Unit 4 - Interactive Notebook
Bonding and IMF

Name:
Period:

Word Wall	Unit 1 Learning Tracker	Unit Opener	
Task Set 1	Task Set 2	Task Set 3	Task Set 4
Task Set 5	Task Set 6	Assignment Log	

Word Wall:

Term	Definition	Example	Picture
Bond			
Covalent			
Ionic			
Metallic			
Polar			
Molecule			
Compound			
Mixture			
Monatomic ion			
Polyatomic ion			
Hydrogen bonds			
Non-polar			
Diatomic molecules			

Unit 4 Learning Tracker:

Bonding and IMF: Use data and models to describe the types and properties of chemical bonds, to inform the formulas of substances, to predict intermolecular forces, and to explain macro-level physical properties of substances.

Anchoring Phenomenon: Chemists use and design materials that utilize the properties of molecules to solve problems.
Unit Essential Questions: How do the structures of molecules determine bulk properties?

How can we answer the task set EQ?	**How does this help us explain the anchoring phenomenon?**
TS1 EQ: Why do substances have different properties? What about the compounds is different and dictates the properties of that substance?	_____ *helps us explain...*
Response:	
TS2 EQ: How do Ionic bonds form and how are they named?	
Response:	
TS3 EQ: How do valence electrons allow us to predict how elements combine?	
Response:	
TS4 EQ: How do the attractions between molecules affect a substance's properties?	
Response:	
TS5 EQ: Unit assessment	
Response:	
TS6 EQ: Salad dressing engineering	
Response:	
Unit Essential Questions: How do the structures of molecules determine bulk properties?	
Response to Unit Essential Question:	

Unit Opener: Why does salad dressing contain an oil, an acid, and an emulsifier?
Our unit's larger investigation will be making the "best" recipe for a salad dressing. Use these slides and our class Jamboard to document our beginning work on this project.

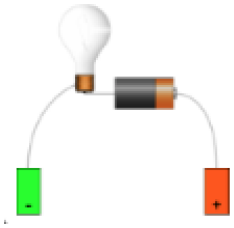
Compare and contrast the three different types of substances that make up salad dressings:

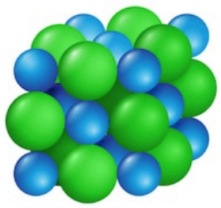
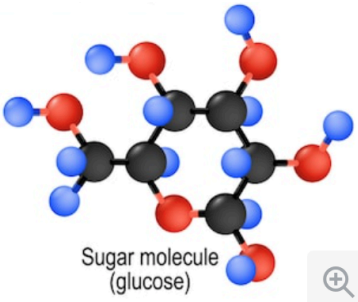
Compare - how are they alike?	Contrast - how are they different?

Think about your favorite salad dressing. What are its specific different substances (some speculating may be required)?

Acid	Oil	Emulsifier

Task Set 1: Why does table salt dissolve and conduct, but not melt? Sugar, also a white solid, dissolves, but does not conduct. What are the differences between these two compounds that can explain these properties?

Look at the salt and sugar phet simulation here Drag the conductivity apparatus into the liquid Conductivity 	Try shaking salt into the container What happens to the light? Drain the container and refill it. Shake sugar into the container What happens to the light? Click on the micro tab. What do you notice happens when the salt goes in the water vs the sugar in the water? Click on the water tab What do you notice happens when the salt is dragged into the water vs the sugar in the water?
Below are shutterstock images of salt and an image of sugar by Designua	What do these images have in common(the same) ? What differences do you see between the images?

 Salt molecule  Sugar molecule (glucose)	The difference between the images lead to the different properties you see. Can you make a guess what they are?

