HONORS CHEMISTRY: Reviewing Ionic Bonds

DATE:_____

Learning Activities: **SWBAT. . .**

…review/extend ionic bond knowledge base.

SODIUM <3 CHLORINE

IN MOST STABLE COMPOUNDS, ALL ATOMS INVOLVED HAVE GAINED NOBLE GAS ELECTRON CONFIGURATIONS.

- It is extremely important and useful to start viewing chemical bonding in this fashion.
- In ionic compounds, atoms will gain or lose electrons to become ____________ with the closest noble gas.

ex) Na = **Cl =**

If sodium loses one electron it becomes **isoelectric** with neon:

If chlorine gains one electron it becomes **isoelectric** with argon:

Remember: all chemical compounds have to be…
These ions form a 1:1 ratio, NaCl.

Try this…

ex) **Al =** **O =**

If aluminum loses three electrons it becomes **isoelectric** with neon:

If oxygen gains two electrons it becomes **isoelectric** with neon:

So it would take 2 aluminum ions (+3 charge) to balance out 3 oxygen ions (-2 charge) =

- Ionic compounds are composed of _____________ combining together into large, stable ______________.
- Cations will always be ______________ than their parent atom, anions will always be _________________.
- Many transition metals are capable of multiple charges, for reasons beyond the scope of this class.
- Polyatomic ions are…

Predict the most likely charge of the following ions. What noble gas do they become isoelectric with?

Rb = **Se =** **Mg =** **Ga =** **Br =**

Determine the formula for the following ionic compounds:

beryllium bromide **ferric hydroxide** **ammonium bicarbonate**

Determine the name of the following ionic compounds:

$CoBr_3$ **NaClO** **$LiC_2H_3O_2$**

"Look not mournfully into the past. It comes not back again. Wisely improve the present. It is thine. Go forth to meet the shadowy future, without fear." ~ Henry Wadsworth Longfellow

HONORS CHEMISTRY: ELECTRONEGATIVITY AND YOU DATE:_____

LEARNING ACTIVITIES: **SWBAT. . .**

…explain the relationship between bond length and bond energy.

…use electronegativity values to determine the nature of a chemical bond.

Remember that **bond energy** (KJ/mol)…

… is the energy required to…

… also equals…

… and bond length are…

- As bond length decreases…

ex) H - H length = 75pm Bond energy = 436 KJ/mol

I - I length = 266 pm, Bond energy = 151 KJ/mol

Remember: ionic bonds are _____________________. Covalent bonds are ____________________.

WHAT CAUSES CERTAIN COMPOUNDS TO HAVE IONIC BONDS AND OTHERS TO HAVE COVALENT BONDS?

-

ELECTRONEGATIVITY:

- Values range from ______________________ to ______________________.
- The higher the value…
- This is similar to electron affinity and follows the same periodic trends.
- Note: As with electron affinity, we'll ignore the noble gases since…

VERTICAL TREND:

Why? As previously stated, radius and shielding effects both _____________ down a family

∴ the nucleus has…

HORIZONTAL TREND:

Why? As previously stated, the number of protons ________________

, while the shielding effect remains ________________

∴ the nuclear pull on the electrons in a bond_______________.

ALL ELECTRONS ARE NOT EQUALLY SHARED! THIS DECIDES WHAT TYPE OF CHEMICAL BOND EXISTS!

To determine what kind of chemical bond is present, one must compare the electronegativities of the two atoms. ***Determine the <u>absolute</u> difference between the two atoms:***

TYLER DEWITT TALKS ABOUT ELECTRONEGATIVITY

H 2.1																	He x
Li 1.0	Be 1.5											B 2.0	C 2.5	N 3.0	O 3.5	F 4.0	Ne x
Na 0.9	Mg 1.2											Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0	Ar x
K 0.8	Ca 1.0	Sc 1.3	Ti 1.5	V 1.6	Cr 1.6	Mn 1.5	Fe 1.8	Co 1.9	Ni 1.9	Cu 1.9	Zn 1.6	Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8	Kr x
Rb 0.8	Sr 1.0	Y 1.2	Zr 1.4	Nb 1.6	Mo 1.8	Tc 1.9	Ru 2.2	Rh 2.2	Pd 2.2	Ag 1.9	Cd 1.7	In 1.7	Sn 1.8	Sb 1.9	Te 2.1	I 2.5	Xe x
Cs 0.7	Ba 0.9	La-Lu 1.0-1.2	Hf 1.3	Ta 1.5	W 1.7	Re 1.9	Os 2.2	Ir 2.2	Pt 2.2	Au 2.4	Hg 1.9	Tl 1.8	Pb 1.9	Bi 1.9	Po 2.0	At 2.2	Rn x
Fr 0.7	Ra 0.9	Ac 1.1	Th 1.3	Pa 1.4	U 1.4	Np-No 1.4-1.3											

