

EXPLAIN

As students work in pairs they demonstrate their understanding by explaining to each other.

An internet site which includes "Balancing Activity," "Balancing Equations," "Reaction Types," worksheets, video clip, labs, and links was http://www.nclark.net/ChemicalReactions

Other sites found were:
http://richardbowles.tripod.com/chemistry/balance.htm#part1
http://dbhs.wvusd.k12.ca.us/webdocs/Equations/Balance-Equation.html
http://www.middleschoolscience.com/balance.html

Chemical Interactions
Day 7

6.03 Identify the reactants and products of chemical reactions and balance simple equations of various types:

- Single replacement.
- Double replacement.
- Decomposition.
- Synthesis.

ENGAGE

Engage students by reviewing chemical changes and reviewing the concept that chemical changes are the result of chemical reactions.

Explain to students that chemical equations are shorthand ways to represent a chemical reaction.

Write a chemical equation on the board and help students differentiate between and identify reactants and products. Do several examples until students can quickly identify the reactants and products.

Review the law of conservation of matter and why/how this law applies to chemical equations (there must be the same types and numbers of atoms on both sides).
Remind students that all chemical equations must be balanced to satisfy the law of conservation of Mass.
Review/explain the terms subscript and coefficient and show students how to count number of atoms in a compound before you start actually balancing. Do as many as needed to reinforce the concept.

Example- $CaCl_2$- calcium-1, chlorine-2
Al_2O_3- aluminum-2 oxygen-3
$Mg(OH)_2$-magnesium-1, oxygen-2, hydrogen-2
2 K_2SO_4- potassium-4, sulfur-2, oxygen-8

Write a simple equation on the board and help students count atoms on each side and then ask if it is balanced and if not, how they can balance it. Make sure they understand that only coefficients, not subscripts, can be added/changed to change the number of atoms and that coefficients can only be placed in FRONT of an element or compound. Do several examples of incorrectly placed coefficients to make sure they understand. When you first start balancing, place a blank in front of each element or compound to help students realize that this is the only place where coefficients may be added or changed.

Help students balance the equation.
Ex. ____Ca + ____Cl_2 -→ __CaCl

1) Determine types and number of atoms on each side

Ca-1	Ca-1
Cl-2	Cl-1-

2) If the numbers are equal- it is balanced, if not use coefficients to balance, make sure students change all atoms affected by adding a coefficient. Ask if balanced- if so stop, if not add/change coefficient(s).
____Ca + ____Cl_2 -→ _2_CaCl

Ca-1	Ca-2
Cl-2	Cl-2

3) Ask if balanced- if so stop, if not add/change coefficient(s). repeat until balanced.

__2__Ca + ____Cl_2 -→ _2_CaCl

Ca-2	Ca-2
Cl-2	Cl-2

Do several more examples on the board (or whatever you use) with the students. Then give them practice as needed.

Chemical Reactions
Day 8

6.03 Identify the reactants and products of chemical reactions and balance simple equations of various types:

- Single replacement.
- Double replacement.
- Decomposition.
- Synthesis.

EXPLORE:
This activity (The Nuts and Bolts of Chemical Reactions- Reaction Types) provides students the opportunity to visually explore how elements combine to form compounds. The visual experience will help explain how only certain elements can combine to form compounds as well. It is also used to give students a way to visualize the four main types of chemical reactions: synthesis, decomposition, single replacement, and double replacement. Students use bolts, nuts, washers, etc. to show reactants and/or products for the various reaction types.

The Nuts and Bolts of Chemical Reactions (Reaction Types)

Materials: an assortment of bolts (maybe 2 inches), nuts, washers, lock washers, wing nuts of the same diameter; paper for addition signs and arrows

Have students clear their tables. First students should draw 2 addition signs and 1 arrow on the paper and cut them out. Have them take one bolt, element B, and place it to the very left of the table. Next have them put down an addition sign followed by two nuts, element N, and the arrow. Point out to students that the substances to the left of the arrow are called reactants because they react together. In this case the reactants are B and N_2. Have the students write "$B + N_2 \rightarrow$ on a sheet of paper. Now have the students put the nuts on the bolt so that they have one unit of BN_2. Write BN_2 on the right of the arrow. Substances on the right of the arrow are called products because they are produced. This represents a chemical reaction which happens to be a synthesis because just one product is formed. The general form for a synthesis reaction is $A + B \rightarrow AB$, where the one product is more complex than any of the reactants on the left.

EXPLAIN
Use the same idea to model decomposition, single replacement, and double replacement reactions and have the students explain to each other and/or the class why they represent the different types.

ELABORATE
This quick activity (Dancing Partners) will provide elaboration as students “see” what elements do when they react as they separate or move to different partners. It will also help them visualize the four main types of reactions.

Dancing Partners

This quick activity will help students “see” what elements do when they react and will help them visualize the 4 main types of reactions.
Ask for a boy and a girl to move to the front of the room and stand several meters apart. Ask your students what would happen if one was positive and the other was negative (or if they had a crush on each other). They will realize that the 2 will come together and form a couple- a compound. This represents a synthesis reaction.

Ask for a boy & girl to come to the front of the room and have them form a compound by linking arms. Ask your students what would happen if they no longer “liked” each other- they will reply- they breakup, so have them “ breakup” or decompose.

Pick one girl and then a girl-boy couple and have them move to the front of the room. Have the couple link arms. Ask your students what would happen if the single girl was more “active” than the girl in the couple. They should realize that she would “replace” the other girl and link arms with the boy. This represents a single replacement reaction (the single person could also be a boy).

Ask for 2 boys and 2 girls to move up front and have 2 couples form to represent 2 compounds. Pick one student form one of the couples and ask them to “ replace” a student in the 2nd couple- have your students tell the student whom to replace, they should realize, once again, that like replaces like. This represents double replacement reaction.

Chemical Interactions
Day 9

6.03 Identify the reactants and products of chemical reactions and balance simple equations of various types:
- Single replacement.

- Double replacement.
- Decomposition.
- Synthesis.

EVALUATE

This day should be spent reviewing balancing and identifying types of reactions as you evaluate mastery. If you have Internet access for your students, you can use the resources listed below. If Internet is not available, print off copies of equations and have pairs or groups of students balance and identify the equations in a type of relay race activity.