Below are some common substances. Put in your experiences with these substances in the table below. If you don't have experience, talk with your teacher about how to safely test these items. We've filled out the conductivity column for you.

substance	Formula or elements	Does it melt on a stove (no, slowly, or quickly)	Does it dissolve in water?	Does it conduct electricity?
Table salt	NaCl			
Epsom salt	$MgSO_4$			
Salt substitute	KCl			
Dextrose	$C_6H_{12}O_6$			
Sugar	$C_{12}H_{22}O_{11}$			
Candle wax	$C_{18}H_{36}O_2$			
Crayons	$C_{25}H_{52}$			
Brass	CuZn			
Nails	FeCrMo			
Nickels	CuNi			

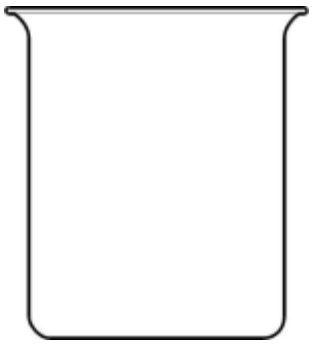
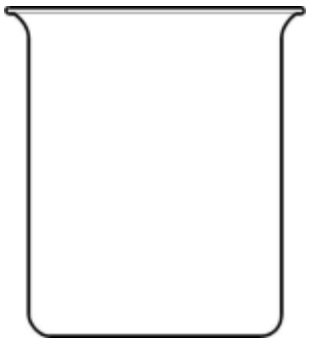
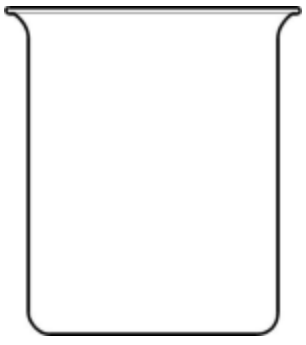
Look at the table above and sort them into 3 groups based on some properties you see

Grouped together			
Elements involved			
Electronegativity difference between elements			
Electronegativity average			
What will electrons do? 1. choose one element and			

leave the other = make ions (big difference) 2. be strongly attracted to both elements (small difference, high average) 3. be weakly attracted to all elements (small difference medium to low average)			
What is a good name for this kind of compound? Ionic = made of ions Metallic = made of metals Covalent = share valence electrons			

What generalizations can you make about substances that dissolve?	What generalizations can you make about substances that conduct?
•	•

In the beakers below, draw a SPM to represent each scenario:

Does Not Dissolve	Dissolves, does not conduct	Dissolves and conducts
		

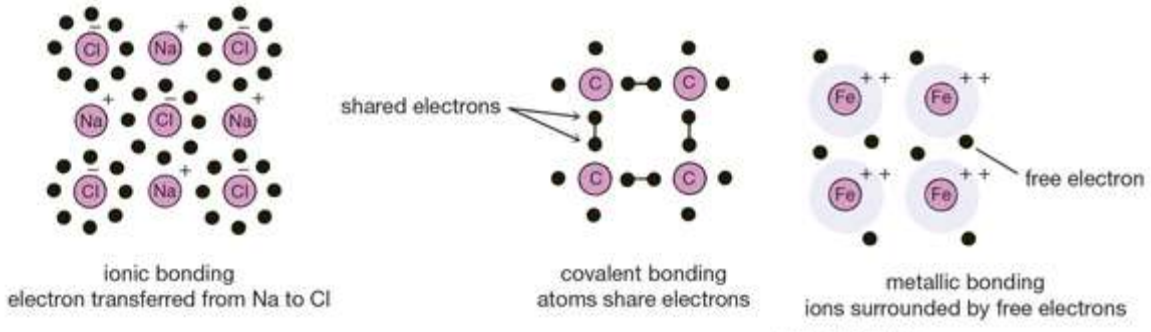
Looking back at salt and sugar. What kinds of bonds do they have and why?

Reflect:

- How do salt and sugar act different
- Can you answer the Task Set Essential Question: What is it that makes these substances act differently? *Unit 4 Learning Tracker*.

Task Set 2 : How do Ionic bonds form and how are they named?

There are three kinds of bonds: **ionic**, **covalent** and **metallic**. **Ionic bonds** are made of **ions**. **Ions** are made when an atom _____ or _____ electrons (electrons are transferred between atoms). **Covalent bonds** are made when two atoms _____ their valence electrons. **Metallic bonds** happen between two or more metal atoms and the electrons float around, not associated with any particular atom.

