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Bond … Chemical Bond [10th-11th grade]

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UNDERSTANDING BY DESIGN

Unit Cover Page

Unit Title: Bond…Chemical Bond

Grade Level: 10th and 11th

Subject/Topic Area(s): Chemistry

Designed By: Katie Fitch

Time Frame: 5-6 Weeks

School District: Spring Branch ISD

School: Northbrook High School

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Brief Summary of Unit (Including curricular context and unit goals):

In the unit, Bond…Chemical Bond, students will learn about chemical bonds. Students will learn how to illustrate, name, write formulas, and characterize the three main types of chemical bonds: ionic, covalent, and metallic. Students will begin with an anchoring activity exploring how the nature of different types of bonds affect properties such as conduction of electricity. At the end of the unit they will demonstrate that they have mastered the skills of illustrating and diagramming bond types, naming compounds and writing correct formulas. They will also demonstrate a conceptual understanding of bonding by identifying and explaining the nature of bonds found in three different powders by relying on data from the anchoring conductivity experiment.

Understandings:

- Bonding joins two or more elements together.
- Bonds are necessary to create compounds which make up the world around us.
- The behavior of electrons determines the type and characteristics of a bond.

Essential Questions:

- What is a bond?
- Why are bonds necessary?
- How do things bond?
- What are the characteristics of a bond?

Unit: Bond… Chemical Bond
Grade: 11th Grade Chemistry

Stage 1: Desired Results

Established Goals (Standards)

TEKS or Scope & Sequence

(7) Science concepts. The student knows how atoms form ionic, metallic, and covalent bonds. The student is expected to:

(A) name ionic compounds containing main group or transition metals, covalent compounds, acids, and bases, using International Union of Pure and Applied Chemistry (IUPAC) nomenclature rules;

(B) write the chemical formulas of common polyatomic ions, ionic compounds containing main group or transition metals, covalent compounds, acids, and bases;

(C) construct electron dot formulas to illustrate ionic and covalent bonds;

(D) describe the nature of metallic bonding and apply the theory to explain metallic properties such as thermal and electrical conductivity, malleability, and ductility; and

(E) predict molecular structure for molecules with linear, trigonal planar, or tetrahedral electron pair geometries using Valence Shell Electron Pair Repulsion (VSEPR) theory.

Understandings

Students will understand that…

- Bonding joins two or more elements together.
- Bonds are necessary to create compounds which make up the world around us.
- The behavior of electrons determines the type and characteristics of a bond.

Essential Questions

- What is a bond?
- Why are bonds necessary?
- How do things bond?
- What are the characteristics of a bond?

Knowledge	Skills
Students will know… • The tree types of chemical bonds: ionic, covalent and metallic • The ways electrons behave to form bonds. • The different characteristics of ionic, covalent and metallic bonds.	*Students will be able to…* • Name all chemical compounds using the IUPAC nomenclature. • Write formulas for covalent and ionic compounds. • Illustrate ionic and covalent bonds using dot structures. • Describe and illustrate the nature of a metallic bond. • Predict the structure of covalent compounds based on VSEPR theory. • Compare and contrast ionic, covalent, and metallic bonds by their names, formulas, structure, electron behavior, and characteristics.

Stage 2: Assessment Evidence

Performance Task:

It is all in the BONDS…

At the beginning of the bonding unit you tested three powders and three solutions and recorded whether a light bulb lit up or not. Now that we are at the end of the bonding unit, your challenge is to explain what is happening with the light bulb in terms of the bonds present in the three powders.

Steps of your process:

Part 1: Re-conduct the experiment from the beginning of the unit.
Part 2: Identify the powders as compounds containing either IONIC, COVALENT or METALLIC bonds.
Part 3: Defend your claims based on what you SAW in the experiment and what you KNOW from class.
Part 4: Extend your understanding on bonding into real world applications.

(Teacher Note: 3 powders- Salt, Sugar, and Iron Filings)

Other evidence:

(quizzes, tests, academic prompts, self-assessments, etc.
note – these are usually included where appropriate in Stage 3 as well)

- Illustrating ionic bonds quiz 1
- Ionic bond quiz 2
- Metallic bonding quiz
- Covalent bonding quiz 1
- Covalent bonding quiz 2
- Final bonding skills assessment—All bond types together

Stage 3: Learning Activities

(Steps taken to get students to answer Stage 1 questions and complete performance task)

Lesson 1: Unit Introduction: Bond…Chemical Bond

- Microlab Protocol (http://schoolreforminitiative.org/protocol/doc/microlabs.pdf ; http://schoolreforminitiative.org/protocol/doc/microlab_guidelines.pdf)
- Adjust Microlab times based on students. May only have them speak for 30-45 sec.
- 3 Microlab Questions:
    - What is a bond?
    - Why are bonds necessary?
    - How are bonds formed?
- Come back as a whole class. Ask group to share out with the following questions.
    - What did you hear that was significant?
    - What were some key ideas?
- Back to triads. Add a fourth question: What are chemical bonds?
- Come back as a whole class. Ask group to share out with the following questions.
    - What did you hear that was significant?
    - What were some key ideas?
- Begin new unit WORD WALL
    - What new vocabulary word(s) do you think are significant today?
    - Are any of the words polysemous?
    - Add words—(bond, join…) to personal and class word walls

- Closure
    - Write 1-3 sentences answering ONE of the following questions.
        - How are chemical bonds similar to a bond of friendship?
        - How are chemical bonds similar to family bonds?
        - How are chemical bonds similar to the bond formed between paper and glue?

<u>Lesson 2: Performance Task Introduction and Chemical Bonding Introduction</u>

- To Light or Not to Light
    - Students complete an experiential lab investigation and propose answers to a phenomenon.
    - Assigned lab groups.
- Come back as a whole class.
    - Have lab groups share out their explanations of what they saw
    - Try to lead them into a discussion about chemical bonding
    - Ask them the other two essential questions: (THINK/PAIR/SHARE)
        - Why are bonds necessary?
        - How are bonds formed?
- Hand out bonding summary booklet. (Booklet will slowly be filled in throughout the unit.)
- Fill in the general bonding questions on the front of the booklet.
- Introduce the names of the three types of bonds they will be learning about.
- Closure
    - Each table write down one new vocabulary word on a sentence strip they will encountered today.
    - Add them to the class and personal word wall.

<u>Lesson 3: Introduction to Ionic Bonding</u>

- Warm-up: Word Wall Vocabulary Activity
- Text Impressions
    - Students are working in pairs. May choose their partner.
    - Students are given a list of 10-20 important vocabulary terms from the cartoon article they are about to read.
    - Read the words together.
    - In their pairs, students will have 15 minutes to try to best predict and write the article they are about to read.
    - Vocabulary words must remain in the same order and they cannot be changed.
    - Students, who are willing, can share their impressions with the class.
    - Students will then be given the actual article to read.
    - Students will record 2 similarities and 2 differences between their writing and the reading.
    - Students will finally be asked to answer the 4 essentials questions as best they can based on the reading.
        - What is an IONIC bond?
        - Why are IONIC bonds necessary?
        - How to things form IONIC bonds?
        - What are the characteristics of IONIC bonds?