WHAT IS THE ELECTRONEGATIVITY DIFFERENCE? *WHAT TYPE OF BOND IS IT?*

< 0.3 ex) = equal sharing of e^-

0.3 - 1.7 ex) = uneven sharing of e^-

> 1.7 ex) = complete transfer of e^-

Note 1: If the difference is right on the split between two choices (0.3 or 1.7), then you'll have to use experience to determine which bond type is present.

Note 2: Not everyone agrees on the cut-off points between the different bond types.

Find electronegativity difference of each of the following types of bonds & determine bond type.

H-H **Rb-Br**

Na-Cl **F-Cl**

Ca-S **Ca-O**

H-O **C-H**

REVIEW & REFLECTION

"He who has a why to live can bear almost any how." ~ Friedrich Nietzche

HONORS CHEMISTRY: Lewis Dot Structures *DATE:_____*

Learning Activities: **SWBAT. . .**

…draw Lewis structures for covalent compounds.

LEWIS STRUCTURES [A.K.A. LEWIS DOT STRUCTURES]:

- Each atom usually wants ____ electrons, either through _________________ or _____________________.

- Unshared pair:

Symbols used in Lewis Dot Structures:

Unshared pair:

Single bond: (Represents the sharing of one pair of electrons between two atoms.)

Double bond: (Represents the sharing of two pairs of electrons between two atoms.)

Triple bond: (Represents the sharing of three pairs of electrons between two atoms.)

Though not usually done, how would you draw Lewis structure for single atoms?

- Look at the periodic table to determine the number of valence electrons that atom has.
- Can put up to two dots (representing two electrons) on each of symbol's four sides.
- Electrons will take side to themselves before they pair up.
- All sides are equivalent, so it doesn't matter which side you put unshared pairs (or bonds) on.

H Cl O C

More importantly, how do you draw Lewis structures for entire molecules?

1. Count up total number of valence electrons.

-

2. Draw chemical symbols in rough representation of structure of molecule.

-

- General guideline:

- General guideline:

BOZEMAN SCIENCE
TALKS LEWIS DOT

3. Start by connecting the atoms to each other with single bonds.

- Though there are exceptions, most atoms will not…

4. Then distribute unshared pairs to the atoms so as to complete as many octets as possible.

- Remember:

- If there aren't enough electrons to give every atom a full octet then (and only then)…

    …

- Usually there aren't leftover electrons, but if there are… *t*

5. CHECK YOUR WORK. Make sure that you used the correct number of electrons!

Try drawing the Lewis Structure for HCl...

Try drawing the Lewis Structure for CH_2O...

CRASH COURSE
ON LEWIS DOT

Try these for practice: ICl, HBr, CH_2Cl_2, CH_3OH, CO, N_2, HCN, C_2H_2, C_2Cl_4

"To find contentment, enjoy your life without comparing it with that of another."
~ Condorcet

HONORS CHEMISTRY: ADVANCED LEWIS DOT STRUCTURE RULES DATE:_____

Learning Activities: **SWBAT. . .**

…explain and draw resonance structures.

…draw Lewis Dot Structures for polyatomic ions.

OZONE HOLE

SITUATION #1: ODD NUMBER OF VALENCE ELECTRONS

Try to draw the Lewis Structure for NO_2.

- Due to the odd number of electrons…
- In cases like this:
- This is allowed if octet formation is impossible.
- Rather unstable structures, but they can exist.

SITUATION #2: MORE THAN ONE POSSIBLE STRUCTURE

Try to draw the Lewis Structure for ozone, O_3.

- Sometimes two drawings are equally possible.
- Which one exists?
- Actual bond is…

  (Bond length measurements match expected results.)
- **Resonance structures:**
- Draw all possible structures and use a double ended arrow to point between each.

SITUATION #3: POLYATOMICS

Try to draw the Lewis Structure for the ammonium polyatomic, NH_4^+.

Remember,

The only difference is that…

- Add or subtract electrons as defined by charge
- Complete the Lewis Structure as normal, accounting for electron charges.
- Put entire structure in brackets and indicate charge.

