Integrated Science Objectives	Unit 6: Bonding

1. ☐ Define the term “Bond” and describe how two atoms become bonded together in terms of how close they must be together.
2. ☐ Explain why it takes Work to bond two atoms together, and how this results in Potential Energy being stored in the bond.
3. ☐ Distinguish between a chemical change (reaction) and a physical change.
4. ☐ Define the term “Valence Electron” and explain the importance of valence electrons in atomic bonding.
5. ☐ Identify the three signs that a chemical reaction is taking place, and explain how bonding and chemical reactions are related.
6. ☐ Define the term “Ionization” and explain what an ion is.
7. ☐ Distinguish between Ionization and Dissolving.
8. ☐ Draw the “Electron Dot Diagram” for any element on the Periodic Table.
9. ☐ Explain the difference between an Ionic Bond and a Covalent Bond.
10. ☐ Describe how you’d use a continuity tester to determine if a substance had ionic bonds or covalent bonds.
11. ☐ Write the ionization reaction that would describe any ionic compound in water.
12. ☐ Define the term “Electronegativity” and use your Periodic Table of Electronegativies to decide if a bond is ionic or covalent.
13. ☐ Explain why metal to non-metal bonds are usually ionic, but non-metal to non-metal bonds are usually covalent.
14. ☐ Explain why bonds only form where there’s a single valence electron in an atoms outermost energy level.
15. ☐ Take any two elements from the periodic table, and use their Oxidation Numbers to write the correct formula for a compound made of those elements.
16. ☐ Take any element from the periodic table, and any of the Polyatomic Ions listed on the handout you got in class, and use their Oxidation Numbers to write the correct formula for the compound you get when you combine them.
17. ☐ Take any element from the periodic table, and any of the Transition Metals listed on the handout you got in class, and use their Oxidation Numbers to write the correct formula for the compound you get when you combine them.
18. ☐ Correctly name compounds made of two elements, compounds made of an element and a polyatomic ion, and compounds made of Transition metals and either elements or compounds.
19. ☐ List the seven Diatomic gases, explain what a diatomic gas is, and explain why all seven gases are held together by covalent bonds.

Lab Report Check-off		Date Complete	Score
Lab 6.1:	Identifying Metals By Their Properties	_____	_____
Lab 6.2:	Electroplating and the Metallic Bond	_____	_____
Lab 6.3:	Electronegativity	_____	_____
Lab 6.4:	Modeling Atomic Bonding	_____	_____

IMPORTANT: **You may not take the Summative Exam until all of the work and assessments listed above are complete.**

Laboratory Exercise 6.1	Identifying Metals By Their Properties

OBJECTIVES:In this lab you will:

- Define the terms Chemical Property, Physical Property and Ionization.
- Identify 6 common metals; Copper, Nickel, Iron, Zinc, Lead and Magnesium using their physical and chemical properties.
- Describe three observations that suggest that a chemical reaction is occurring.

FOCUS QUESTION: What are three ways that you can tell if a chemical reaction has happened or is happening?

MATERIALS AND PROCEDURE

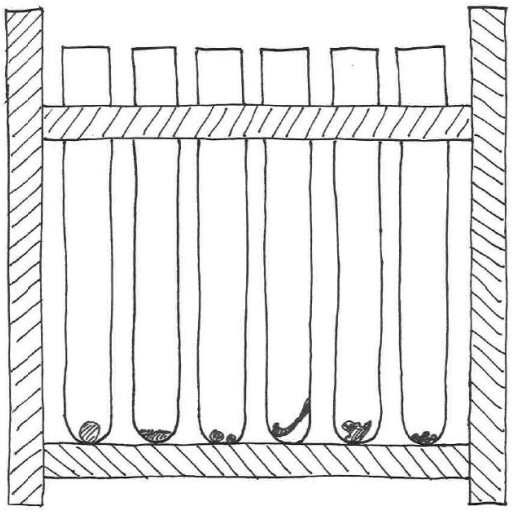
Nickel	Iron	Hydrochloric Acid	Nitric Acid
Copper	Magnesium	Magnet	Test Tube Rack
Zinc	Lead	6 Test Tubes	Wood Splint

WARNING ***Both Hydrochloric Acid and Nitric Acid are very caustic. Use caution in handling both solutions and in case of a spill, clean up with lots of water.***

Lab Apron and Goggles MUST be worn for this lab.