Lesson 4: Illustrating Ionic Bonds

- Warm up- Add another vocabulary word to the word wall or extend a word that is already on the word wall. Are there any words that are polysemous and should be added to your word wall
- Summarize information students should have gathered through the reading.
    - Ionic bonds are bonds between ions—specifically metal ions and nonmetals ions
    - Ionic bonds are necessary to make different important compounds in our lives and to stabilize ions that do not fulfill the octet rule on their own.
    - Ionic bonds are formed when a metal transfers its electrons to a nonmetal to fulfill the octet rules and balance out the overall charge to zero.
    - Some characteristics of ionic bonds are that they form crystals, conduct electricity when dissolved, are brittle.
- Review valance electrons, dot diagrams & octet rule.
- Direct instruction about how to illustrate and name ionic bonds.
- Student practice illustrating and naming ionic bonds.

Lesson 5: Continuing illustrating ionic bonds

- Warm-up- Students are given an illustrated ionic bond that has 3 errors. They must state what the three errors are and draw the correct illustration of the ionic bond.
- Students will continuing to practice illustrating ionic bonds but today will also have to right a written narrative about each step of the processes.
- We will then discuss how the ionic bond structure and process is connected to their characteristics.

Lesson 6: Continuing ionic bonds

- Students will complete a cut and paste activity with ionic bonds.
- Students will then complete a reflective question assignment about their cut and paste activity.

Lesson 7: Criss-Cross Method

- Quiz over illustrating ionic bonds
- Direct instruction on the criss-cross method.
- Student practice on the criss-cross method—20 problems given can pick any 10 to complete.

Lesson 8: Criss-Cross Method Practice

- Ion-Dice
    - Students are given 4 dice.
        - Dice 1: Metals with only one charge.
        - Dice 2: Metals with multiple charges.
        - Dice 3: Nonmetals
        - Dice 4: Polyatomic ions
        - Each dice is color codedl
    - Students are also given a worksheet to record their answers.
    - Studetns are instructed to role one set of di. (Ex. 1 and 3). They must write correct formula and name for the compound made from these dice.
    - This activity can be easily differentiated.
        - Easier: Only have students use dice 1 and 3. Move them slower into using the other dice.
        - Harder: Make them roll all four dice at the same time. Have them create as many compounds as possible from one roll. They have to remember that an ionic compound must always have a cation and anion.

Lesson 9: Identify the ion lab

- In this experiment students will use several qualitative techniques to determine the cation and anion in an unknown sample. The method they will use involves testing a known compound, called the *ion solution* as you test your unknown. The *ion solution* will provide a positive result for a test. You will compare the results of your unknown to this positive to determine if the same ion is presenting your unknown solution. At the end, students will be required to write the correct formula and name for their unknown solution.

Lesson 10: Ionic Bonding Summary

- Ionic bonding mix-up
    - Each student begins with an index card with either a cation or an anion.
    - They must find a partner with the opposite ion you have.
    - They will fill in their cations and anions on a chart.
    - Then they will write the correct formula and name for the compound.
    - Students will then switch cards with their partner.
    - Have them repeat the steps until they have 8 different combinations.
    - They must have EIGHT different partners. No repeats.
- Fill out ionic bond summary that was given on Lesson 2.

Lesson 11: Quiz over ionic bonds and Introduce metallic bonds- metallic bond vocabulary

- Students will take a quiz over Ionic Bonding
- Pre-teach metallic bond vocabulary
    - Malleable, ductile, conductor, crystal, luster, sea of electrons
    - To pre-teach them—assign students different vocabulary words and have the create a motion for the word and teach it to the rest of the class—have groups teach the class their motion—have students take a quick vocabulary quiz by the teacher acting out the motion and students writing down the word—have word bank posted
    - Add new vocabulary words to the word wall

Lesson 12: Alloys and properties

- Have students create a brass alloy by heating a penny that is dated after 1982
- Use this activity as a spring board to how metallic bond occurs and how that affect different properties of metals
- Fill in the metallic bond summary section of chemical compounds summary book from Lesson 2.

Lesson 13: Metallic bonding quiz and Introduce covalent bonds

- Have students take a short quiz over metallic bonding.
- Have students complete a reading or a type of investigation introducing covalent bonds
- Students will add new vocabulary to the Word Wall.

Lesson 14: Naming and writing formulas for covalent bonds

- Students will be modeled problems on how to name covalent compounds.
- Students will complete guided and independent practice on naming covalent compounds.
- Students will be modeled problems on how to write covalent compound formulas.
- Students will complete guided and independent practice on writing formulas for covalent compounds.
- Students will be assigned some naming and formula writing homework.

Lesson 15: Illustrating covalent bonds and how that affects characteristics

- Students will take a short quiz over naming and writing formulas of covalent compounds after going over the homework.
- Students will fill out a reference sheet on the Lewis Dot diagram for covalent bonds.
- Students will be modeled problems on how to illustrate covalent bonds and the sharing of electrons.
- Students will have plastic dots and element cards to use as manipulatives to help them correctly share electrons according to the octet rule.
- Students will complete problems illustrating the sharing of electrons to make covalent bonds.

Lesson 16: Shape of covalent bonds- VSEPR

- Students will be introduced to 6 different shapes covalent compounds make form based on their bonding structure.
- Students will be modeled the structures using balloons and model kits.
- Students will have a reference sheet to follow along with.
- Students will begin interacting with the shapes by correctly matching Lewis dot diagrams with the correct VSEPR shapes.

Lesson 17: Building covalent bonds structures

- Students will use today to extend their knowledge of shapes of covalent compounds by illustrating the correct covalent bonds by using Lewis dot structures and then predicting their shape.
- Students will then choose 3-5 of their predicted shapes and build a model using molecular model kits.

Lesson 18: Summary of covalent bonds

- We will then discuss how the shape and nature of covalent bond affect the properties and characteristics of covalent bonds.
- Students will complete a summary of covalent bonds on the summary book from Lesson 2.

Lesson 19: Quiz over covalent bonds and Comparing and contrasting bonds

- Students will take a quiz over covalent bonds and VESPR theory.
- Students will then complete a sorting and classifying activity where they will have to sort compound names and formulas into ionic, covalent, and metallic bonds.
- They will then match the name to the correct formula.

Lesson 20: Comparing and contrasting bonds

- Students will complete a practice sheet identifying and correctly naming or writing the formula for ionic, covalent and metallic bonds.

Lesson 21: Comparing and contrasting bonds

- Students will complete an activity in which they compare the different properties of ionic, covalent and metallic bonds to prepare for the performance assessment.
- And emphasis will be made on what electricity is and how the different types of bonds change whether or not a compound can conduct electricity.
- Ties will be made to sports drinks, the human body, wires, pots, coolers, etc.