RESONANCE STRUCTURES

"If we are ever in doubt to what to do,
it is a good rule to ask ourselves what we shall wish tomorrow
that we had done today." ~ Avebury

POLYATOMIC LEWIS STRUCTURES

HONORS CHEMISTRY: V.S.E.P.R. IS YOUR FRIEND DATE:_____

Learning Activities: … predict the shape of a molecule from its Lewis structure using VSEPR theory.

LEWIS STRUCTURES ARE A 2-D REPRESENTATION OF A MOLECULE.
WE CAN ALSO USE LEWIS STRUCTURES TO PREDICT THE 3-D SHAPE OF MOLECULES.

- The shape of a molecule is extremely important information. For example…

VSEPR THEORY:

THE RULES

1. **Draw Lewis structure for the molecule.**

2. **Count up the number of electron clouds on a single atom.**

What counts as an electron cloud?

-
-

3. **Determine the basic geometry.**

Two electron clouds =

Three electron clouds =

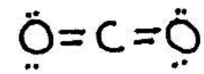
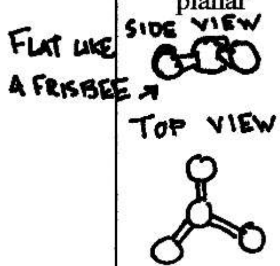
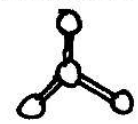
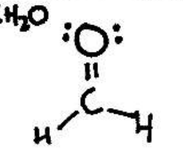
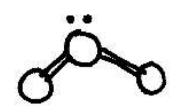
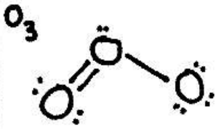
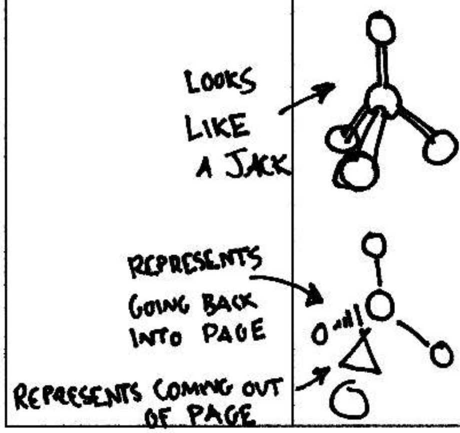
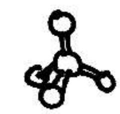
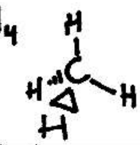
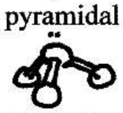
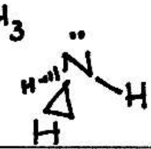
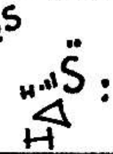
Four electron clouds =

4. **Determine the actual geometry by looking at the number of bonding/nonbonding electron pairs.**

-

5. **Adjust bond angles due to unshared pairs.**

-

# of electron clouds	Geometry category	Bonding pairs	Unshared pairs	Actual molecular geometry	Example
2	Linear	2	0	Linear 	CO_2 
3	Trigonal planar 	3	0	Trigonal planar 	CH_2O 
		2	1	Bent 	O_3 
4	Tetrahedral 	4	0	Tetrahedral 	CH_4 
		3	1	Trigonal pyramidal 	NH_3 
		2	2	Bent 	H_2S 

Determine the geometry and draw the structural formulas for the following molecules:

BF_3, $CHCl_3$, Br_2, $AlCl_3$, HCl, PH_3, NO_2, H_2O, H_3O^+, GaI_3, CF_3Cl, CO

TYLER DEWITT ON VSEPR

"Seize from every moment its unique novelty, and do not prepare your joys." ~ Andre Gide

TO DETERMINE THE INTERMOLECULAR FORCES ALLOWED BY A MOLECULE, YOU MUST FIRST DETERMINE WHETHER IT IS POLAR OR NON-POLAR!

ARE ALL THE ATOMS ATTACHED TO THE CENTRAL ATOM THE SAME?

NO → YOU ARE MOST LIKELY POLAR...

YES ↓

IS THE CENTRAL ATOM FREE OF UNSHARED PAIRS?

NO → YOU ARE MOST LIKELY POLAR...

YES ↓

IS THE STRUCTURE SYMMETRIC? (LINEAR, TRIGONAL PLANAR OR TETRAHEDRAL)

NO → YOU ARE MOST LIKELY POLAR...