1. **SET UP THE EXPERIMENT**

- Place six test tubes in your rack.
- Set the rack on a piece of blank paper, and write the name of each metal in the data table next to the test tube that will contain that metal.
- Place a piece of each metal into the correct test tube.



Identifying Metals						
	Nickel	**Iron**	**Copper**	**Magnesium**	**Zinc**	**Lead**
Magnetism						
Color						
Hydrochloric Acid						
Nitric Acid						

2. **TEST EACH METAL FOR MAGNETISM**

- Only three naturally-occurring metals are magnetic, so this is a good test for narrowing down the possibilities in identifying a metal.
- Place the magnet on the test tube near the metal in it, and record the results.

3. **DESCRIBE THE COLOR OF EACH METAL**

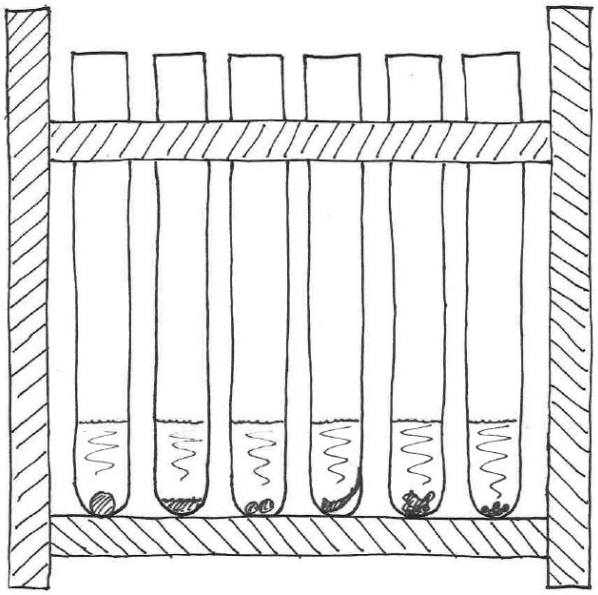
- Record the color of each metal as closely as you can. Remember, the color describes the way that the metal reflects and absorbs light.

4. **TEST THE REACTIVITY OF EACH METAL WITH HYDROCHLORIC ACID**

- All metals react with acid, forming Hydrogen gas. But some metals react best with different types of acid.

- Test each metal with Hydrochloric Acid, watching for the following:
  - Does the metal react?
  - How does the reactivity of each compare with the others?

- If the metal reacts, test for Hydrogen gas production by passing a lighted wood splint across the mouth of the test tube. A "pop" of ignition as the Hydrogen combines with Oxygen in the air is a positive test for this gas.



5. **OBSERVE THE DISPLAY OF EACH METAL IN NITRIC ACID**

- Nitric Acid is too dangerous for you to handle, so your teacher has set up a demonstration for you to look at.
- If the metal is gone, it reacted completely with the acid.
- The reaction of certain metals with Nitric Acid causes solutions of a very characteristic color. Record the color of the resulting solution.

ANALYSIS

1. **WRITE THE IONIZATION REACTION FOR HYDROCHLORIC ACID IN WATER.**

- Write a chemical equation to describe the ionization of HCl in water.
- Explain what ionization is, when it occurs, and how you can tell when it's occurred.

2. **DISTINGUISH BETWEEN PHYSICAL AND CHEMICAL PROPERTIES.**

- Make a list of three physical properties and three chemical properties.
- Explain how physical properties are different from chemical properties.

3. **MAKE A METAL IDENTIFICATION FLOW CHART.**

- Create a flow diagram which could be used in the identification of an unknown metal sample using the tests outlined in this lab.