For balancing chemical equations activities, worksheets, reaction types, puzzles, "Cartoon Chemistry" worksheets, etc
http://www.nclark.net/ChemicalReactions

For a Balancing Chemical Equation Activity use the following website

http://www.middleschoolscience

For Balancing Equations
http://funbasedlearning.com/chemistry/chemBalancer/default.htm

http://funbasedlearning.com/chemistry/chembalancer/worksheet.htm

Chemical Interactions
Day 10

6.03 Identify the reactants and products of chemical reactions and balance simple equations of various types:

- Single replacement.
- Double replacement.
- Decomposition.
- Synthesis.

ENGAGE:

Have students get in groups of two or three and develop a “Brady Bunch” diagram for the reaction types. This type of diagram is a 3x3 matrix (like the opening of the TV show “The Brady Bunch”). In the center block, the title “Reaction Types” should appear. In the surrounding blocks, the four reaction types alternate with visuals of the types.

Note: A good thing to use for this is the free book covers that companies often send to schools—one side is usually blank. Chart paper works…as does plain 8.5x11 paper—the size is up to you.

Once the diagram is made, each group should explain their diagram to another group in the class. This can be done more than once to reinforce concepts.

Revisit this after the EXPLAIN portion.

EXPLORE:
The purpose of this lab is to study and explore single replacement and double replacement reactions.

Part A- Single Replacement Reactions

In nature, elements can occur either free or in a compound. The tendency of as particular element to combine with other substances is a measure of the ACTVITY of the element. In a single replacement reaction, an uncombined element replaces a less active element that is combined in a chemical compound. The less active element is then freed.

For example, in the reaction

Zinc + Copper Sulfate ---→ Zinc Sulfate + Copper,

Zinc replaces the less active copper. In part A of this investigation you will observe how various metals undergo single replacement reactions when placed in an acid. If the metal is more active than the hydrogen in the acid, it will replace the hydrogen and hydrogen gas will be released.

Part B- Double Replacement Reactions

In a double replacement reaction, a clear solution of an ionic compound is added to a clear solution of another ionic compound. The positive ions of one compounds reacts with the negative ions of the other compound to form a Precipitate, a gas, or water. A precipitate is an insoluble solid.

Types of Reactions: Background Information

Targeted *Standard Course of Study* Goals and Objectives

GOAL 1: The learner will develop abilities necessary to do and understand scientific inquiry.

1.02 Design and conduct scientific investigations to answer questions about the physical world.

- Create testable hypotheses.

- Identify variables.
- Use a control or comparison group when appropriate.
- Select and use appropriate measurement tools.
- Collect and record data.
- Analyze and interpret data.
- Communicate findings.

1.05 Analyze reports of scientific investigations of physical phenomena from an informed scientifically literate viewpoint including considerations of:

- Appropriate sample.
- Adequacy of experimental controls.
- Replication of findings.
- Alternative interpretations of the data.

GOAL 6: The learner will build an understanding of regularities in chemistry.

6.03 Identify the reactants and products of chemical reactions and balance simple equations of various types:

- Single replacement.
- Double replacement.
- Decomposition.
- Synthesis.

Notes to Teacher:

Introduction to the Teacher

Clear well plates work best. It is helpful to place plates over black paper to better see bubbles. You will need to give students either the formulas for the compounds or the charges of the transition metals in order for them to write the balanced chemical reactions. Fe +3, Cu +2, Zn +2, Ag +1

Safety Considerations

Students should wear goggles because students will be working with HCl, Make sure disposal of materials is done correctly.

References

This activity was adapted from *Exploring Physical Science- Prentice Hall* and was modified by Tammy Schooley (East Carteret High School, Beaufort, NC).

Types of Reactions: Laboratory

Purpose
To study and explore single replacement and double replacement reactions.

Materials
- Safety goggles
- Well plate
- Iron
- Zinc
- Copper
- Magnesium
- Aluminum
- HCl
- Silver (I) nitrate
- Potassium iodide
- Distilled water
- Graduated cylinder
- 2 cups or beakers

Introduction to Student

Part A- Single Replacement Reactions
In nature, elements can occur either free or in a compound. The tendency of as particular element to combine with other substances is a measure of the ACTVITY of the element. In a single replacement reaction, an uncombined element replaces a less active element that is combined in a chemical compound. The less active element is then freed.

For example, in the reaction

Zinc + Copper Sulfate ---→ Zinc Sulfate + Copper,

Zinc replaces the less active copper. In part A of this investigation you will observe how various metals undergo single replacement reactions when placed in an acid. If the metal is more active than the hydrogen in the acid, it will replace the hydrogen and hydrogen gas will be released.

Part B- Double Replacement Reactions

In a double replacement reaction, a clear solution of an ionic compound is added to a clear solution of another ionic compound. The positive ions of one compounds reacts with the negative ions of the other compound to form a Precipitate, a gas, or water. A precipitate is an insoluble solid.

Procedure

Part A Part 1

1. Label 5 wells on the well plate. Place 1 piece of magnesium in well 1, aluminum in 2, iron in 3, copper in 4 and zinc in 5.
2. Using the pipette, add 2 drops of HCl to each well. Observe the color of the liquid at time zero. Observe what happens for 3 minutes. Look for bubbles. Record observations
3. Carefully pour the HCl into the waste beaker and then place the metals in the metal container. Rinse the well plate.

Part A Part 2

1. Place a piece of copper in well 1.
2. Place 3 drops of Silver (I) nitrate on the copper. Observe for 3 minutes.

Part B

1. Pour 50 ml of distilled water into cup A and into cup B.
2. Add substance A to cup A. Stir until dissolved.
3. Add substance B to cup B. Stir until dissolved.
4. Pour A into B. Observe. Stir it and observe.

Lab Data

Part A Part 1

	Magnesium	Aluminum	Iron	Copper	Zinc
Reaction					

Questions to Guide Analysis

Part A- Part 1

1. Write the single replacement reaction for each reaction
   a. Magnesium

   b. Aluminum

   c. Iron

   d. Copper

   e. Zinc

2. Which of the metals are more active than hydrogen? Less active?

3. The rate of hydrogen gas production is an indication of the relative reactivity of metals. List the metals in order of their activity from most active to least active.

4. Nonmetals can also be involved in single-replacement reactions. If chlorine is more active than bromine, write the equation for the reaction between chlorine and potassium bromide.

Part A- Part 2

1. Identify the color of the copper at the beginning of the experiment. What color is the liquid?

2. Identify the color of the solid after several minutes. Identify the color of the solid after several minutes.

3. Describe what happened to cause the color changes.

4. Are the substances in the well the same as the starting substances? Explain.

5. Write the equation for the reaction that took place.

ELABORATE:

Part B

1. What happened when you mixed A with water?

2. What happened when you mixed B with water?

3. What happened when you mixed A and B together?

4. What ions were present in the potassium iodide solution?

5. Write the equation for the reactions that took place.

EXPLAIN:
Instruct students to explain their answers to the class.