Lesson 22: Performance assessment

- **It is all in the BONDS…**
    - At the beginning of the bonding unit you tested three powders and three solutions and recorded whether a light bulb lit up or not. Now that we are at the end of the bonding unit, your challenge is to explain what is happening with the light bulb in terms of the bonds present in the three powders.
        - Steps of your process:
            - Part 1: Re-conduct the experiment from the beginning of the unit.
            - Part 2: Identify the powders as compounds containing either IONIC, COVALENT or METALLIC bonds.
            - Part 3: Defend your claims base on what you SAW in the experiment and what you KNOW from class.
            - Part 4: Extend your understanding on bonding into real world applications.

Lesson 23: Skill assessment

- Students take a skill test to demonstrate they can do the following:
    - Name, write formulas and illustrate ionic bonds
    - Name, write formulas and illustrate covalent bonds
    - Describe the nature and characteristics of ionic, covalent and metallic bonds
    - Distinguish between the three types of bonds
    - Answer extension questions on the performance assessment

(Performance Assessment)

It is all in the BONDS…

At the beginning of the bonding unit you tested three powders and three solutions and recorded whether a light bulb lit up or not. Now that we are at the end of the bonding unit, your challenge is to explain what is happening with the light bulb in terms of the bonds present in the three powders.

Steps of your process:

Part 1: Re-conduct the experiment from the beginning of the unit.
Part 2: Identify the powders as compounds containing either IONIC, COVALENT or METALLIC bonds.
Part 3: Defend your claims based on what you SAW in the experiment and what you KNOW from class.
Part 4: Extend your understanding on bonding into real world applications.

Part 1:

1. Locate the 3 powders labeled A, B, and C on your lab table.
2. Place the leads connected to the light bulb into each powder.
3. Record whether or not the light bulb lights up.
4. Locate the 3 solutions labeled A, B, and C on your lab table.
5. Place leads connect to the light bulb into each solution.
6. Record whether or not the light bulb lights up.

What do I SEE?

	Powder A	Solution A (Powder A + Water)	Powder B	Solution B (Powder B + Water)	Powder C	Solution C (Powder C + Water)
Does the light bulb light up?						

Part 2 & 3:

For each powder (A, B, & C) complete the following:

1. Make a claim.
    a. State whether the powder contains ionic, covalent or metallic bonds.
2. Support your claim with laboratory evidence.
    a. What did you see in lab that leads you to this claim?
3. Support your claim with scientific knowledge.
    a. What did you learn in class about the behavior of electrons with in a bond that supports your claim?
    b. What did you lean in class about the characteristics of different bonds that supports your claim?
    c. What did you learn in class about electricity to support your claim?
    d. What do you know that helps you rule out the other bonds as a possibility?

Powder A: Claim, Laboratory Evidence and Scientific Knowledge

Powder B: Claim, Laboratory Evidence and Scientific Knowledge

Powder C: Claim, Laboratory Evidence and Scientific Knowledge

Part 4:

Using the knowledge you have learned about bonding answer the following extension questions to the best of your ability. Use complete sentences.

1. Why do we make wires out materials containing metallic bonds and not covalent bonds?

2. Why do athletes drink sports drinks containing dissolved ionic compounds?

It's All in the Bonds… Rubric

Categories	Exceeds Expectations (100 %)	Meets Expectations (85 %)	Below Expectations (70 %)	Not Included (0 %)
Experimental Data **20 pts.**	Collects and records all necessary experimental data and the data is accurate.	Collects and records all necessary experimental data but data contains 1-2 errors.	Does not collect or record all necessary experimental data or contains more than two errors.	There is no record that experimental data had been collected.
Compound Identification (Claim) **10 pts./powder = 30 pts. total**	Claim is clearly stated and is accurate. ☐ A ☐ B ☐ C	Claim is stated but inaccurate. ☐ A ☐ B ☐ C	No claim is made. ☐ A ☐ B ☐ C	
Laboratory Evidence **10 pts./powder = 30 pts. total**	Claim is well supported by the data seen and collected in the lab. All information is accurate. ☐ A ☐ B ☐ C	Claim is support by the data seen and collected in the lab but not written as clearly as it could be. ☐ A ☐ B ☐ C	Claim is poorly supported by the information collected in the lab and/or the information is inaccurate. ☐ A ☐ B ☐ C	The data collected in lab is not mentioned in support of the claim. ☐ A ☐ B ☐ C
Scientific Knowledge **10 pts./powder = 30 pts. total**	Claim is well supported by information learned in class. Student mentions the characteristics of the type bond. Student emphasized the impact of the behavior of electrons in the bond and how that impacts the ability to conduct or not conduct electricity. Student supports claim by stating why it could not be one of the other types of bonds. ☐ A ☐ B ☐ C	Claim is supported by information learned in class. Student mentions the characteristics of the type of bond. Student talks about the behavior of electrons in the bonds. Student mentions conduction of electricity. ☐ A ☐ B ☐ C	Claim is weakly supported by the information in class. Students fail to mention one or more of the following things: characteristics of the bond, behavior or electrons, conduction of electricity. ☐ A ☐ B ☐ C	No information from class is used to support the students claim. ☐ A ☐ B ☐ C
Mechanics **10 pts.**	Uses complete sentences and grammar throughout the writing. All key terms are spelled correctly.	Most sentences are complete. Small errors in grammar and spelling of key terms but they do not impede the reading of the writing.	Multiple incomplete sentences. Grammar and spelling errors make the writing challenging to read.	Most of the sentences are incomplete. Grammar and spelling errors make the writing very difficult to read.

(Anchor activity (Lesson 2))

To Light or Not to Light?

Today you will be experiencing different powders in and out of solution. You will be observing and offering ideas about the differences in their behavior. Don't worry about a correct answer, today I want your best thinking. Put together what you see and what you already to know in chemistry class to come up with an idea.

Part 1: Powders

1. Locate the 3 powders labeled A, B, and C on your lab table.
2. Record 4 qualitative descriptions about each powder.
3. Place the leads connected to the light bulb into each powder.
4. Record whether or not the light bulb lights up.

What do you SEE?

	Powder A	Powder B	Powder C
Qualitative observations (use at least 4 description words)			
Does the light bulb light up?			

What is the independent variable? _____

What is the dependent variable? _____

What are the controlled variables? _____

What is your IDEA?

Answer the following questions to the best of your ability. Please use complete sentences when appropriate.

A. Which powder(s) allowed for the conduction of electricity to light up the light bulb? _____

B. What do you think is the difference between the powder(s) that had the light bulb light up and the powder(s) that did not have the light bulb light up?

_____

_____

_____

_____

Part 2: Solutions

5. Locate the 3 solutions labeled A, B, and C on your lab table.
6. Record 4 qualitative descriptions about each powder.
7. Place leads connect to the light bulb into each solution.
8. Record whether or not the light bulb lights up.

What do you SEE?

	Solution A (Powder A + Water)	Solution B (Powder B + Water)	Solution C (Powder C + Water)
Qualitative observations (use at least 4 description words)			
Does the light bulb light up?			