SYNTHESIS QUESTIONS

1. Explain what an atomic bond is.

2. What is a valence electron, and why are they of interest to us? Use the terms chemical reaction, bond, atom and molecule in your answer.

Laboratory Exercise 6.2	Electroplating and the Metallic Bond

OBJECTIVES:In this lab, you will:

- Define the term Bond.
- Describe the bonding process in terms of Valence electrons.
- Electroplate a nickel (actually made of zinc) with copper.

FOCUS QUESTION: What exactly is a bond, and how does the bond between copper ions and a nickel form when the nickel is plated with the copper?

MATERIALS AND PROCEDURE

Saturated solution of Copper (II) Sulfate ($CuSO_4$)
6V Battery
Shiny new nickel (5¢)
Soap and Paper towels
Leads (From Unit 4: Electricity)
Ammeter
Pre-1980 penny (1¢)
Switch

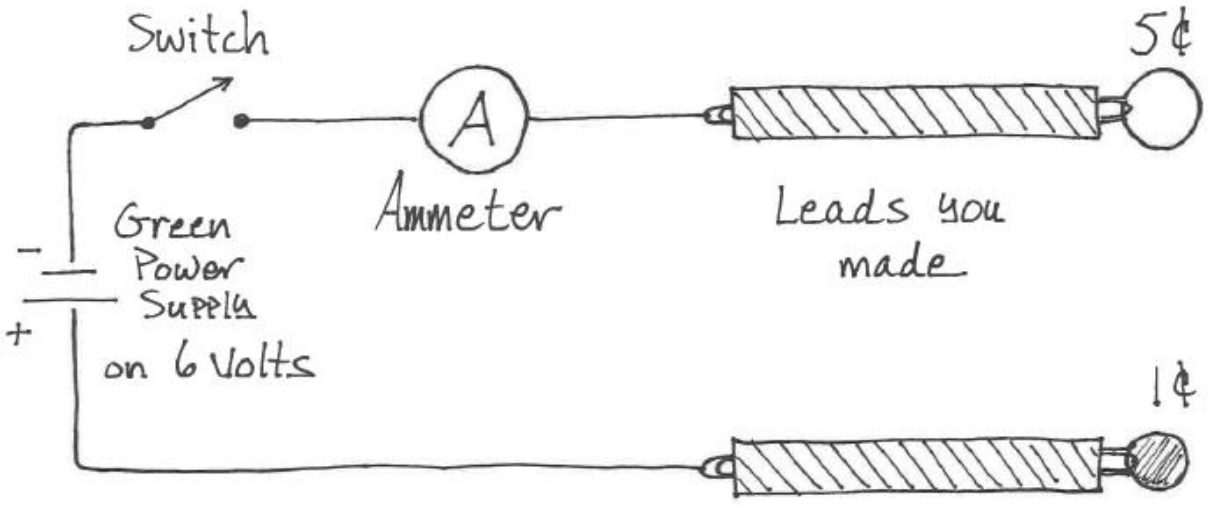
WARNING! Copper (II) Sulfate is toxic and caustic. Use caution in handling it and in case of a spill, clean up with lots of water. Wash you hands after completing this lab.