Students should then get back into their groups from earlier in class and revisit the "Brady Bunch" diagrams with emphasis on single and double replacement reactions. They may revise or add to the diagrams from earlier. Have them explain to another group, just like before.

EVALUATE:
Provide the following examples (Reaction Practice- Single & Double Replacement) of single and double replacement equations. Ask students to balance the equation (if necessary) and classify them appropriately as single or double replacement.
Optional: Are the single replacement reactions anionic or cationic ? (It is determined by what part of the compound is replaced, the anion or the cation.)

Reaction Practice- Single & Double Replacement

Directions: Balance the equations (if necessary) and classify as single or double replacement.

1) $Al + CuCl_2 \text{ ---> } Cu + AlCl_3$

2) $Br_2 + CaI_2 \text{ ---> } I_2 + CaBr_2$

3) $AgNO_3 + KCl \text{ ---> } AgCl + KNO_3$

4) $Al_2(SO_4)_3 + Ca_3(PO_4)_2 \text{ ---> } AlPO_4 + CaSO_4$

5) $Cl_2 + NaI \text{ ---> } I_2 + NaCl$

6) $AgC_2H_3O_2 + K_2CrO_4 \text{ ---> } Ag_2CrO_4 + KC_2H_3O_2$

7) $Al + HCl \text{ ---> } AlCl_3 + H_2$

8) $Mg + HCl \text{ ---> } MgCl_2 + H_2$

9) $Cl_2 + MgI_2 \text{ ---> } I_2 + MgCl_2$

10) $K_2CO_3 + BaCl_2 \text{ ---> } KCl + BaCO_3$

Key: Coefficients/Reaction Type

1. 2,3,3,2 single (cationic)
2. 1,1,1,1 single (anionic)
3. 1,1,1,1 double
4. 1,1,2,3 double
5. 1,2,1,2 single (anionic)
6. 2,1,1,2 double
7. 2,6,2,3 single (cationic)
8. 1,2,1,1 single (cationic)
9. 1,1,1,1 single (anionic)
10. 1,1,2,2 double

Chemical Interactions
Day 11

6.04 Measure and analyze the indicators of chemical change including:
- Development of a gas.
- Formation of a precipitate.
- Release/absorption of energy (heat or light).

ENGAGE
This activity (Fizzie Lab) is designed to engage students by having them examine the physical and chemical natures of various chemicals.

Teacher Notes: For both Parts I and II of this lab, be careful with the matches and hazards and safety issues always present with fire. Make sure loose clothing and hair is tied back as well as use safety glasses or goggles. This is a great lab activity to illustrate endothermic and exothermic changes as well as chemical changes in matter. It is very inexpensive to perform and the students get really excited with the results after they observe no changes occur with the original chemicals with water, save the exothermic change with the water and calcium chloride.

Safety: goggles, closed shoes, fire, MSDS for chemicals

Fizzie Lab

Teacher Notes: This is a lab that can have one or two parts, depending upon how much detail you want your students to go into. It is a variation of a popular lab found online, with a few added twists. Craft sticks work really well as stirring rods, are cheap and do not break when dropped. The disposable (plastic) Petri dishes are also great for this type of lab. The calcium chloride is anhydrous so do not leave it out for a long period of time as it will attract the water vapor in the air. It does not matter whether the $CaCl_2$ is in pellet or flake form. However, the flake form works best for observation by students.

Materials: baking soda, calcium chloride, water, Petri dishes (plastic), stirring rods, paper towels, matches and wooden splints or safety matches

Procedure: To prep for this lab, you need to add similar amounts of baking soda and calcium chloride each to individual Petri dishes. Have students make observations regarding the physical properties and characteristics of each chemical, recording this in their notebooks. This is a great method of reinforcing these concepts in the minds of your students. Have them note the differences in the whiteness of each substance as well as the touch of each. The flaked $CaCl_2$ will have a smooth feel, similar to talcum powder while the baking soda has a gritty texture. Extend this observation by having students observe the substances under a magnifying glass or even setting up a microscope to observe them both. (Optional) Have students check the Petri dishes for the temperature, both of which should be at room temperature. Once they have noted

these physical properties, have students add the same amounts of water to each substance in the Petri dishes. Observations should be made regarding the rate of dissolving of each substance in the water. At this point, have the students check the bottoms of the Petri dishes for any temperature change. As the water is added, students will be able to note an increase in the temperature of the $CaCl_2$ (exothermic) with water while the baking soda with water stays at room temperature. They will also note that the baking soda is dissolving in the water which is a physical change. Be sure to remind students that changes in state are physical changes, not chemical changes.

EXPLORE

This lab is also designed to allow exploration by having students make observations of chemical reactions and perform gas tests.

Once they have completed this portion of the lab and have recorded their observations, students should place similar amounts (as in the first part) of baking soda and calcium chloride in one Petri dish and then add water to these combined substances. Once the two substances are completely mixed with the water, have students observe the results. Fizzing and bubbling occurs, which is and indication of a chemical change. This is not the only indication of chemical change. Have students touch the bottom of the Petri dish as this change is happening. The temperature has dropped, which indicates an endothermic reaction. Students then can combine baking soda and $CaCl_2$ in water and conduct a flame test. Light the safety matches or the splints and test the gases given off to determine what type of gas is being produced in this reaction. If the flame is extinguished, CO_2 is produced. If the flame continues to burn, O_2 or H_2 is produced. If you wish to have them complete the second part of this lab, have students label their Petri dishes with their names for use in Part II.

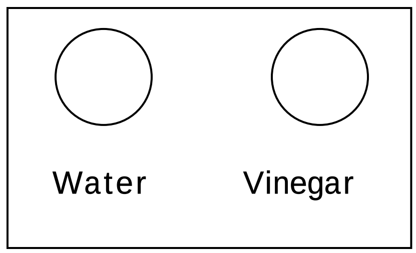
1. Fizzie Lab Part II (OPTIONAL)

Safety: goggles, closed shoes, fire, MSDS for chemicals

Materials: Petri dishes with new compounds form Part I, water, vinegar, stirring rods or sticks, paper towels, matches and wooden splints or safety matches

Once the students have thoroughly mixed the baking soda and calcium chloride in Part I, they can leave their Petri dishes with the resulting new compounds out to allow the water to evaporate off. This may take a week or more, depending upon the temperature of your classroom and the time of year (heat versus air conditioning). Once the new compounds in the Petri dishes have completely dried out, you will notice the formation of a powdery white substance (calcium carbonate) and a crystalline structure that may or may not be cubic, sodium chloride. Once these two substances have dried out, you can begin Part II of the Fizzie lab.