What is the independent variable? _____

What is the dependent variable? _____

What are the controlled variables? _____

What is your IDEA?

Answer the following questions to the best of your ability. Please use complete sentences when appropriate.

C. Which solution(s) allowed for the conduction of electricity to light up the light bulb? _____

D. What do you think is the difference between the solution(s) that had the light bulb light up and the solution(s) that did not have the light bulb light up?

_____

_____

_____

_____

E. Did any of the powders not light up on their own but lit up when dissolved in water? _____

F. If so, why do think this difference occurs?

_____

_____

_____

_____

Metallic

What is a METALLIC bond?

Why are METALLIC bonds necessary?

How are METALLIC bonds formed?

What are the characteristics of METALLIC bonds?

How do the structure and electron behavior of METALLIC bonds influence the characteristics?

How do you name METALLIC bonds?

How do you write the formulas of METALLIC bonds?

What are some examples of METALLIC bonds?

Profile of Chemical Bonds

What is a bond?

Why are bonds necessary?

How are bonds formed?

Ionic

What is an IONIC bond?

Why are IONIC bonds necessary?

How are IONIC bonds formed?

What are the characteristics of IONIC bonds?

How do the structure and electron behavior of IONIC bonds influence the characteristics?

How do you name IONIC bonds?

How do you write the formulas of IONIC bonds?

What are some examples of IONIC bonds?

Covalent

What is a COVALENT bond?

Why are COVALENT bonds necessary?

How are COVALENT bonds formed?

What are the characteristics of COVALENT bonds?

How do the structure and electron behavior of COVALENT bonds influence the characteristics?

How do you name COVALENT bonds?

How do you write the formulas of COVALENT bonds?

What are some examples of COVALENT bonds?

Name _____

(Lesson 4) Date _____ Period _____

Let's Make Ionic Bonds!

Directions:

1. Choose a GREEN metal card. Draw the Lewis Dot Diagram for the metal in the box.
2. Choose an ORANGE nonmetal card. Draw the Lewis Dot Diagram for the nonmetal in the box.
3. Draw an arrow showing the transfer of electrons from metals to nonmetals.
4. Draw the final dot diagrams for the metal cation and nonmetal anion.
5. Write down ALL of the charges. Check that they add to zero.
6. Name the cation and anion (ends in –ide).
7. Name the compound by combining the cation name (without the word ion) and anion name.
8. Write the ATOM symbol for the metal with the number of atoms used as a subscript.
9. Write the ATOM symbol for the nonmetal with the number of atoms used as a subscript.
10. Write the compound formula by combining the atom symbols and subscripts.

Example	Metal(s)	Nonmetal(s)	
Original Dot Diagrams & Transfer Arrow(s)			
Final Dot Diagrams with Charge			
Charges	+		= 0 (ZERO)
Name Ions			Compound Name Cation + Anion
Formula	Atom Symbol$_{number}$	Atom Symbol$_{number}$	Compound Formula
	+	=	

	Metal(s)	Nonmetal(s)	
Original Dot Diagrams & Transfer Arrow(s)			
Final Dot Diagrams with Charge			
Charges	+		= 0 (ZERO)
Name Ions			Compound Name Cation + Anion
Formula	Atom Symbol$_{number}$	Atom Symbol$_{number}$	Compound Formula
	+	=	

	Metal(s)	Nonmetal(s)	
Original Dot Diagrams & Transfer Arrow(s)			
Final Dot Diagrams with Charge			
Charges	+		= 0 (ZERO)
Name Ions			Compound Name Cation + Anion
Formula	Atom Symbol$_{number}$	Atom Symbol$_{number}$	Compound Formula
	+	=	

(Lesson 6)

Ionic Formula Lab

Purpose: In this lab, you will cut out models of the ions and construct ionic compounds. You will then write the correct formula for each compound, the correct name for the compound, and state how many electrons were transferred.

Procedure:

1. Obtain three different pieces of paper.
    a. Green Cation Sheet
    b. Orange Anion Sheet
    c. White Template Sheet (Names and Formulas of 10 Ionic Compounds)

2. Cut out all of the ions.

3. Construct a model for each of the following compounds using the cutout ions. (Make sure the positive and negative charges equal 0.)

	Cations (+)		**Anions (-)**
1)	Aluminum ion	and	Bromine ion
2)	Sodium ion	and	Oxygen ion
3)	Iron (II) ion	and	Sulfur ion
4)	Aluminum ion	and	Nitrate
5)	Potassium ion	and	Sulfate
6)	Iron (III) ion	and	Chlorine ion
7)	Ammonium	and	Sulfur ion
8)	Aluminum ion	and	Oxygen ion
9)	Iron (III) ion	and	Sulfate
10)	Sodium ion	and	Phosphate

4. Place each model on the white paper and glue or tape them down.

5. Write the correct **formula** for each compound. (Don't write 1's.)

    Metal $\text{Symbol}_{\text{number}}$ Nonmetal $\text{Symbol}_{\text{number}}$

6. Write the correct **name** for each compound.

    Cation + *Anion or Polyatomic*

7. Write the number of electrons that are transferred from the cation to the anion.

8. Turn in to Ms. Fitch. Make sure your name is on it.

Al^{+3}	Al^{+3}	Al^{+3}	Al^{+3}
Fe^{+3}	Fe^{+3}	Fe^{+3}	K^{+1}
			K^{+1}
			Na^{+1}
Fe^{+2}	Na^{+1}	Na^{+1}	Na^{+1}
	NH_4^{+1}	NH_4^{+1}	Na^{+1}

Al^{+3}	Al^{+3}	Al^{+3}	Al^{+3}
Fe^{+3}	Fe^{+3}	Fe^{+3}	K^{+1}
			K^{+1}
			Na^{+1}
Fe^{+2}	Na^{+1}	Na^{+1}	Na^{+1}
	NH_4^{+1}	NH_4^{+1}	Na^{+1}

Br^{-1}	Br^{-1}	O^{-2}	O^{-2}
Br^{-1}	NO_3^{-1}		
O^{-2}	S^{-2}	S^{-2}	O^{-2}
NO_3^{-1}	SO_4^{-2}	SO_4^{-2}	SO_4^{-2}
PO_4^{-3}	Cl^{-1}	Cl^{-1}	SO_4^{-2}
	Cl^{-1}	NO_3^{-1}	

Br^{-1}	Br^{-1}	O^{-2}	O^{-2}
Br^{-1}	NO_3^{-1}		
O^{-2}	S^{-2}	S^{-2}	O^{-2}
NO_3^{-1}	SO_4^{-2}	SO_4^{-2}	SO_4^{-2}
PO_4^{-3}	Cl^{-1}	Cl^{-1}	SO_4^{-2}
	Cl^{-1}	NO_3^{-1}	

(Lesson 7)

Ionic Formulas- Criss-Cross Method

Cross down the charge numbers and write the correct formulas for the following cations and anions.

