H +	H +	O 2-
H +	H +	O 2-
H +	H +	O 2-
Ca 2+	Cl -	Cl -
Ca 2+	Cl -	Cl -

Mg^{2+}	OH^{-}	OH^{-}
Mg^{2+}	OH^{-}	OH^{-}
Th^{4+}	CO_3^{2-}	CO_3^{2-}

Discovering how to read chemical formulas

Materials list: you should have the following cards

Number of cards	Element or polyatomic ion	Symbol	Number of cards	Element or polyatomic ion	Symbol
6	Hydrogen	H^+	3	Oxygen	O^{2-}
4	Chlorine	Cl^-	2	Calcium	Ca^{2+}
2	Magnesium	Mg^{2+}	4	Hydroxide ion	OH^-
1	Thorium	Th^{4+}	2	Carbonate ion	$CO3^{2-}$

Section 1: Something familiar

1. You know water's formula is written as H_2O.  <---a model of a water molecule

   a. Match up hydrogen cards with oxygen cards to make water.

   b. Why was the ratio one oxygen to two hydrogen? _____

   _____

   c. How many water molecules can you make with the cards given? _____

INFORMATION: The number of molecules (or ionic compound structures) you have is written as a *"coefficient"— this is a number in the very front of the formula that applies to ALL atoms in the formula*.

   d. Use the number from 1c as the coefficient. Write it ***in front of the formula*** for water. _____

   e. Draw the model of what you wrote in 1d.

   f. Since the coefficient applies to ALL atoms in a formula, how many **TOTAL hydrogen atoms** are there in three water molecules? Count your cards or the hydrogens in your models if you aren't sure! _____

   g. How many **TOTAL oxygen atoms** are there in three water molecules? _____

Section 2: applying what you know

2. Match up calcium cards with chlorine cards to make one compound of calcium chloride.

   a. How many Ca cards did you use for one compound? _____ How many Cl cards? _____

   b. Why did you use cards in this ratio for calcium and chlorine? _____

   _____

   c. What is the formula for calcium chloride? _____

   d. How many calcium chloride compounds can you make with the cards given? _____

   e. Write the formula with the coefficient to show the number of calcium chloride compounds you have:_____

f. Draw the model of what you wrote in 2e

g. Since the coefficient applies to ALL atoms in the formula, how many **TOTAL calcium atoms** are there in two calcium chloride compounds? Count your cards or the calciums in your models if you aren't sure!

_____

h. How many **TOTAL chlorine atoms** are there in two calcium chloride compounds? _____

Section 3: Something new, with a catch

3. Remember polyatomic ions? There is one called "hydroxide" which is written OH-. Match up magnesium cards with hydroxide ion cards to make magnesium hydroxide.

a. How many Mg cards did you use? _____

b. How many OH cards? _____

c. Why did you use cards in this ratio? _____

_____

INFORMATION: Notice that you needed more than one OH card. When you write the formula, ***if you put a subscript "2" by the H*** {like this: $MgOH_2$ }, ***it will be misunderstood*** that you need two hydrogens but only one oxygen. Remember that the card was "OH-". ***You can't put a coefficient in front of the OH*** {like this: Mg2OH} because *coefficients are only allowed at the very beginning of the formula* to show how many particles of the new substance you've made.

d. How can you show that the subscript must apply to <u>the entire quantity</u> of OH?

I will use _____ to show the OH must stay together!

e. What is the proper formula? _____

f. How many magnesium hydroxide compounds can you make with the cards given? _____

g. Write the formula with the coefficient to show the number of magnesium hydroxide compounds you have:_____

f. Draw the model of what you wrote in 3g

g. Since the coefficient applies to ALL atoms in the formula, how many **TOTAL magnesium atoms** are there in two magnesium hydroxide compounds? _____

h. How many **TOTAL oxygen atoms** are there in two magnesium hydroxide compounds? _____

i. How many **TOTAL hydrogen atoms** are in two magnesium hydroxide compounds? _____

j. Look at what you are doing with the subscripts outside of parentheses. What math property is this similar to? _____

Section 4: On your own

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4. Model the reaction of thorium with the polyatomic ion carbonate to make thorium carbonate by matching up cards as before.

a. Write the formula: _____

b. Draw a model of what you wrote in 4a

c. If you had three particles of the compound thorium carbonate, how would you write the formula? _____

d. Counting up the atoms in <u>three particles of thorium carbonate</u>, you would have a **TOTAL of _____thorium atoms**, a **TOTAL of _____carbon atoms** and a **TOTAL of _____oxygen atoms**.

Section 5: Try it without the cards.

Gallium sulfate is written $Ga_2(SO_4)_3$ (gallium has a 3+ charge and the sulfate polyatomic ion has a 2- charge)

a. Why must there be 2 gallium atoms for every 3 sulfates? _____

b. How do you write the formula if you have 5 particles of this compound? _____

c. How many TOTAL of each atom would there be if I had 5 particles of the compound gallium sulfate?

_____ gallium atoms _____sulfur atoms _____oxygen atoms

Chemical equations tell us what we start with and what we end with in a reaction.

	Reactants		Product
example:	$P_4 + 5O_2$	$\longrightarrow$	P_4O_{10}
	start with	yields	end with

Count the atoms of each element on both sides of the " $\longrightarrow$ ". Why is this called a chemical *equation?* _____

Equations show us that the law of conservation of mass holds true in reactions. Atoms are not created or destroyed, they just re-arrange to make new forms. When mass is conserved in a reaction, we say the equation is "balanced".

Inspect the following equations and state whether or not mass is conserved (are they balanced?).

_____ $H_2 + O_2 \longrightarrow H_2O$

_____ $N_2 + 3H_2 \longrightarrow 2NH_3$

_____ $Al_2O_3 \longrightarrow Al + O_2$

_____ $SiCl_4 \longrightarrow Si + Cl_2$

When equations are unbalanced, coefficients are used to make things balance.

example: $P_4 + O_2 \longrightarrow P_4O_{10}$ becomes $P_4 + 5O_2 \longrightarrow P_4O_{10}$