Have students, who have labeled their Petri dishes, take the two Petri dishes and observe the two different substances for physical properties. Have the feel the texture of these substances as well as using a magnifying glass or microscope as in Part I. Students should note the differences in each of these two substances, as a chemical change occurred resulting in new substances with new physical and chemical properties. Once students have observed and recorded the physical properties of the two compounds, have them scrape the dried substances out of the Petri dishes using their craft or “stirring” sticks. They should divide the two solids in two equal portions evenly divided between the two Petri dishes. Place the Petri dishes on a paper towel, and write “water” on the bottom of one side and write “vinegar” on the bottom of the other side of the towel. See below.



Students then add water to the one Petri dish with the mix of solids and the same amount of vinegar to the other Petri dish with the mix of solids. They should record the results in their notebooks. The dish with the water added just dissolves while the fizzing and bubbling that is indicative of a chemical change occurs in the second Petri dish. Additionally, students can do a flame test on the Petri dish that has the gases produced to determine whether CO_2 or H_2 or O_2 is being produced.

Chemical Interactions

Day 12

6.04 Measure and analyze the indicators of chemical change including:
- Development of a gas.
- Formation of a precipitate.
- Release/absorption of energy (heat or light).

<u>EXPLAIN</u>

Review the indicators of chemical change given in the Fizzie Lab by asking students to list indicators and explain their use to their peers.

Specifically review the terms endothermic and exothermic. Ask students how they can graphically represent the difference in energy between the reactants and the products for each.

Introduce the term *precipitate* as another indicator of chemical change, and either do a demonstration of the reaction or show the video from the following website:

http://www.nitrogenorder.org/experiment/dblreplace.shtml

We suggest this route due to safety issues involved in the use of chemicals routinely used to demonstrate precipitate formation.

In class discussion, be sure to point out that “bubbles” do not necessarily indicate a chemical change. Ex: bubbles in boiling water

ELABORATE

Have students read the corresponding section from the text. Have them make a chart listing 4-5 things that indicate physical and chemical changes and give examples.

EVALUATE

Make a combined chart on the board listing every example the students give and then discuss any misconceptions.

Chemical Interactions
Day 13

6.05 Investigate and analyze the properties and composition of solutions:

- Solubility curves.
- Concentration.
- Polarity.
- pH scale.
- Electrical conductivity.

ENGAGE

This activity engages students by giving them a visual example of a solution and its parts.

To introduce the concept of solutions, have two beakers of water as well as some salt and sand. Pour some salt into beaker 1 and sand into beaker 2. Have the students observe. (They may do this orally or on paper to compile and discuss later.) Then stir both beakers and have students observe again. Compile student observations on whatever type of board you use. As you discuss the observations, students should have noticed that that the salt is no longer visible but the sand is; some may be familiar with the terminology and say that the salt dissolved and the sand did not.

Once you have established that the salt dissolved (not "melted" as some may say), be sure to point out that you still have the same two original substances, salt and water. Ask which part of the solution was present in the larger amount (water). Ask which part causes the other to dissolve (water). Tell students that this is the solvent.

When you ask about the substance in the smaller amount and which is dissolved in the other, they recognize this as the salt. This substance is the solute. The type of solution is liquid since the solvent is liquid

Be sure to distinguish the solution as a homogeneous mixture as opposed to a heterogeneous mixture like the sand in water.

Move on to talk about other types of solutions (gaseous and solid). You can start out by having students brainstorm other types of solutions they can think of. If they don't give either of these two types, lead them in this direction by asking "What about stainless steel (or brass, or bronze)? Is this a solution?" You may need to review the differences between mixtures and compounds. In the case of the examples above, they are all solid solutions (alloys in this case) because the solvent is solid at room temperature. Then ask students to think of gaseous solutions. Air is a good example to give, and you can talk about the relative percentages of the gases in air, with nitrogen being the solvent at about 79%. Also, water vapor dissolves in air (humidity).

Essential Question: What is polarity?

<u>EXPLORE</u>

The use of this activity (Coffee Filter Lab) will enable students to examine why substances dissolve at different rates, and it will allow them to explore aspects of solubility at a basic level and to use their creativity to integrate art into science.

Coffee Filter Lab

Materials: Coffee filters (2 - 6 for each student), crayons, water soluble makers, water, Petri dishes

Give each student 2 coffee filters, 1 crayon , 1 marker, 2 Petri dishes and a cup of water. The marker and crayon should be different colors and the marker should not be black. Have students draw a circle about an inch form the outside edge of the filter with their marker. Then have them write their name with the crayon in the center of the filter. The filter should then be folded in half and folded in half once more (quartered). The students should then place the filter in the Petri dish which is filled half full of water. The filter will stand on its own if you lace its edge so that the filter resembles a cone.

While this filter is absorbing the water, you should have students prepare the next filter, only this time swap the maker and crayon. The circle around the edge should be drawn with the crayon and their name should be written in marker.

However, be careful to allow students to observe the movement of water up the filter as it dissolves the marker ink and carries it up the filter. Have students note the speed with which the ink moves upward. They will then observe that the crayon is not dissolving in the water. Students then can observe that the marker ink is again dissolving but not the crayon on the second filter.

At this point, ask students about how paints are cleaned up (water based in soap and water, oil based in petroleum based products such as paint thinner). They will generally be aware of this and it helps relate “like dissolves like” to their life experiences.

You can introduce polarity to them at this point as well and let them derive how anything that is water based will “dissolve” anything lese that is water based. They will also have prior knowledge that oils and petroleum based products will not mix with water. Introduce the idea that these are nonpolar substances.

A fun extension for students is to have them create their own artwork using the water soluble markers and crayons. It is a good activity for them to explore how different inks will also dissolve at different rates. You can introduce chromatography to them as well. It also allows them to experience some creativity in science as well.

Chemical Interactions
Day 14
6.05 Investigate and analyze the properties and composition of solutions:
- Solubility curves.
- Concentration.
- Polarity.
- pH scale.
- Electrical conductivity.

ENGAGE:
After reviewing what the term “rate” means, have students think about what happens when they put a piece of hard candy in their mouth and don’t chew it versus what happens when they do chew it and break it into smaller pieces. Ask them to tell what happens and to explain why. Then ask them to think of some other things that might cause a solid to dissolve in a liquid more quickly. Most students will answer with crushing, breaking, temperature, stirring, etc.