1. Na^{+1} N^{-3}

2. Ca^{+2} Cl^{-1}

3. Mg^{+2} CO_3^{-2}

4. Fe^{+2} PO_4^{-3}

Remember:
*Don't write 1's!
*Don't write (+) or (-) !
*REDUCE!
*Parentheses around polyatomic ions!

Write the correct formulas for the combination of the following metals and nonmetals.

Example: magnesium bromide

Step 1: Write the ion symbols. Mg^{+2} Br^{-1}

Step 2: Write the formula. $Mg\ Br_2$

(Cross and reduce.)

5. calcium fluoride

Step 1:

Step 2:

6. sodium oxide

Step 1:

Step 2:

7. tin (IV) chloride

Step 1:

Step 2:

8. iron (III) sulfide

Step 1:

Step 2:

9. potassium nitrate

Step 1:

Step 2:

10. calcium carbonate

Step 1:

Step 2:

More Ionic Formulas- Criss-Cross Method

Write the correct ionic formulas for the following combination of metals and nonmetals.

1.	lithium sulfide		2.	calcium nitride
Step 1: Ion symbol (symbol + ox. #)	Li^{+1} S^{-2}		Step 1:	
Step 2: (Cross ox. # and reduce if necessary)	Li_2S		Step 2:	
3.	beryllium chloride		4.	magnesium oxide
Step 1:			Step 1:	
Step 2:			Step 2:	
5.	lead (IV) sulfide		6.	chromium (III) iodide
Step 1:			Step 1:	
Step 2:			Step 2:	
7.	aluminum sulfate		8.	magnesium chlorate
Step 1:			Step 1:	
Step 2:			Step 2:	
9.	nickel (II) cyanide		10.	ammonium hydroxide
Step 1:			Step 1:	
Step 2:			Step 2:	

IONIC COMPOUND NAMING PRACTICE

Name the following ionic compounds.
Don't forget Roman Numerals on the TRANSITION METALS!

1. Na_2O _____
2. $CaSO_4$ _____
3. $LiOH$ _____
4. $CuNO_3$ _____
5. FeO _____
6. $Cu(NO_3)_2$ _____
7. $(NH_4)_2S$ _____
8. Mg_3N_2 _____
9. $Co(NO_2)_2$ _____
10. $Fe_2(CrO_4)_3$ _____

Name _____ Date _____ Period _____

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5. FeO _____
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7. $(NH_4)_2S$ _____
8. Mg_3N_2 _____
9. $Co(NO_2)_2$ _____
10. $Fe_2(CrO_4)_3$ _____

(Lesson 8)

ION DICE!
Practice writing Ionic Compounds

Roll the **Green** Dice and **Orange** Dice to make 6 NEW and DIFFERENT IONIC compounds.				
#	Cation	Anion	Formula	Ionic Compound Name
1.				
2.				
3.				
4.				
5.				
6.				

Roll the **Blue** Dice and **Orange** Dice to make 6 NEW and DIFFERENT IONIC compounds.				
#	Cation	Anion	Formula	Ionic Compound Name
1.				
2.				
3.				
4.				
5.				
6.				

Roll the **Green** Dice and **Red** Dice to make 6 NEW and DIFFERENT IONIC compounds.				
#	Cation	Anion	Formula	Ionic Compound Name
1.				
2.				
3.				
4.				
5.				
6.				

Roll **ALL 4** dice. Write down ALL possible NEW and DIFFERENT IONIC compounds.				
#	Cation	Anion	Formula	Ionic Compound Name
1.				
2.				
3.				
4.				
5.				
6.				

BONUS ION DICE PRacatice!

Roll **ALL 4** dice. Write down ALL possible NEW and DIFFERENT IONIC compounds.				
#	Cation	Anion	Formula	Ionic Compound Name
1.				
2.				
3.				
4.				
5.				
6.				

Roll **ALL 4** dice. Write down ALL possible NEW and DIFFERENT IONIC compounds.				
#	Cation	Anion	Formula	Ionic Compound Name
1.				
2.				
3.				
4.				
5.				
6.				

Identification of Anions and Cations in Solution

Background

In this experiment you will use several qualitative techniques to determine the cation and anion in an unknown sample. The method you will use involves testing a known compound, called the *ion solution* as you test your unknown. The *ion solution* will provide a positive result for a test. You will compare the results of your unknown to this positive to determine if the same ion is presenting your unknown solution.

Several types of tests will be observed in this experiment. You may see any of the following:

- **Color change:** this does not happen because of the colors of any of the chemicals, but is a result of a specific ionic interaction
- **Gas evolution:** watch for the formation of tiny bubbles
- **Precipitate formation (ppt):** a precipitate is a solid material produced when certain ions change places between compounds. The ppt may be very fine and require time before it settles out of the solution, or it may be cloudy. Sometimes ppt's are colored. This is not be confused with a color change alone. If a solid material forms, it is a ppt reaction.

Lab Objectives

1. To recognize both positive and negative test results using qualitative techniques.
2. To determine the cation and anion present in your unknown sample.

What's Due: Your results are due **TODAY**. Turn in ONLY the Data & Conclusions Page.

Materials

1 well spot or spot plate per team
Toothpicks
1 L waste beaker
DI water bottles

Solutions of: iron(III) sulfate, sulfuric acid, potassium thiocyanate, lead(II) nitrate, sodium chloride, calcium nitrate, sodium oxalate, silver nitrate, sodium sulfate, hydrochloric acid, barium chloride, sodium bicarbonate, and your unknown.

Lab Notes:

- Wear safety eyewear at all times, especially during cleanup and glassware washing.
- BE CAUTIOUS! Assume your unknown sample contains the worst of the chemicals.
- You may work on either the Cation Tests or Anion Tests first—the order does not matter.
- Be sure all glassware is EXTREMELY CLEAN before you begin. It s very easy to get false positive results from contaminated glassware.
- Once you have cleaned up at your station, thoroughly wash and dry your hands before leaving.

Testing for Cations

Testing for iron(III) ion, Fe^{3+}

1. Place 2 drops of iron(III) sulfate to one spot on your spot plate.
2. Place 2 drops of each unknown in the next spots on your spot plate.
3. Add 2 drops of sulfuric acid to each substance.
4. Next, add 2 drops of potassium thiocyanate solution to each well.
5. The iron(III) sulfate will indicate what a positive test for the iron(III) ion. Compare and record your results.

Testing for lead(II) ion, Pb^{2+}

1. Place 2 drops of lead(II) nitrate to one spot of your spot plate.
2. Place 2 drops of each unknown in the next spots on your spot plate.
3. Add 2 drops of sodium chloride to each of the spots.
4. The lead(II) nitrate spot will produce a positive test for the lead(II) ion. Compare and record your results.

Testing for the calcium ion, Ca^{2+}

1. Add 2 drops of calcium nitrate to one spot of your spot plate.
2. Add 2 drops of each unknown to the next spots on your spot plate.
3. Add 2 drops of sodium oxalate solution to each of the spots.
4. The calcium nitrate will indicate what a positive test for the calcium ion.