YES ↓

YOU ARE MOST LIKELY POLAR...

AND HAVE AN UNEVEN DISTRIBUTION OF CHARGE.

↓

DO YOU HAVE AN H-N, H-F OR H-O BOND?

NO → NOT BAD! YOU CAN FORM STRONG **DIPOLE-DIPOLE** INTERMOLECULAR FORCES. (1-25KJ/MOL)

YES → YOU HAVE ACHIEVED THE STRONGEST INTERMOLECULAR FORCE... THE **HYDROGEN BOND!** (10-40 KJ/MOL)

YOU ARE MOST LIKELY NON-POLAR...

AND HAVE A SYMMETRIC DISTRIBUTION OF CHARGE.

↓

THE ONLY INTERMOLECULAR FORCE AVAILABLE TO YOU ARE **LONDON DISPERSON FORCES** (AKA LONDON FORCES AKA VAN DER WAALS FORCES) (0.4-4.0 KJ/MOL)

NOTE: LDF IS THE DEFAULT IMF. EVERYONE CAN DO IT.

FOR THE SAKE OF COMPARISON
INTRAMOLECULAR FORCES:
IONIC BONDS: 400-4000 KJ/MOL
COVALENT: 150-1100 KJ/MOL
METALLIC: 75-1000 KJ/MOL

CRASH COURSE
POLAR AND NON-POLAR

'Only from the alliance of the one, working with and through the other, are great things born.' ~ Antoine de Saint-Exupery

HONORS CHEMISTRY: Intermolecular Forces DATE:_____

Learning Activities: **SWBAT. . .**

…define and differentiate the difference intermolecular forces available in between covalent molecules.

What differentiates covalent bonds from ionic is that…

∴ no ions are made,

∴ no ionic compounds are made. **They exist as separate, discrete molecules.**

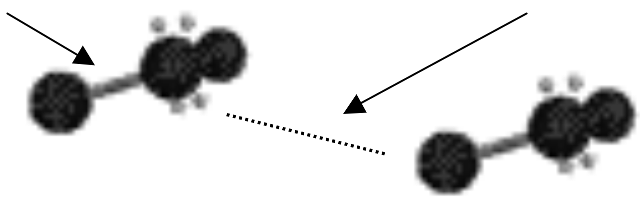
NICE SUMMARY

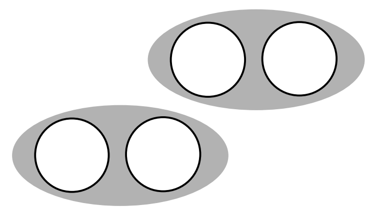
It is critical to understand how covalent molecules interact with each other.

INTERMOLECULAR FORCES:

- These are not chemical bonds! There is no transfer or sharing of electrons!

- These forces are always much weaker than chemicals bonds.
- If enough are present, however, they can have…
- Intermolecular forces are broken before chemical bonds are ∴





There are three different types of intermolecular forces:

LONDON DISPERSION FORCES

-The only intermolecular force that substances with ________________________________ can experience.

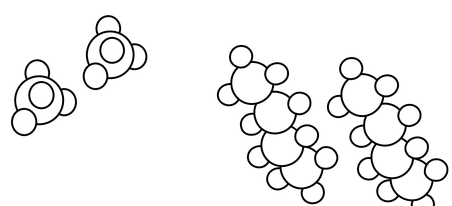
- Since both atoms have an equal pull on the electron cloud, it remains evenly distributed.
-

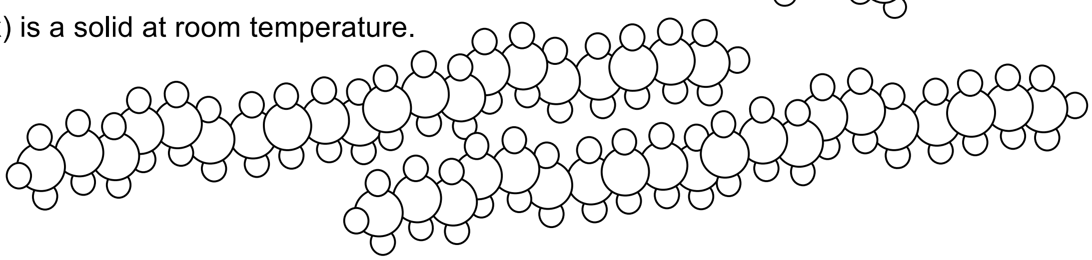
- Bigger the compound larger the forces:

CH_4 (methane) is a gas at room temperature.