EXPLORE:
The activity (Rate of Solution Lab) on rate of solution gives students the opportunity to explore what factors affect the rate at which a solute dissolves in a solvent.

Materials: beakers (or clear plastic cups), sugar granules, sugar cubes, stirring rods, hot plate, stopwatch

Safety: Goggles, heat

Ask students to design a way to test the answers they thought of using sugar as the solute and water as the solvent.

Before they test their ideas, help them determine what constants they should use (amount of each, etc.), what the control will be, and what the independent and dependent variables will be.

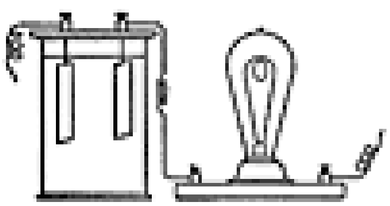
Have students test their ideas, develop a data table, and write a conclusion explaining what happened.

EXPLORE

Students will explore yet another characteristic of solutions – conductivity.

The purpose of this demonstration (Let There Be Light) is to show that some solutions conduct a current (electrolytic) and some do not (nonelectrolytic).

Materials: electrical conductivity apparatus, beakers, water, various materials to test in solution (ex: salt, sugar, baking soda, vinegar, dilute hydrochloric acid), water, stirring rods, paper towels



Before beginning the demonstration, show students that the apparatus is not designed to conduct electricity (to light the bulb) as soon as you plug it into the outlet. Review that electricity is a flow of electric charge (electrons, not protons). You can also remind them that the metallic bond with its 'sea of electrons" allow electricity to move through easily.

Have students make a data table or make one together and put on your whiteboard. Instruct students to record observations as you proceed.

First, test the apparatus with plain water. They may be surprised to see that the bulb does not come on when the apparatus is plugged in. Regardless of their reactions, have them record the results in the table. Continue with the different beakers, making different solutions to test each time. (Be sure to rinse the electrodes with plain water between each trial. Talk with the class about this and ask them why this is needed. Hopefully, they will remember form the beginning of the course that you do not need to mix chemicals as this introduces too many variables for one valid trial.)

After you have tested all materials, ask students why some solutions conducted electricity while others did not. Since they do know that electricity is the flow of electrons, they may infer that the solutions which cause the light to come on have charges in them, while those that do not cause the light to come on do not.
At this point introduce the terms electrolyte (electrolytic solution) and nonelectrolyte (nonelectrolytic solution).

When you ask students why some substances are electrolytes (conduct current in solution) and some are not, they may remember the different types of bonds and that come compounds are made of charges while others are not.
Go back to your results for the activity and ask the students to predict the types of compounds that were tested. Give the formulas if you listed only the common names earlier. (Review of molecular and ionic compounds with covalent and ionic bonds.)

Introduce the following terms: *dissociation, dispersion,* and *ionization*. Have students find the terms in the appropriate section of the text. Based on what they have just read and the types of compounds that were identified, have the students tell which substances they think underwent which process.

Salt (NaCl), sugar ($C_6H_{12}O_6$), baking soda($NaHCO_3$), vinegar (CH_3COOH), hydrochloric acid (HCl)

Dissociation (ionic compounds separate into ions; conduct) – salt, baking soda, vinegar
Dispersion (molecular compounds separate into molecules; conduct) – sugar
Ionization (molecular compounds that form ions; conduct) – hydrochloric acid
(Review ions and molecules if needed.)

Ask students why the light was brighter for some substances than for others (more ions present).

Have pairs of students discuss and list general conclusions they can make form this activity.

Electrolytes conduct current in solution to form electrolytic solutions. Substances that form electrolytes undergo either dissociation of ionic compounds or ionization of molecular compounds. Substances that form more ions in solution conduct more current causing the light to burn brighter.

Nonelectrolytes do not conduct a current in solution and form nonelectrolytic solutions. Substances that form electrolytic solutions undergo dispersion of molecules from molecular compounds so the bulb cannot light (no charges present).

Essential Question: What is solubility?

By using familiar items such as Kool Aid® or Tang® to give students an analogy for solubilities, students can immediately relate to what they know, such as weak Tang® for an unsaturated solution. (Activity follows.)

“Tang®” Lab Activity

Materials: Tang®, plastic spoons for each student, 2 plastic cups for each student, drinking water, paper towels.

Obtain the powdered drink, Tang®. Any other sweetened fruit drink will be OK to use, but Tang® seems to work best. Measure out amounts of Tang® into individual plastic cups for each student. Probably, one third of a cup will be sufficient. Have a plastic spoon for each student as well. Make sure students do not share spoons or cups in order to avoid the spread of germs. Students should also have paper towels to lay their spoons on during the lab. Measure out about ½ cup of cold water for each student. Students should each have one each of these items. Have students place one spoon of Tang® into their cold water. Ask them how they can get the Tang® to dissolve best (stirring) in the water. At some point, ask if warmer water will affect the rate of dissolving of the Tang®. Have the students taste a small sip of “weak” Tang® (one spoon full---this represents the unsaturated Tang®.

Teacher Notes: At this point, have the words *saturated, unsaturated* and *supersaturated* on the board or overhead. Do not explain these words to students. Once students have recorded their response to the question, “How does the Tang® taste?” Most will say sour or weak.

Next, have them add one more spoon of Tang® to the “weak” solution in their cups and stir. You may also introduce students to the terms “solute” (Tang®) and “solvent” (water). Have students take another small taste of the “Just right Tang®” (saturated). They may/may not add a little more Tang in order to have a solution of Tang that is “just right”. Once again, have students be diligent about not drinking too much of the Tang® solution so that the amount of solvent remains fairly constant. Once the Tang® is “just right”, allow students to drink about ½ of that solution.

Teacher Notes: Point out that the amount of solvent is changing while the water temperature is staying about the same. While this is NOT an exact replication of the effects of temperature on solubility of a substance, it is a good analogy that will enable students to conceptually understand solubilities and how solutes and solvents are affected by temperature, volume, etc.

When students have tasted the “just right Tang®”, have them add at least two spoons of Tang® to it. This will be the “crunchy Tang®” or supersaturated version. Allow students to drink it, if they want or you can extend this part of the lesson by having them decide how they can make the “crunchy Tang®” back into “just right Tang®” again. They can even go back to the “weak Tang®” and add more solute (Tang®) to the “weak Tang®” if there is enough available to do so.