Testing for Anions

Testing for the chlorine ion, Cl^-

1. Place 2 drops of sodium chloride solution to a spot on your spot plate.
2. Place 2 drops of each unknown in the next spots on your spot plate.
3. Add 1 drop of silver nitrate to each well.
4. The sodium chloride solution will produce a positive test for the chloride ion. Compare and record your results.

Testing for the sulfate ion, SO_4^{2-}

1. Place 2 drops of sodium sulfate to one spot on your spot plate.
2. Place 2 drops of each unknown in the next spots on your spot plate.
3. Add 2 drops of hydrochloric acid to each substance.
4. Add 4 drops of barium chloride to each substance.
5. The sodium sulfate solution will produce a positive test for the sulfate ion. Compare and record your results.

Testing for the bicarbonate ion, HCO_3^-

1. Place 2 drops of the sodium bicarbonate to one spot on your spot plate.
2. Place 2 drops of each unknown in the next spots on your spot plate.
3. Add 2 drops of hydrochloric acid to each spot.
4. The sodium bicarbonate will provide the positive test for the carbonate ion. Observe, compare and record your results.

Grade

Data & Conclusion for Identification of Cation and Anion in an Unknown Solution

Points Lost for not Wearing Goggles or Unsafe Lab Behavior

Cation Results (30 pts.)

Ion symbol	*Positive result: formation of ppt, gas or color change*	*Unknown result: No change or ppt, gas or color change*		*Analysis: Ions Present Place a Y or N*	
		Unknown _____	*Unknown _____*	_____	_____
Iron(III) ion					
Lead(II) ion					
Calcium ion					

Anion Results (30 pts.)

Ion symbol	*Positive result: formation of ppt, gas or color change*	*Unknown result: No change or ppt, gas or color change*		*Analysis: Ions Present Place a Y or N*	
		Unknown _____	*Unknown _____*	_____	_____
Chloride					
Sulfate					
Bicarbonate					

*You should have only written Yes ONE TIME for each unknown in each data section. If not, you have a false positive and you will need to re-run the tests in question.

Conclusions on the back.

Conclusions:
Using the cation and anion you have identified in your unknown solution, complete the conclusion section below:

First Unknown (15 pts.)

Unknown # _____ contained _____ as the cation and _____ as the anion.

The correctly written formula for this compound is _____.

The name of my unknown chemical is _____.

Second Unknown (15 pts.)

Unknown # _____ contained _____ as the cation and _____ as the anion.

The correctly written formula for this compound is _____.

The name of my unknown chemical is _____.

*****Before you turn this in I must sign off that your lab equipment and station is clean (10 pts.)** _____

(Lesson 10)

Ionic Formula Mix-Up

1. Start with an index card with either a cation or an anion.
2. Find a partner with the opposite ion you have.
3. Fill in the chart according to your cations and anions.
4. Switch cards with your partner.
5. Repeat steps 1-4 until you have 8 different combinations.
6. You must have EIGHT different partners. No repeats.

	Cation	Anion	Formula	Name	Partner
Ex.					
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					

(Lesson 12)

Name _____
Period _____ Date _____

Gold Pennies

Background

The first penny was made in 1787 and was designed by Benjamin Franklin. The pennies we use today with Lincoln on the front have been made since 1909 to commemorate the 100th anniversary of Lincoln's birth. Up until 1982 pennies were made out of solid copper. As the price of copper increased it began to cost the government more than one cent to make a penny. They were losing money by making money! After 1983, pennies began to be manufactured with a zinc core and a copper coating. If heated, enough energy is provided to the copper atoms near the surface of the penny to cause them to intermingle with, or diffuse, with the zinc atoms below. Copper and zinc form the alloy brass which has a color much like gold. The rapid cooling (quenching) of the hot penny stops the diffusion process and locks the atoms in their new positions.

Purpose: To create an alloy using a post-1983 penny and a heat source.

Materials: Penny (after 1983) Hot plate Tongs Water(for quenching)

Pre-Lab Questions:

1. What is an alloy?

2. What are the two metals that make up a penny? _____ and _____

Procedure

1. Clean your penny using the vinegar or soap and water mixture. Use the tongs to remove your penny. Try not to touch it with your fingers so you don't add oils and other contaminants to the surface. Dry the penny with a paper towel.
2. Make detailed observations about your cleaned penny and record them in the **Data Table**.
3. Place the cleaned penny on a pre-warmed and **HOT** hot plate.
4. Watch the penny carefully as it heats up. Record any changes you see in your penny in the **Data Table**.
5. Leave your penny on the hot plate until Ms. Fitch tells you to remove it.
6. Use the tongs to remove your penny and quench it in the cup of water to cool it down.
7. Remove your penny from the cup of water and make your final observations of your penny in the **Data Table**.

Data Table

Item	Observations
Appearance of original penny	
Description of changes while the penny was being heated	
Appearance of penny after heating and quenching	

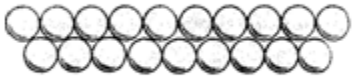
Post Lab Questions

1. At one point during the lab, the pennies looked red in color. Why do you think they had this appearance?

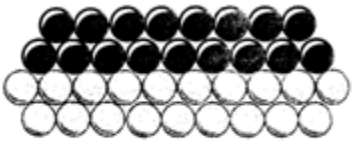
2. At the end of the lab, the pennies looked gold. Why do you think they had this appearance?

3. What alloy did you create by heating you penny? What are the two metals that make up this alloy?

4. Draw a picture of what you think the alloy you created looks like at the atomic level.



Copper Atoms In Penny



Copper Atoms In Penny With Zinc Coating

My newly created alloy looks like this:

5. Why did you have to use a penny made after 1983?

6. Describe what you think a penny made before 1982 would look like if it were heated in the same way.

(Lesson 14)

Naming Covalent Compounds

- **To name covalent compounds we use _____ to tell the # of atoms.**
  - **Exception- Don't use mono- before the first element**
    - **Wrong- CO- monocarbon monoxide**
    - **Correct- CO- carbon monoixde**
- **Just like ionic bonds, the ending of the second element is still changed to _____.**

Prefixes

Prefix	Mono	Di	Tri	Tetra	Penta	Hexa	Hepta	Octa	Nona	Deca
Number										

Name the following covalent compounds.

1. HCl _____
2. SO_2 _____
3. N_2O_3 _____
4. P_2O_5 _____
5. P_4S_5 _____
6. NF_3 _____
7. CH_4 _____

Super 7

Diatomic Elements

(elements that always come in pairs)

	Formula	Name
1	**H_2**	
2	**N_2**	
3	**O_2**	
4	**F_2**	
5	**Cl_2**	
6	**Br_2**	
7	**I_2**	

Naming Covalent Compounds

Fill in the prefix table before starting the rest of the assignment.

Prefix										
Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

Part 1- Name the following covalent compounds using prefixes.

First element- use prefixes if there is more than one atom in the formula (do not use mono-)
Second element- always use prefixes and change the ending to "-ide."