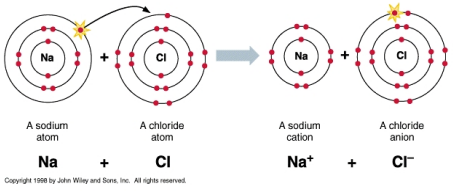


Imagine three different materials: butter, a cooking pan, and salt. Fill in the table below for each of the following materials:

Type of material	**butter**	**pan**	**salt**
Type of elements (metal only, nonmetal only or metal and nonmetal)			
What happens to electrons			
Type of bond			

Focus: Ionic Bonds - What do they look like?

I. Writing & Naming Ionic Compounds

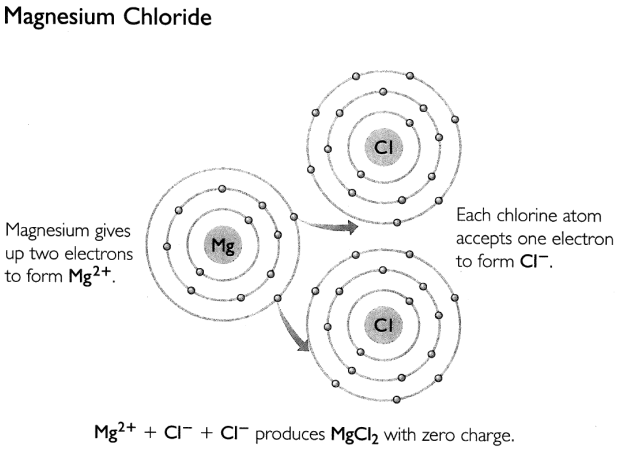


Atoms are motivated to gain or lose electrons in order to get 8 valence electrons in their outer shell (exception: _____.) This can be accomplished by sharing electrons, which occurs generally between two _____. Or, it can occur when electrons are transferred from the _____ to the _____ atom.

When magnesium combines with chlorine, the metal magnesium loses both of its valence electrons to reveal the full valence shell beneath. Each nonmetal chlorine only needs one electron to fill its outer (valence) shell. This creates an imbalance. If I only have one magnesium atom and one chlorine atom, the remaining electron has no place to go. We need to bring in an additional atom of chlorine to make all the charges balance. How

many magnesium atoms and chlorine atoms are needed to ensure all electrons have a place to go and the resulting compound has no charge?

Look at the picture to the right. Explain what this picture is showing and why the resulting balanced compound is $MgCl_2$.



Now, if we had to draw out Bohr models each time we wanted to write a balanced compound, it would be very time consuming. There is a shorter way! The steps below outline how to put together an ionic compound [1].

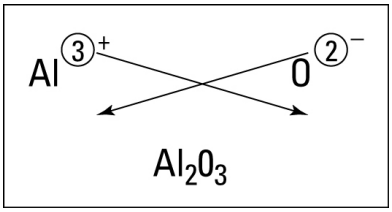
A. Identify the cation. (positive ion - usually the 1st element)
   a. Cation is written first in the name of the compound.

B. Write the correct formula and charge for the cation. (based on periodic table)

C. Identify the anion. (Negative ion - usually the remainder of compound

D. Write the correct formula and charge for the anion.
   a. May come from periodic table or table of ions

E. Make sure the ratio of positive cations to negative anions add up to zero
   a. If the charges on the cation and anion are equal size (i.e. +1/-1, +2/-2, +3/-3), then you have a 1:1 ratio.
   b. If the charges on the cation and anion are NOT equal size, the value of the positive cation charge tells you the number of negative anions you need. The value of the negative anion charge tells you the number of the cations you need. Cross the values as shown in the picture.



   c. Some anions are more than one element. These are called polyatomic ions (meaning many atoms). If you need more than one polyatomic ion, put parentheses around the whole ion and put the number on the outside of the parenteses
   d. Never write charges in your final compound.

