

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	CO ₃ ²⁻

Section 1: Something familiar

1. You know water's formula is written as H₂O.



←---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: MgOH₂}, **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 the entire quantity 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

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? _____

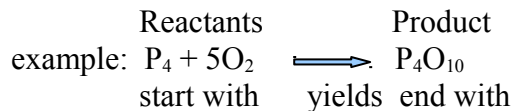
d. Counting up the atoms in three particles of thorium carbonate, you would have a **TOTAL of _____ thorium atoms**, a **TOTAL of _____ carbon atoms** and a **TOTAL of _____ oxygen atoms**.

Section 5: Try it without the cards.

Gallium sulfate is written $\text{Ga}_2(\text{SO}_4)_3$ (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

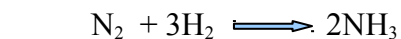
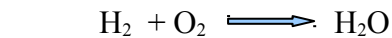
Chemical equations tell us what we start with and what we end with in a reaction.



Count the atoms of each element on both sides of the " \rightleftharpoons ". 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?).



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