1. **PREPARE YOUR COIN FOR ELECTROPLATING**

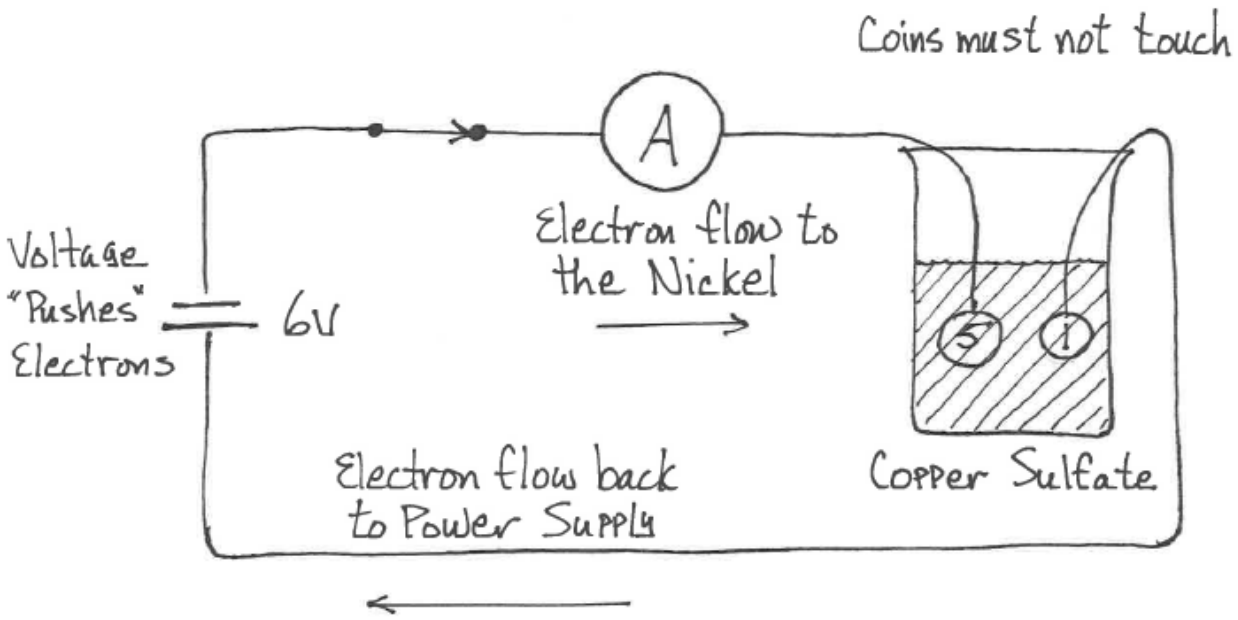
- Wash your coin with soap by really scrubbing it, rinsing it in water, and drying it.
- Once you've cleaned the nickel, don't handle it with your bare fingers as oils in your skin will interfere with the plating process.

2. **SET UP THE EQUIPMENT**

- Assemble the circuit below. Instructions are on the facing page.



- Attach a switch to the negative post of the battery.
- Attach the negative lead of the ammeter to the switch.
- Attach the positive lead of the ammeter to one of your leads.
- Attach the nickel to the lead.



- Attach another lead to the penny, then to the positive pole of the battery.
- Place both coins in the $CuSO_4$ solution so they are completely immersed and hanging from the leads.
- The coins must not touch each other. If they do, you will end up with a bad spot in your copper plating.

3. ELECTROPLATE THE COIN

Current Used During Electroplating	
Amps to Nickel	

- Turn the switch to "ON".
- Gently swirl the solution around.
- While you're swirling, being careful that the coins or leads don't touch!
- Record the Current indicated by the Ammeter.
- After 2 minutes, pull the coin out and switch the lead in a new spot so that you get complete plating on the coin.
- Electroplate for another 2 minutes.

4. **CLEAN THE COINS**

- Once your plating is complete, wash off both coins, the leads, and your hands with water. Wipe any spilled $CuSO_4$ solution with a wet paper towel.
- Straighten up your area for the next group.
- Polish your coin with a damp paper towel. The more you polish, the brighter the copper will get.
- Save your coin, it's your data and will be taped in your lab journal.

ANALYSIS

1. **WRITE THE IONIZATION REACTION FOR COPPER (II) SULFATE IN WATER.**

- Write the chemical equation describing the ionization of $CuSO_4$ in water. (Copper has two valence electrons)
- Explain why Sulfate (SO_4^{-2}) is a polyatomic ion.

2. **DESCRIBE THE PLATING REACTION USING A DIAGRAM.**

- Prepare a diagram that describes in detail how the nickel becomes copper plated.
- Indicate the electron flow.
- Explain why the nickel becomes negative and the penny becomes positive.
- Explain why the nickel becomes coated with Copper, and why the penny ends up with a yellowish coating.
- Explain why the penny ends up with less mass than when it started.