Teacher Notes: On the board, write:
Unsaturated **= weak Tang**®

saturated = **just right Tang**®

supersaturated **= crunchy Tang**®

But do not label the “Tang® versions”. Let the students decide in groups which term best matches the “Tang® version” they have just made in lab. Be sure to point out that the temperature did not change, but the amount of solvent (water) did change.
This is an opportunity to introduce the less detailed terms dilute and concentrated to students. Let them decide which terms match the Tang® “terms”.

At this point, go ahead and show them a solubility graph. Have students write their Tang® versions on their solubility graph.

Unsaturated **= weak Tang**®

saturated = **just right Tang**®

supersaturated **= crunchy Tang**®

This will remind them of what is happening with respect to the solubilities of the substances on the chart.

When you introduce students to the solubility graph, relate the unsaturated, saturated and supersaturated terms to under the line, on the line and above the line to correspond to the solubilities of the salts on the graph.

Solubility Notes

EXPLAIN
Ask students to explain what happened during the solubility demonstration.

Review the concept of rate of solution and use the data from the temperature part to introduce the idea of solubility and how it is affected by temperature. Explain that gases are different form solids in liquids in that they solubility of a gas decreases with temperature. Once you have covered this, ask students what happens if water in a fish tank or river gets too warm. Lead them to the idea that thermal pollution kills fish because as the temperature of the water increases the amount of dissolved oxygen decreases.

Show students a solubility curve and ask which is a gas and why. Do several examples with your students and then have them complete the solubility curve worksheet.

Introduce and explain the terms *saturated, unsaturated* and *supersaturated* in terms of amount of solute dissolved in a given amount of solute.

Unsaturated solution- Occurs when all of the solute added dissolves and the solvent could hold more solute at those conditions (constant temperature and volume of solvent)

Saturated solution- Maximum amount of solute that a given volume of solvent can hold has dissolved (at a constant temperature) and undissolved solute is visible

Supersaturated solution- Formed when saturated solution is heated and more solute is added and it dissolves.

If the solution is cooled to original temperature and the solute remains in solution=supersaturated solution

Use a sponge absorbing water and adding sugar to hot vs. cold tea as ways to explain the types of solutions.

EXPLAIN

Have students write a paragraph explaining the difference between unsaturated, saturated, and supersaturated solutions. Have them cite evidence from the Tang® activity.

ELABORATE

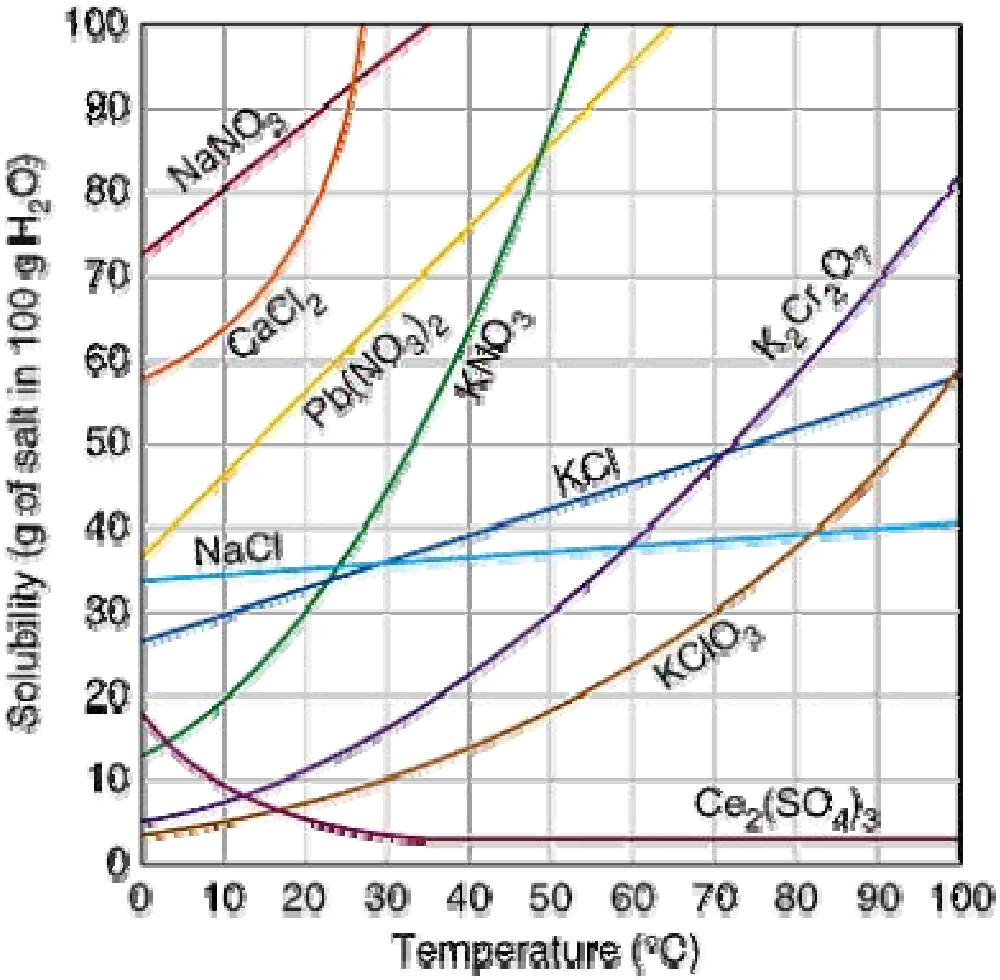
Have students refer to the solubility curve to elaborate as they determine if a solution is saturated, unsaturated or supersaturated. For example ask what type of solution is formed if 10g of $KClO_3$ is dissolved in 100 g of water at 40^{o}C- unsaturated.

A writing extension that can be used to allow for student elaboration (and evaluation) would be to have students write poems or stories about the three types of solutions: saturated, unsaturated, or supersaturated. An example would be to adapt a known children's story such as "Goldilocks and the Three Bears" to "Goldilocks and the Three Solutions." Integration of writing and communication skills provides support to other curriculum areas.

EVALUATE

Do several more examples with your students and then have them complete the Part 2 solubility worksheet.

Show a video of a supersaturated demonstration.
http://www.mefeedia.com/entry/rapid-crystallization-supersaturated-solution-demo/8129986/



Solubility Graph

1. What is the solubility of 40 grams of NaCl at 100°C ? ___________
2. What is the solubility of 40 grams of KCl at 100°C? ___________
3. What is the solubility of 60 grams of $CaCl_2$ at 10° ? ___________
4. What is the solubility of 60 grams of KNO_3 at 40° ? ___________
5. What is the solubility of 70 grams of $K_2Cr_2O_7$ at 90° ? ___________
6. What is the solubility of 80 grams of $NaNO_3$ at 10° ? ___________
7. At what temperature are the solubilities of KNO_3 and NaCl the same? ____________
8. What is the solubility of 100 grams of NaCl at 100° ? ___________
9. What is the solubility of 60 grams of KCl at 90° ? ___________

Using the solubility graph to explain how temperature and amount if solute effect the rate of dissolving will also tie the analogies of various solubilities of the Tang that students physically saw and tasted in the lab.