F. Simplify ratio of cation to anion to get the smallest ratio.

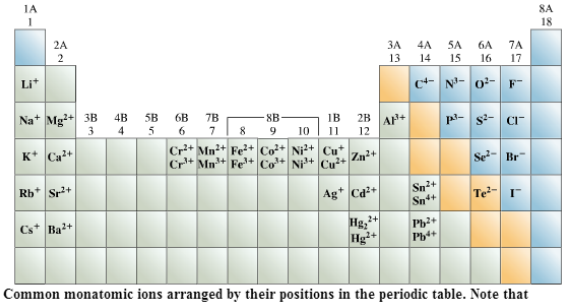
A note about polyatomic ions

Sometimes nonmetals combine in a way that doesn't quite make a compound. To make every atom have the right number of valence electrons, they have to add 1, 2, or 3 electrons to be stable. These get bundled together into one ion and are called **polyatomic**, meaning there is more than one atom that makes up the ion.

[1] "Writing Formulas for Ionic Compounds - OCCC.edu." http://www.occc.edu/kmbailey/Chem1115Tutorials/Formulas_Ionic.htm. Accessed 29 Mar. 2020.

Common Polyatomic Ions	
Nitrite	NO_2^-
Nitrate	NO_3^-
Sulfite	SO_3^{2-}
Sulfate	SO_4^{2-}
Phosphite	PO_3^{3-}
Phosphate	PO_4^{3-}
Carbonate	CO_3^{2-}
Hydroxide	OH^-
Hypochlorite	ClO^-
Chlorite	ClO_2^-
Chlorate	ClO_3^-
Perchlorate	ClO_4^-
Permanganate	MnO_4^-
Acetate	$C_2H_3O_2^-$
Hydrogen carbonate	HCO_3^-
Ammonium	NH_4^+
Iodate	IO_3^-

For example, a nitrite ion is NO_2^{-1}. It is composed of one nitrogen and two oxygens. Together these three atoms are covalently bonded, they need one additional electron to be stable. We'll learn more about this in the next section. The picture on the left references the most common polyatomic ions and their charges. Make sure you copy them with the small subscript when writing them.



Common monatomic ions arranged by their positions in the periodic table. Note that mercury(I), Hg_2^{2+}, is not actually a monatomic ion.

What common *d*–block ion (see the figure above) is isoelectronic with Zn^{2+}?

Naming compounds

When naming compounds or writing compounds the positive cation always goes first. The name is the same as what is written in the periodic table. Anions have 2 rules. If they are a single element, the ending of the element changes to -ide. For example: The anion, Cl, is called chlorine on the periodic table. Since it is an anion, the ending of its name changes to **-ide**. So, chlorine becomes chlor**ide**. The compound is called magnesium chloride.

For compounds with polyatomic ions, the cation still keeps its own name, but the polyatomic ion does as well. Use the chart above to see the names of the common polyatomic ions. For example, $Sr_3(PO_4)_2$ is called strontium phosphate.

Let's practice!

Fill in the table below:

Ions	Compound formula	Compound Name
Ca and NO_3^{-1}		
Al and OH^{-1}		
	$BaSO_4$	
		Iron (II) Phosphate
K and SO_4^{-2}		
	PbO_2	

Task Set 3: How do valence electrons allow us to predict how elements combine? (Lewis dot structures)

1. Draw the lewis dot structure for calcium.	 Double-click to edit and input the correct symbol and number of electrons
2. Draw the lewis dot structure for chlorine.	 Double-click to edit and input the correct symbol and number of electrons
3. What type of bond are these two elements likely to form? *Use a EN difference table to calculate the type of bond (ionic, polar covalent, nonpolar covalent).*	
4. Based on their valence electrons, how many atoms of each element will we need?	
5. Draw the outcome of these two elements bonding.	 Double-click to edit and input the correct symbol and number of electrons
6. What's the name of this compound?	

Task Set 4: How do the attractions between molecules affect a substance's properties? What do some covalent compounds act differently than others? (Molecular polarity)

Metallic bonds like steel nails usually melt at high temperatures and don't dissolve in water. Ionic bonds like those in salt usually melt at high temperatures and do dissolve in water. Covalent bonds are more complicated. Think about the difference between coconut oil and sugar. Both have covalent bonds, but both act in different ways. Coconut oil is a solid in the winter, but in the summer it will melt if left in the sun. It also doesn't dissolve in water. Sugar is a solid and it is hard won't melt unless you leave it on a hot stove for a while. It easily dissolves in water. What is different about these two molecules?