SYNTHESIS QUESTIONS

1. Which of an atom's electrons are used to form bonds with other atoms?

2. How do you know that $CuSO_4$ ionizes in water?

Laboratory Exercise 6.3	Electronegativity

OBJECTIVES:In this lab, you will:

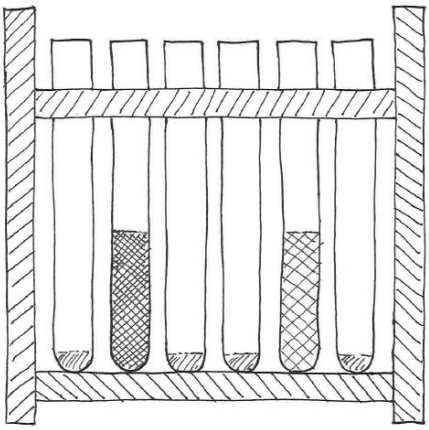
- Define the terms Continuity, Ionic bond, Covalent bond, and Electronegativity.
- Describe how a "Conductivity Test" can be used to see if a bond is ionic or covalent.
- Describe how "Electronegativity" can be used to see if a bond is ionic or covalent.
- Use the Periodic Table to estimate whether a bond is ionic or covalent.
- Explain what a Polyatomic Ion is.

FOCUS QUESTION: What is ELECTRONEGATIVITY, and how is it used to figure out what type of bond is holding two atoms together in a molecule?

MATERIALS AND PROCEDURE

NaCl	Potassium Chloride (KCl)	Dextrose ($C_{12}H_{22}O_{11}$)
Alcohol (CH_3OH)	Sodium Sulfate (Na_2SO_4)	Ethylene Glycol
6V Battery	3 Leads	Light Bulb Assembly
Copper Electrodes	9 Test Tubes in a Rack	Distilled Water

1. **SET UP THE EXPERIMENT**

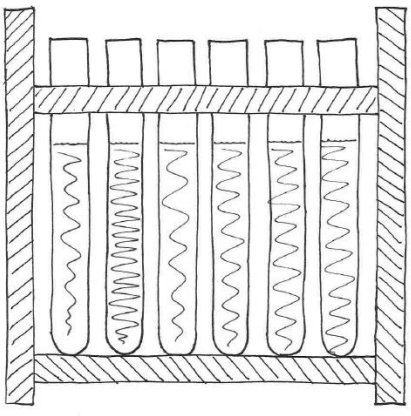


- Place nine test tubes in your rack.
- Set the rack on a piece of blank paper, and write the name of each compound in the data table next to the test tube that will contain that compound.
- Place a small amount of each compound into the correct test tube.

2. **DESCRIBE THE APPEARANCE OF EACH COMPOUND BEFORE WATER IS ADDED**

- Describe the appearance of each substance before adding water to any of them.
- Use the terms "transparent liquid", "semi-transparent liquid" or "white, crystalline solid".