Chemical Interactions
Day 16

Objective 6.05 – Investigate and analyze the properties and composition of solutions: solubility curves, concentration, polarity, **pH scale**, electrical conductivity

ENGAGE
This intro activity (Taste Bud Teasers) will engage students by catching their attention through relating to real life experiences.

Taste Bud Teasers

Ask students to close their eyes and imagine the taste of the following substances: soap, slice of lemon, pecan pulp, vinegar, etc (or you can actually bring them in). Ask students to describe the taste sensations created by each. Then ask students to group these together by similar sensation. The lemon and vinegar should be grouped together and the soap and pecan pulp will be grouped together. (Pecan pulp is the bitter material between the halves of a pecan when it is shelled. A substitute that could be used is the pith from the lemon slice. Pith is the white material between the yellow "zest" and the pulp of the fruit.)

If students do not mention the acid/base connection, introduce that here.

After the students realize that lemon and vinegar, the sour samples from earlier discussion, are acids, you can ask them to predict which is a stronger acid (by taste). Ask students what it means for an acid or a base to be "strong."

Next, introduce litmus paper as a way to determine whether acid or base and the pH scale as way to determine the strength of an acid or base.

EXPLORE
Students will explore various substances that they encounter on a daily basis to determine whether they are acids or bases.

Acids, Bases, and pH scale Activity

Materials: small plastic containers (like the ones used to measure chemicals on the balance), pH (hydrion) paper, litmus paper,10 samples of substances brought by students to test (include water and milk), goggles

Safety: Instruct students to wear closed-toe shoes and goggles. Provide the MSDS for chemicals.

**On the day prior to this activity in class, have students volunteer to bring materials from home such as shampoo, conditioner, mustard, lemon or lemon juice, etc. Instruct them to bring at least ten different substances, showing them the size of the containers you will use. Be sure to give students guidelines as to the types of substances you think they should or should not bring.

EXPLAIN

Students will determine pH values, arrange them on the pH scale, and explain what this means in terms of ion concentration.

Students should first test the substances with litmus paper to determine color change. Instruct students to use the strips of pH paper to find the pH values for the substances they have brought by dipping the strips into the substance and then comparing the color of the paper to the charts on the vials. They do need to construct a data table to record the substances, the corresponding pH values, and the litmus paper color change. Have students group substances together based on same litmus paper change. Ask students to predict which color changes in litmus show acids and which show bases.

Also have them group substances by similar pH as well as properties they know. Based on their groupings, have students determine which pH values are acid and which pH values are base. Check class results to be sure students realize that those below seven are acid and those above seven are base, while those at seven are neutral. Once neutrality is established at seven, have students predict on a number line, with seven at the center, where strong and weak acids and bases will be. Have students compare and then choose a group to put their “number line” on the board.

Put a list of chemical formulas for common acids on the board and see if students can give a general statement about the elements in them. As a general rule, acids contain hydrogen and a nonmetal or a nonmetal group. Then do the same for bases. As a general rule, bases contain a metal with hydroxide. Be sure to point out that ammonia is an exception to this rule. This will allow students to recognize acids and bases in neutralization reactions if you add this later. As an extension you might want to demonstrate that more reactive metals form stronger bases than less reactive metals by checking pH number.

Once this is established you can define acids as substances that increase hydrogen ions in solution and bases as substances that increase hydroxide ions in solution.

EXPLORE:

Have students research (either with texts or Internet) to find the following information about acids and bases: general properties, common examples, and common uses. You can have all students look up all information and compare/ compile, or you can divide it up among groups, have them make posters, and then present and share with

the class. Be sure they have stressed the increase of hydrogen (proton) / hydronium ion concentration in solution from acids and the increase of hydroxide ion concentration in solution from bases.

Take time to list general properties of acids and bases such as corrosive and caustic. Include that bases are slippery and are used to make soaps. At this point you can define pH as percent hydrogen ion concentration. The stronger the acid the higher the hydrogen ion concentration is, and the stronger the base the lower the hydrogen ion concentration. Higher pH values indicate more complete ionization or dissociation.

You can demonstrate that a metal in an acid will produce hydrogen gas using a burning splint. The stronger the acid, the more hydrogen will be produced. You could also demonstrate that the combination of an acid and a base will produce neutral substances (a salt and water) using pH paper to show the pH values of the reactants and the products.

An additional enrichment lab on acids, bases, pH, and conductivity can be found in the Physical Science Support Document.

Chemical Interactions
Day 17

Neutralization Reactions

ELABORATE

Students will elaborate on what they know about acids and bases as they learn about neutralization.

Review acids and bases with students- make sure they can identify that acids contain a hydrogen ion (H+) and that bases contain a hydroxide ion (OH-). Also review what double replacement reactions are. Ask students what it means to neutralize something. Many will already understand the concept that neutralizing means to make something neutral. Review the pH scale and ask what neutral means in terms of acids and bases. Either give the definition of neutralization or have students look it up--neutralization reactions is when an acid and a base combine and produce 2 neutral compounds- a salt and water. Write the following reaction on the board as an example and way to explain what happens during neutralization. Show students how it is a double replacement reaction- the anion and cation trade places.

HCl	+	NaOH	→	H_20	+	NaCl
Acid	+	Base	→	water	+	salt

The nonmetal (anion) from the acid (Cl^-) reacts with the metal (cation) from the base (Na^+) to form a salt. A salt is a compound formed when a nonmetal anion from an acid combines with a metal cation from a base. A common misconception is that the only

compound that is salt is sodium chloride (table salt). Address this! While we call sodium chloride salt, a salt is an ionic compound—any ionic compound. Also make sure students understand that the pH of the salt solution is 7 because it is neutral.

EXPLAIN:
Have students complete the following as practice. Instruct students to explain their answers to the class.

NEUTRALIZATION- Use your knowledge of neutralization to complete and balance the following reactions.

a) HCO_3 + $Mg(OH)_2$ →

b) H_3PO_3 + KOH →

SALTS
Complete the chart by giving the formula of the salt formed.