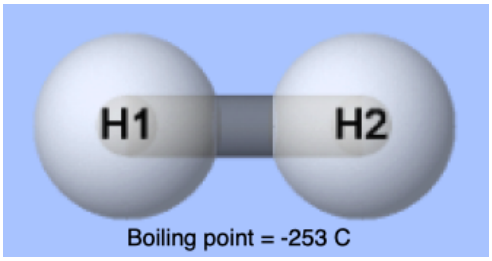
Go to the phet simulation listed here
Answer the following questions

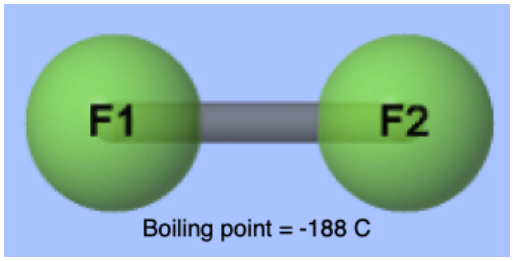
Atom A Electronegativity	**Atom B Electronegativity**	**Size of bond dipole** (none, small, med, large)	**Direction of bond dipole** (none, points to A or points to B	**Bond character**	**Electrons** (Near A, Near B, evenly spaced)
Low	Low				
Low	Med				
Low	High				
Med	Low				

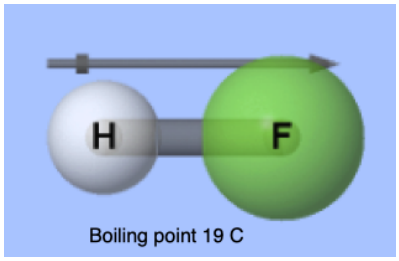
Med	Med				
Med	High				
High	Low				
High	Med				
High	High				

A polar bond is a bond where the electrons are pulled in one direction. What circumstances lead to a polar bond? *Tip: Try to use the words electronegativity in your response.*

How does this affect real molecules and their properties?
Look at the molecules below. The arrows represent polar bonds

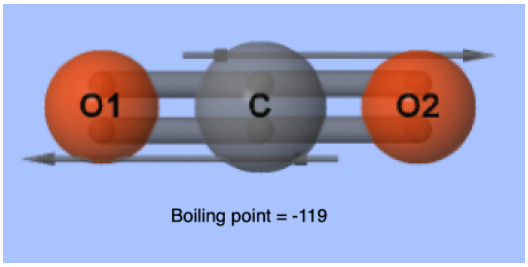


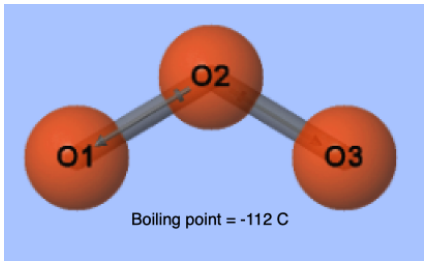


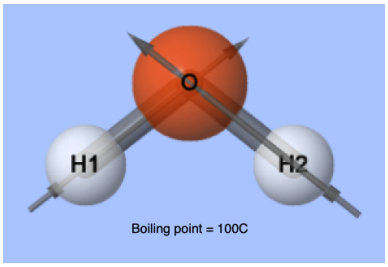


What is different about the molecules that have a negative boiling point versus the one that has a positive boiling point?

A molecule is usually more than two atoms connected together. When we have more than one bond, we have to see how those interact. Look at the molecules below. The arrows represent polar bonds.