3. **DESCRIBE THE APPEARANCE OF EACH COMPOUND WHEN WATER IS ADDED.**

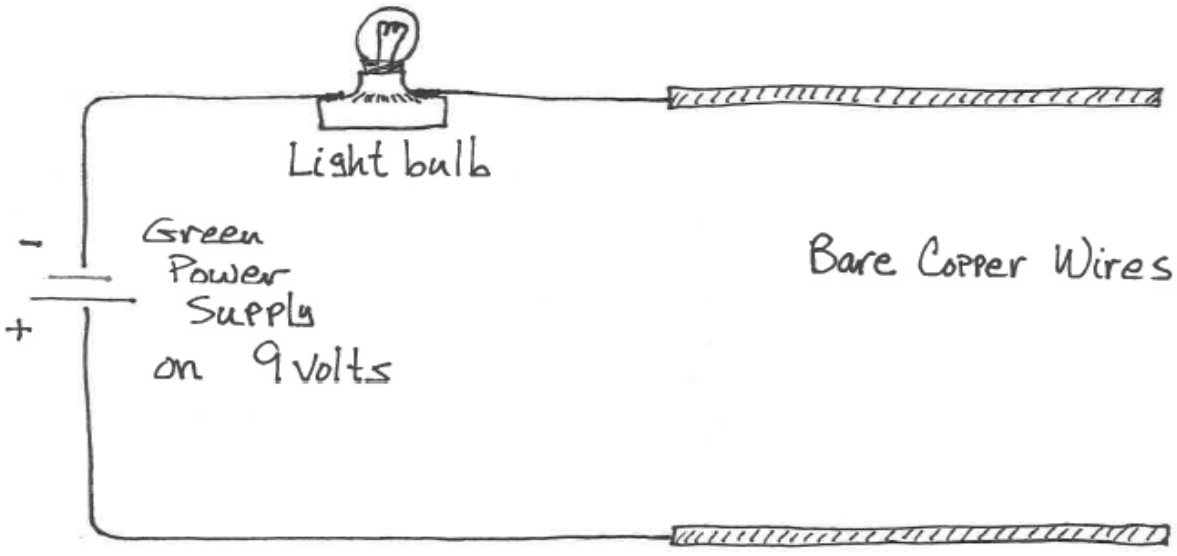


- Add distilled water to Potassium Chloride, Sodium Sulfate, Dextrose, and Alcohol.
- Stir each solution until the solids have disappeared.
- Describe the appearance of each substance with water added.
- Use the terms "transparent liquid", "semi-transparent liquid" or "white, crystalline solid".

Compound	Appearance	Appearance in Water	Conductivity	Electronegative Difference	Bond Type
Sodium Chloride ($NaCl$)					
Ethylene Glycol ($C_2H_4(OH)_2$)					
PotassiumChloride (KCl)					
Dextrose ($C_{12}H_{22}O_{11}$)					
Alcohol (CH_3OH)					
Sodium Sulfate (Na_2SO_4)					
Distilled Water (H_2O)					
Sodium Nitrate ($NaNO_3$)					
Sodium Carbonate (Na_2CO_3)					

4. TEST EACH SOLUTION FOR CONTINUITY.

- Assemble the continuity apparatus as shown below.



- Test to make sure current will flow by touching the copper electrodes together.
- Test each solution for whether it will conduct electricity or not by putting the two copper electrodes in the solution and seeing if the light bulb comes on.
- It is important that the electrodes not touch while they are in the solution.
- After each test, clean the electrodes well before testing the next solution.

ANALYSIS

1. **MAKE A SKETCH OF A CONTINUITY TESTER.**

2. **MAKE MOLECULAR MODELS FOR EACH OF THE NINE SUBSTANCES TESTED.**

- Using a dash "-" to represent a bond, sketch the molecular model for each compound you tested.
- For example Sodium Chloride would be Na-Cl

3. **USE ELECTRONEGATIVY TO DETERMINE BOND TYPE.**

- Determine the bond type for each compound using electronegativity.
- Note that some compounds will have more than one type of bond.
- Show your work for each computation.
- Label the ionic and covalent bonds in each of your molecular models.

4. **WRITE IONIZATION REACTIONS FOR THE IONIC COMPOUNDS.**

- If a compound is ionic, write the equation describing their ionization in water.
- Summarize the THREE ways that you can determine the type of bond holding a molecule together.

SYNTHESIS QUESTIONS

1. Describe how an ionic bond forms, and how a covalent bond forms.

2. What type of bond to Metals and Non-metals usually form? How about Non-metals and other non-metals?

3. What is a Polyatomic Ion, and what are three examples of polyatomic ions?

Laboratory Exercise 6.4	Modeling Atomic Bonding

OBJECTIVE: In this lab, you will:

- Define the terms Oxidation Number, Bonding Site, Stable, Unstable, Inert and Reactive.
- Make models for a selection of atoms on the Periodic Table to help you visualize how atoms look, and how they bond together to form molecules.
- Learn to correctly write the formula for any combination of atoms and polyatomic ions from the Periodic Table.
- Learn to correctly name a compound by looking at its formula.