1. CI_4 Carbon tetraiodide
2. SiF_4 _____
3. N_2S_3 _____
4. F_2 _____
5. CS_2 _____
6. C_3H_8 _____
7. HI _____
8. PH_3 _____
9. B_2Cl_4 _____
10. Cl_2O _____

Part 2- Write the formulas for the following covalent compounds using the names.

11. Bromine trifluoride BrF_3
12. Iodine heptafluoride _____
13. Disulfur decachloride _____
14. Tetraphosphorus decaoxide _____
15. Carbon tetrabromide _____
16. Dinitrogen difluoride _____

(Lesson 15)

Let's Make Covalent Bonds

1. Write the original dot diagrams for each element.
2. Rearrange the disks (represent electrons) around the cards to get each element to have 8 electrons. (Hydrogen is an exception. It only needs 2.)
3. Draw the final dot diagrams you formed by moving the buttons.
4. Circle the pairs of electrons that the elements share.
5. Name the compounds.

1. I_2 Name _____

Original Dot Diagrams	→	Final Dot Diagrams (Circle Shared Electrons)

2. NH_3 Name _____

Original Dot Diagrams	→	Final Dot Diagrams (Circle Shared Electrons)

3. HF Name _____

Original Dot Diagrams	→	Final Dot Diagrams (Circle Shared Electrons)

4. H_2O Name _____

Original Dot Diagrams	→	Final Dot Diagrams (Circle Shared Electrons)

5. CO_2 Name _____

Original Dot Diagrams	→	Final Dot Diagrams (Circle Shared Electrons)

6. N_2 Name _____

Original Dot Diagrams	→	Final Dot Diagrams (Circle Shared Electrons)

7. PCl_3 Name _____

Original Dot Diagrams	→	Final Dot Diagrams (Circle Shared Electrons)

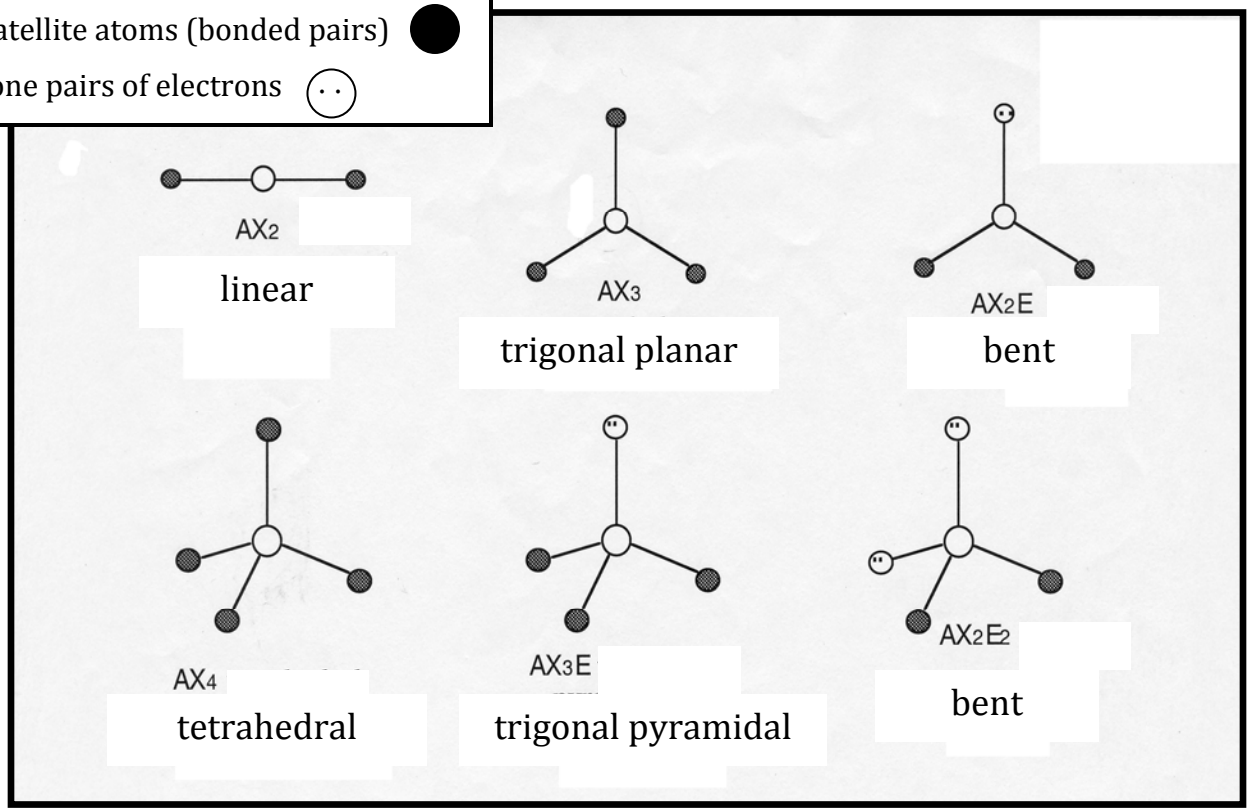
Key

A= central atom

X= satellite atoms (bonded pairs)

E= lone pairs of electrons

Molecular Geometry



Key

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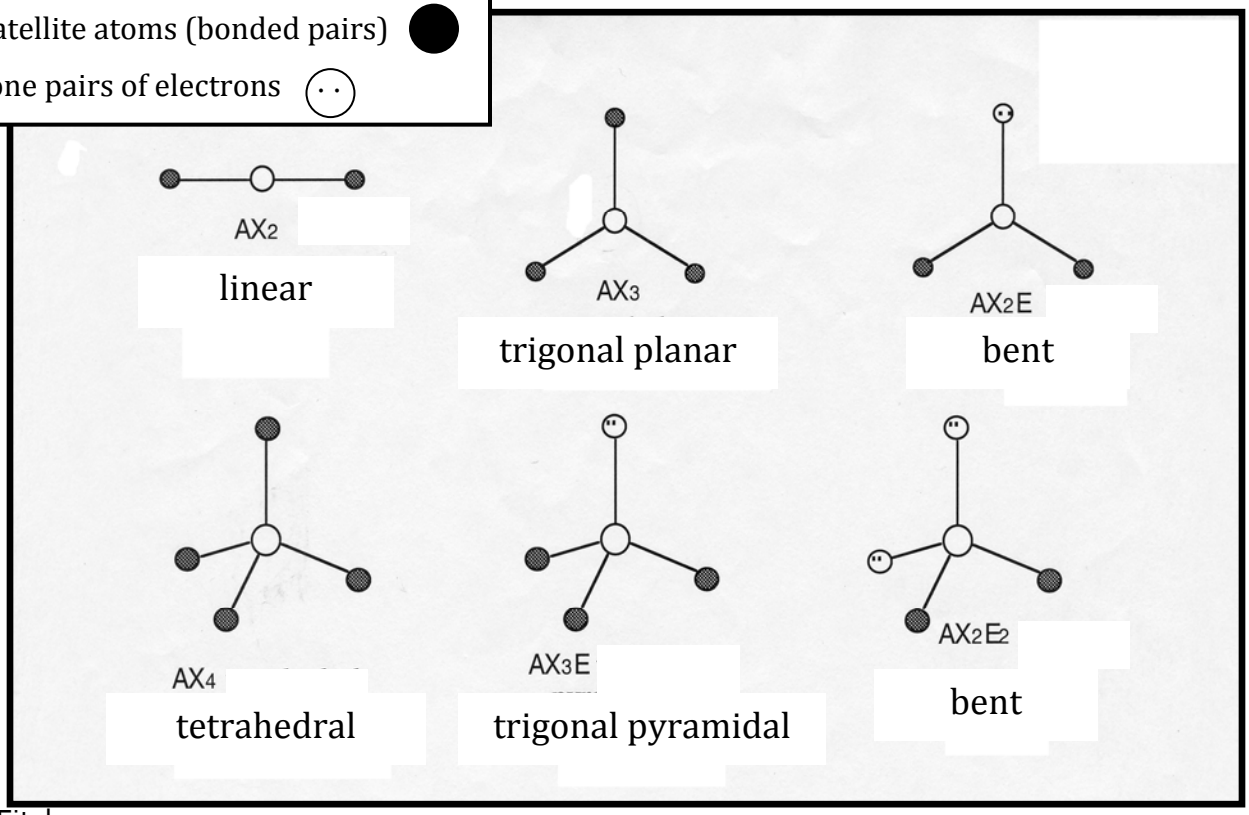
X= satellite atoms (bonded pairs)