ACID	BASE	SALT
H_2SO_4	NaOH	
HCl	KOH	
HCl	$Ca(OH)_2$	
HNO_3	KOH	
HBr	LiOH	
H_3PO_4	NaOH	

Chemical Interactions
Day 18
Conduct a review for this unit. Be sure to include a review of the terms and concepts listed below. A suggestion for student elaboration is to have them make a concept map relating these terms.

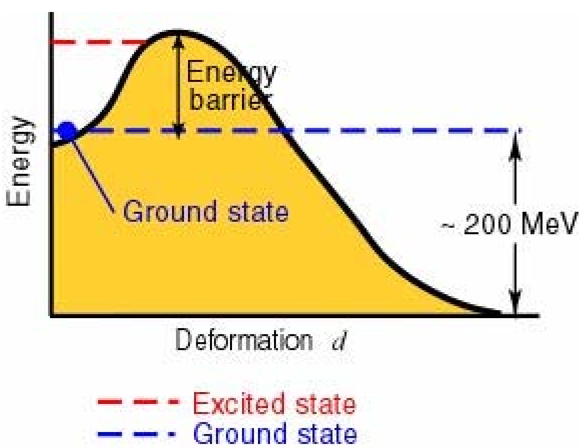
Vocabulary List
Inorganic compound
Valence electrons
Ionic bond
Ion
Covalent bond
Polar covalent bond
Nonpolar covalent bond
Metallic bond
Oxidation number (continued on next page)

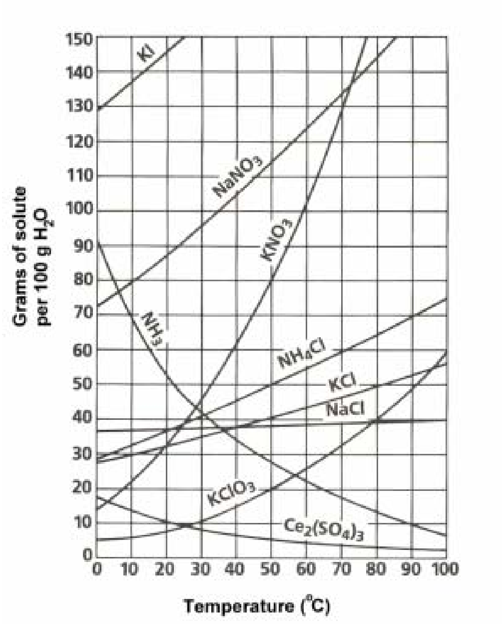
Molecular compound
Ionic compound
Chemical formula
Binary compound
Ternary compound
Polyatomic ion
Chemical reaction
Chemical equation
Reactant
Product
Subscript
Coefficient
Diatomic molecules (gases)
Law of conservation of mass/matter
Single replacement reaction
Double replacement reaction
Decomposition reaction
Synthesis reaction
Precipitate
Endothermic
Exothermic
Solution
Solute
Solvent
Solubility
Saturation
Saturated
Supersaturated
Unsaturated
Dilute
Concentrated
Concentration
Electrolyte
Electrolytic solution
Nonelectrolyte
Nonelectrolytic solution
Polarity
Acid
Base
Salt
Hydroxide ion
Hydronium ion
Neutralization
pH scale
Electrical conductivity
Conductivity apparatus

Chemical Interactions
Day 19

EVALUATE
Sample Assessment Questions for Unit 5

Objective Number	Objective & Questions	RBT Tag
6.02	Investigate and analyze the formation and nomenclature of simple inorganic compounds. • Ionic bonds (including oxidation numbers). • Covalent bonds. • Metallic bonds.	A3 B4 C2
Question	1. Which of the following best describes why lithium fluoride is an ionic compound? a. Lithium and fluorine atoms combine by sharing electrons. b. Lithium and fluorine atoms combine to form molecules. c. Lithium ions form by gaining electrons while fluorine atoms form by losing electrons. d. Lithium ions form by losing electrons while fluorine ions form by gaining electrons. 2. Which of the following is an ionic compound? a. carbon monoxide b. lithium fluoride c. nitrogen trioxide d. sulfur dioxide 3. What is the correct chemical name for $Pb_3(PO_4)_4$? a. Lead phosphate b. Lead III phosphate c. Lead IV phosphate d. Lead phosphorus oxide	
6.03	Identify the reactants and products of chemical reactions and balance simple equations of various types: • Single replacement. • Double replacement. • Decomposition. • Synthesis.	A5 C3
Question	1. Which of the following best illustrates a balanced synthesis reaction? a. $2H_2O \rightarrow 2H_2 + O2$ b. $Mg + 2HCl \rightarrow MgCl_2 + H2$ c. $2Cu + O_2 \rightarrow 2CuO$	

	d. HCl + NaOH → NaCl + H2O 2. Which of the following statements is true of the following equation? $CH_4 + O_2 \rightarrow CO_2 + 2H_2O$ a. CH_4 and CO_2 are products b. CH_4 and O_2 are products c. O_2 and CO_2 are reactants d. CO_2 and H_2O are reactants	
6.04 Question	Measure and analyze the indicators of chemical change including: • Development of a gas. • Formation of a precipitate. • Release/absorption of energy (heat or light). 1. A chemical reaction occurs between a metal and an acid in which a gas is given off. When the gas is collected and tested with a burning splint, the flame is blown out with a popping sound. What can you best infer about the gas? a. the gas is carbon dioxide b. the gas is hydrogen c. the gas is inert d. the gas is oxygen  http://www2.kutl.kyushu-u.ac.jp/seminar/MicroWorld3_E/3Part3_E/3P33_E/fission_barrier_E.jpg 2. Which of the following explanations best describes the chemical reaction illustrated by the graph above? a. The reaction is a decomposition reaction. b. The reaction is an endothermic reaction. c. The reaction is an exothermic reaction. d. The reaction is a synthesis reaction.	C2 C3

6.05 Question	Investigate and analyze the properties and composition of solutions: • Solubility curves. • Concentration. • Polarity. • pH scale. • Electrical conductivity.  http://www.saskschools.ca/curr_content/chem30_05/graphics/4_graphics/sol_curve_sm.jpg 1. According to the graph, which of the following is a gas with the greatest solubility at 20°C? a. $NaNO_3$ b. NH_3 c. KNO_3 d. $Ce_2(SO_4)_3$ 2. Which explanation below describes why carbon tetrachloride does not cause the light in an electrical conductivity apparatus to light? a. It is not an acid. b. It is not a base. c. It does not completely dissociate in solution. d. It does not completely ionize in solution.	A3 C2 C3