FOCUS QUESTION: What is an OXIDATION NUMBER, and how is it used to figure out the correct formula for a molecule?

MATERIALS AND PROCEDURE

Atom Model Sheets Scissors Periodic Table Envelope

1. **REVIEW THE METHOD FOR WRITING ELECTRON DOT NOTATIONS**

- You'll need to recall how to do dot notations, so the diagram below will be useful:

6 2

3 Element 5
7 Symbol 1

4 8

- Remember that each number represents a valence electron.

2. **FILL OUT YOUR ATOM MODEL SHEETS**

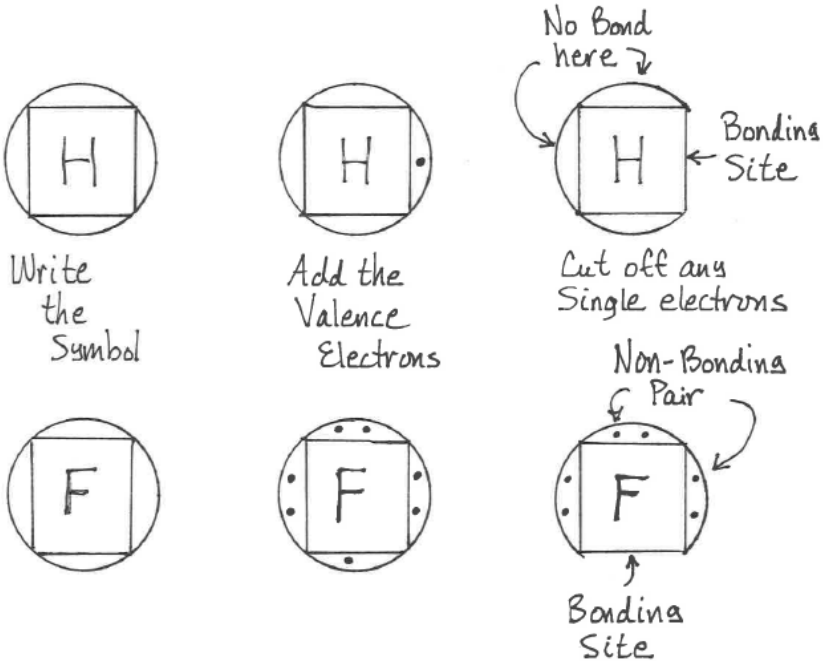
- Write the symbol for each element you're going to make in the square space on each model.
- Here's the list of which atoms you'll make and how many of each:

8 Hydrogens	4 Lithiums	4 Sodiums	1 Silicon
3 Carbons	2 Nitrogens	2 Oxygens	4 Chlorines
4 Fluorines	1 Helium	1 Neon	1 Argon
2 Calciums	2 Sulfurs	2 Magnesiums	4 Bromines
1 Aluminum	1 Boron	1 Phosphorus	

- Arrange the valence electrons for each atom in the spaces between the square space and the circle outline.
- Remember that you find the valence electrons by looking at which column of the Periodic Table that element comes from.
- Cut out the atomic models.

3. MAKE THE ATOMIC MODELS.

- Cut out the circles, so that you've got a round model of each atom with its electron dot diagram.
- Trim off any ***single valence electrons*** along the straight side of the square space so that your model ends up with a flat place where the single valence electron was.
- Leave the spaces with a ***pair of valence electrons*** or ***no valence electrons***.



4. PREPARE YOUR DATA POUCH FOR STORING YOUR MODELS

- When you've made all your models, tape an envelope where your data table normally goes in your lab book, and keep your atom models in it for future use.
- Close the envelope with a paper clip so the models don't fall out.