C_4H_{10} (butane) is a liquid at room temperature.

$C_{12}H_{24}$ (a wax) is a solid at room temperature.

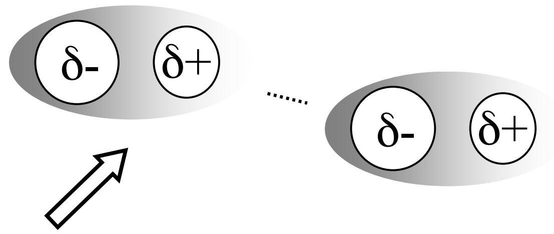




Compounds with polar covalent bonds can have stronger intermolecular interactions. Why?

- Polar molecules have an unequal distribution of the electron cloud ∴

- Though the are still overall neutral, they can have a____________________ and_________________________ part of the molecule.



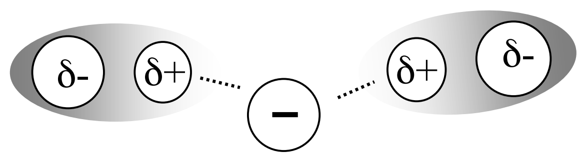
DIPOLE FORCE:

- These involve permanent charge distributions ∴

- The geometry of the molecule is also important for dipole force creation (more on this later in the chapter).

(NOTE: The charged ends of polar molecules can also interact with charged ions.)

-



A stronger sub-class of dipole forces is the **HYDROGEN BOND**

- Despite the name, **THIS IS NOT A CHEMICAL BOND.**

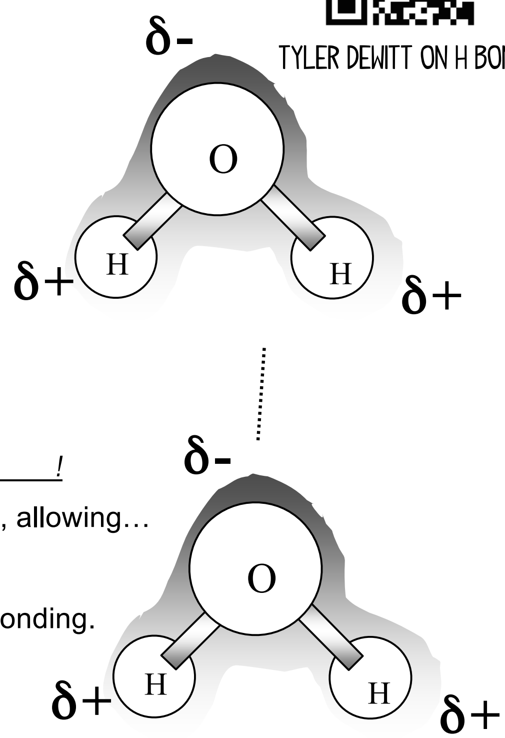
- It is…

- The strongly electronegative element…

This creates stronger partial charges ∴

- Pretty strong as intermolecular forces go, but…

TYLER DEWITT ON H BONDS



CRITICAL TO LIFE AS WE KNOW IT!

- Otherwise water would probably be a gas around__________________*!*

- When frozen, hydrogen bonds lock water into a less dense structure, allowing…

…

- The double helix of ________ is bound together through hydrogen bonding.

This allows…

"No man suffers injustice without learning, vaguely but surely, what justice is." ~ Isaac Rosenfeld

HONORS CHEMISTRY EMPIRICAL FORMULA DETERMINATION

INTRODUCTION:

Remember that an empirical formula of a compound is the simplest whole-number ratio of atoms making up that compound. In this experiment you will burn a known mass of magnesium in the presence of atmospheric oxygen. Based on the Law of Conservation of Mass, you will be able to determine the amount of oxygen that reacted. From this, you can determine the empirical formula of the product.