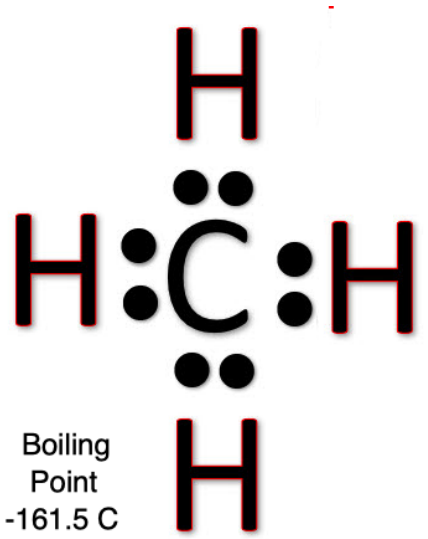
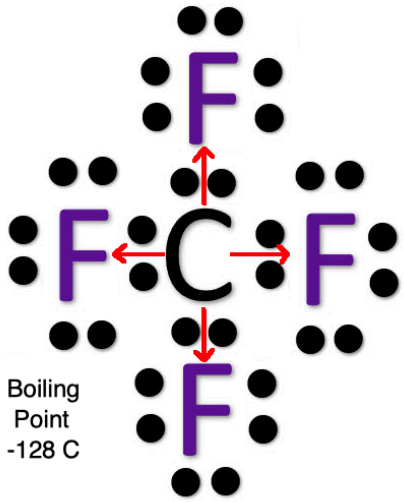
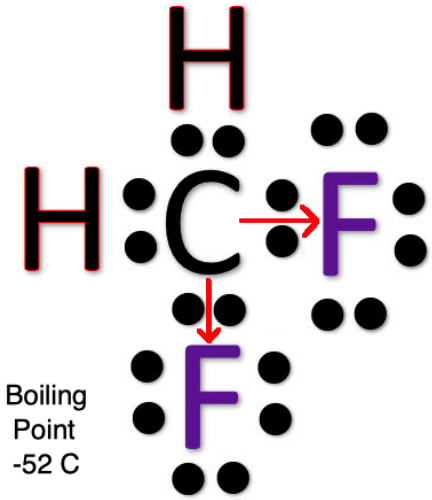






What is different about the molecules that have a negative boiling point vs the one that has a positive boiling point?

Things get more complicated when you get more bonds.

methane	tetrafluoromethane	difluoromethane
 Boiling Point -161.5 C	 Boiling Point -128 C	 Boiling Point -52 C

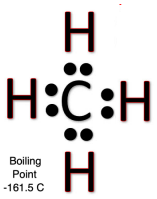
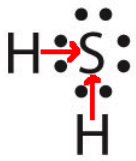
What do you think causes the boiling point to be higher for difluoromethane than methane? *Hint: look for differences in the number of dots, are there arrows indicating polar bonds? do the arrows cancel?*

Here is a table with the data

Molecule (View from above)	**Does it have polar bonds?** (look for arrow in the pictures	**Do the bonds cancel?** (go exactly opposite directions)	**Boiling point**	**Does it dissolve in water?**
H-H			low	Small amounts
F-F			low	Reacts with water
H-F			high	Very well
O=C=O			low	Small amounts
O-O-O			low	Small amounts
H-O-H			high	Very well

Based on the data you have seen, what do you think would make something dissolve in water very well?
Hint: think about the arrows. If the electrons are pulled towards one part of a molecule, it can make the molecule have a charge. Do you think the molecules that dissolve are charged or not charged?

Below are the molecules

methane	Dihydrogen monosulfide
	
Natural gas	Added to natural gas by gas company

Why does the gas company add dihydrogen monosulfide (H2S) to natural gas (methane-CH4)?
Word bank: polar, nonpolar, mucus, receptor, symmetrical, asymmetrical, bond, molecule

Sentence Frames:

_____ needs _____ because… This is due to…
_____ is illustrated by… This causes….
_____ contains _____ and tends to… This results in..

Task Set 5: Assessment

Task Set 6: Salad Dressing engineering

Assignment Log:

Assignment	Due	Turned in on Canvas?
TS 1 - Unit Opener - kinds of bonds	-	-
TS 2 writing and naming ionic		

compounds		
TS 3 valence electrons and bonding		
TS 4 why do different covalent compounds act different		
TS 5 unit 4 assessment		
TS 6 Salad dressing engineering		