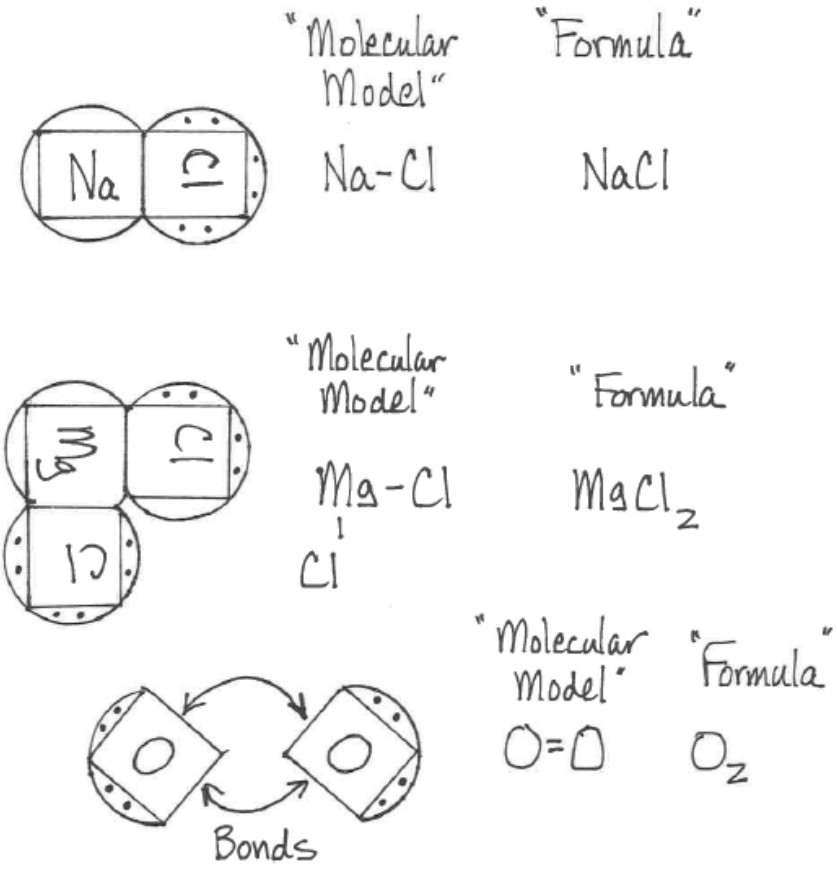
ANALYSIS

1. SKETCH THE MOLECULAR MODEL FOR EACH OF THE COMPOUNDS ON THE LIST.

- Use your atom models to help you sketch the molecule representing each of the following compounds.

Sodium Chloride (1 Na and 1 Cl)
Hydrogen Oxide (2 H's and 1 O)
Calcium Chloride (1 Ca and 2 Cl's)
Boron Fluoride (1 B and 3 F's)
Hydrogen Nitride (3 H's and 1 N)
Methane (1C and 4 H's)
Hydrogen Carbide (4 H's and 1 C)
Magnesium Oxide (1 Mg and 1 O)
Hydrogen Gas (2 H's)
Nitrogen Gas (2 N's)Sodium Oxide

Lithium Fluoride (1 Li and 1 Fluorine)
Sodium Sulfide (2 Na's and 1 S)
Magnesium Bromide (1 Mg and 2 Br's)
Aluminum Chloride (1 Al and 3 Cl's)
Sodium Phosphide (3 Na's and 1 P)
Silicon Fluoride (1 Si and 1 F)
Lithium Silicide (4 Li's and 1 Si)
Calcium Sulfide (1 Ca and 1 S)
Oxygen Gas (2 O's)
Carbon Dioxide Gas (1 C and 2 O's)



- Use models to see what the molecule looks like. Remember, flat sides are "bonding sites".
- Sketch the molecule using a dash to represent the bond. For example: **Na-F**
- Notice that molecules can have "single bonds", "double bonds" and even "triple bonds" but no "James Bonds".

2. WRITE THE FORMULA FOR EACH OF THE COMPOUNDS ON THE LIST.

- Write the correct formula for each of your sketches in step 1.

3. WRITE THE RULES FOR NAMING COMPOUNDS.

SYNTHESIS QUESTIONS

1. What do the straight edges on each atom represent?

2. Based on your models, explain why atoms from column 8 of the periodic table are "stable".

3. Explain how you find Oxidation Numbers, and how they're used to find the formula for a compound.