E= lone pairs of electrons

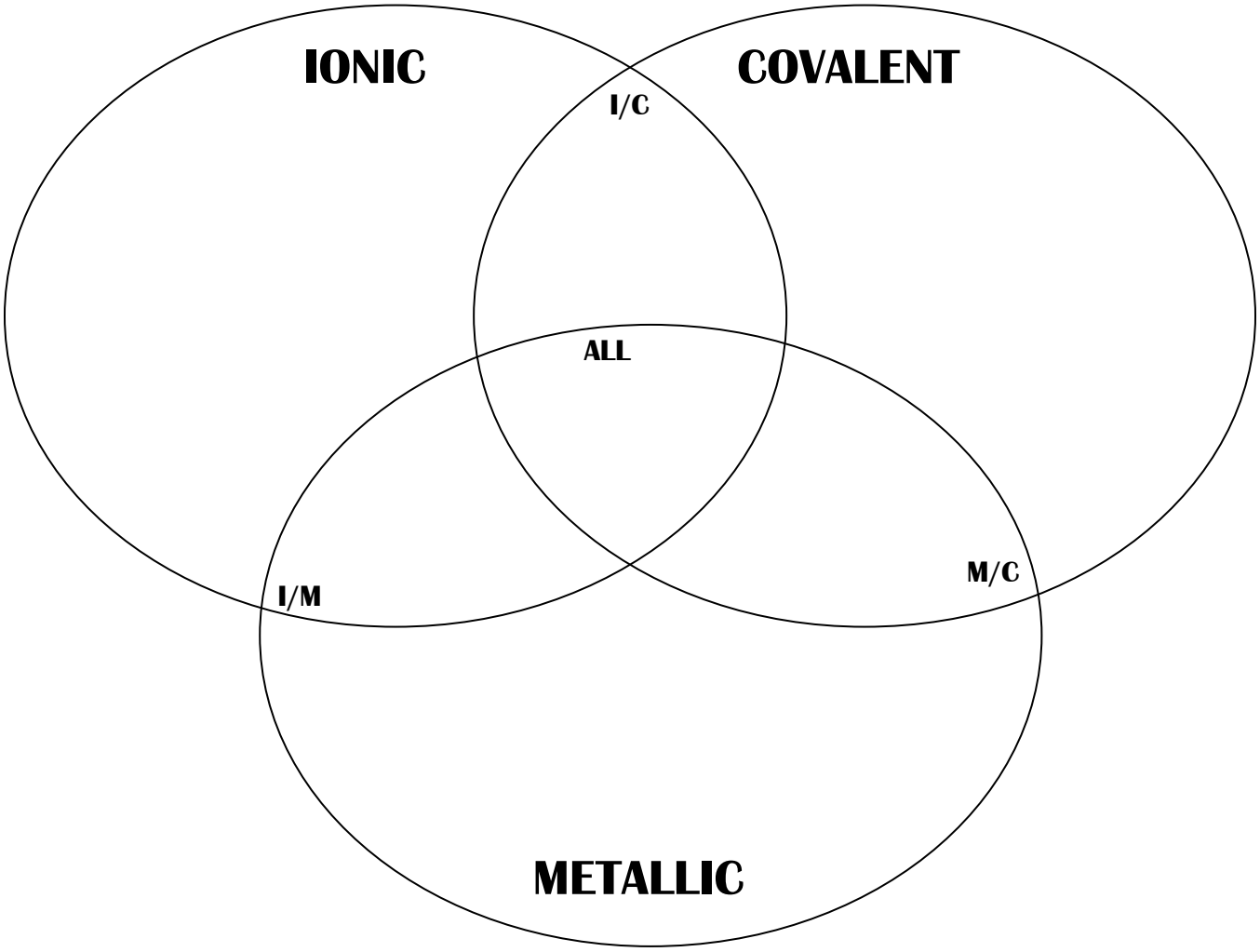
Molecular Geometry



Ionic vs. Covalent vs. Metallic compounds

Place the following words in the ionic circle, covalent circle, and metallic circle or in between the circles if the properties apply to more than one.

*Metal * ductile *high melting point *crystal *nonmetals *share electrons *Transfer electrons *alloy *molecule *low melting point *malleable *type of bond *uses electrons to bond * conducts electricity *variable melting point * steel *$CaCO_3$ *sea of electrons *doesn't conduct electricity *H_2O



Name _____ Date _____ Period _____

Ionic Compounds Vs. Covalent Compounds

Ionic Name	Formula		Covalent Name	Formula
Magnesium chloride	$MgCl_2$		Carbon dioxide	CO_2
Iron (III) oxide	Fe_2O_3		Dinitrogen disulfide	N_2S_2
Sodium nitrate	$NaNO_3$		Dihydrogen monoxide	H_2O

Use **COMPLETE SENTENCES** to answer the following questions. Please do not start your complete sentence with BECAUSE. (Complete sentences= 10 points.)

1. **How are the way you name ionic compounds and covalent compounds SIMILAR?**
   Ionic and covalent compound's names are similar because
   _____
   _____
2. **How are the way you name ionic compounds and covalent compounds DIFFERENT?**
   _____
   _____
   _____
3. **How can you tell the difference between an ionic compound and a covalent compound?**
   _____
   _____
   _____
4. **Why do you have to use Roman numeral sometimes when naming ionic compounds?**
   _____
   _____
   _____
5. **What is the only time you don't use prefixes when naming covalent compounds?**
   _____
   _____
   _____