MATERIALS:

Crucible and Cover	Crucible tongs	Pipe Stem Triangle	
Ring stand w/Iron ring	Bunsen burners	Balances	Safety goggles

CHEMICALS: Approximately 25 cm of magnesium metal ribbon

NOTE:

The crucibles will get very hot during the experiment. Practice handling them with the crucible tongs while they are cool. ***They are fragile and expensive, so be extra careful!***

PROCEDURE:

1. Set up your pipe stem triangle on your iron ring. Adjust the height of the iron ring to ~ 4-5 inches above the Bunsen burner.
2. Make sure your crucible and cover are clean. Determine their combined mass.
3. Obtain a 25 cm length of magnesium ribbon and coil it up loosely in the bottom of the crucible.
4. Determine the combined mass of the crucible, lid and ribbon.
5. Place the crucible containing the magnesium on the triangle pipe stem. Place the crucible cover slightly ajar to allow oxygen to enter. Can open wider as time progresses. If the magnesium starts to smoke, replace the lid.
6. Heat gently for two minutes, then heat intensely for an additional ten minutes. Allow to cool.
7. Transfer cool crucible (along with the cover) to the balance and determine the combined mass.
8. Repeat steps 5-7. Until the mass measurements no longer differs significantly.
9. Clean up and put equipment away. Wipe down work area. Put oxide in marked waste beaker.

RESULTS/DATA TABLE:

Be sure to clearly show all data and the results of any calculations. Results should include the mass of all reactants and products (measured or calculated). It should also contain your empirical formula for the oxide of magnesium produced.

CALCULATIONS:

Neatly, show all work for determining data in the results section. You should be able to calculate the mass of oxygen consumed. From there, you can use the technique we learned to determine the empirical formula from the masses of the components.

QUESTIONS:

1. Based on your initial mass of magnesium, use stoichiometry to determine how much magnesium oxide should you have produced. From this determine you absolute and percent error.
2. If the production of magnesium oxide is exothermic, why did you have to heat it up?

What would you attempt to do if you knew you could not fail? - Dr. Robert Schuller

HONORS CHEMISTRY BUNSEN BURNER FLAME TEMPERATURE ESTIMATION

INTRODUCTION:

We can use the principles of specific heat to determine an approximate temperature for the Bunsen burner flame. Remember that the equation for change in heat **(Q) = (ΔT x m x c_p).** If we heat a suspended iron nail (Cp = 0.444 J/g/°C) in the flame, we can make a general assumption that the nail's final temperature will eventually equal the flame's temperature. Given this, you should be able to use a water (Cp = 4.184 J/g/°C) calorimeter to calculate the flame's temperature.

BEFORE YOU CAN ENTER THE LABORATORY:

Review your specific heat notes/experiments. Make a blank data table to record all data necessary during the procedure. Set up the equation that you will use to solve for the temperature, accounting for constants. Your pre-experimental work must be approved by your instructor before you can start!

MATERIALS:

Ring stand w/Iron ring	Bunsen burners	Balances	Safety goggles
250 ml beaker w/Styrofoam cup	Chrome wire	Iron nail	Thermometer

NOTE: *The nail and wire will get very hot during the experiment. Be very careful not to touch them!*

PROCEDURE:

1. Make a simple calorimeter by nestling a Styrofoam cup in a 250 ml beaker. Measure the mass.
2. Fill the cup with enough water to submerge the entire nail. Record the mass of calorimeter with water.
3. Determine mass of nail. Suspend it from a chrome wire hanging from the iron ring on the ring stand.
4. Light burner. Adjust iron ring so that the tip of the nail is centered in the inner cone of the flame.
5. Heat nail for ten minutes. Near the end of the ten minutes, record the initial temperature of calorimeter water. Turn off flame and remove the burner.
6. Without touching the nail with your hands immediately, but carefully, immerse the nail in the calorimeter. Do not allow the hot nail to touch the Styrofoam cup.
7. While one partner is holding the calorimeter, the other partner can record the water's highest temperature without touching the nail. If needed, stir water with a stirring rod.
8. Lower the calorimeter and shake all excess water back into it and then re-measure its mass.
9. Repeat steps 2-8 for a second trial.

CALCULATIONS:

You should **clearly** show all equations and work necessary to determine the flame temperature.

NOTE: Some of the heat from the nail went to vaporizing a bit of the calorimeter water instead of heating it. First, determine how much water was turned into steam. Then determine…

…how many Joules it took to raise that mass of water's temperature to boiling.

…how many Joules it took to vaporize that mass of water (given that it takes 40.7 kJ/mol to do so).

So instead of just saying… $| Q_{nail} = Q_{calorimeter} |$

…a more accurate way of looking at it is… $| Q_{nail} = Q_{calorimeter} + E_{\text{heat \& boil that small bit of water}} |$

QUESTIONS:

1. Cite at least three different sources for Bunsen burner flame temperatures. Compare to your data.
2. Research and come up with a different way of indirectly determining a flame's temperature.

"I'd much rather feel the heat of August, than be sheltered and numb." ~ Michael Penn