Dear AP Chemistry Student,

First of all, let me say how much I admire you for enrolling in this course. That you are willing to undertake a challenging course like AP Chemistry and see it to completion says much about your character and commitment to your academic and personal growth.

You must work through the following review assignment over the summer. Instructions are given either in this letter or on each page of the assignment. A MAJOR PART OF THIS ASSIGNMENT IS LEARNING THE IONS. The assignment may, for some of you, be review. It will be due on the first day of class of the upcoming school year. Answers will be posted then. Completion of this assignment does indeed count toward your grade in the course. (If you have successfully completed CP Chemistry at SSHS, then you should already know much of this material. But that is where the similarities end. If you are expecting AP Chemistry to be more of the same, I caution you: It is not!)

You will need to check out a textbook (Zumdahl, Zumdahl, and DeCoste: *Chemistry, Tenth Edition*; Cengage Learning) from the SSHS library before the start of summer. Using the *AP Chemistry Syllabus* available at ***mrthaler.net***, you should become familiar with the topics we will cover in this course; and we will cover them *all*. You will have to have thoroughly read Chapters 1, 2, and 3 before you return from summer vacation. You will be responsible for doing a fair amount of reading for this course, so learn to make it a priority. Also, the syllabus is subject to change, so try not to get too attached to the one online.

Algebra skills are also necessary to success in AP Chemistry. There will be little or no time to "re-teach" algebra during class time; the assumption will be that you are coming into the course understanding exponents, logs, quadratic equation—just to name a few things. If you need to review, do so over the summer.

Likewise, memorization of the ions included after this letter with the summer assignment is MANDATORY and CRUCIAL. Get started on this ASAP. Make flash cards, self-quizzes, recordings—ANYTHING that enables you to commit to memory all of the ions on this list. You must know their names, symbols, and their charges backward and forward. I will quiz you regularly on these ions from day one—with or without prior notice, so be ready. To reiterate, YOU MUST SHOW UP TO THE FIRST DAY OF CLASS KNOWING THESE IONS!!

You will need *at the very least* a scientific calculator. Graphing calculators are acceptable, too. No calculators of the QWERTY keyboard sort are allowed, however. Most other materials should be supplied (which is yet another advantage of taking AP Chemistry at SSHS). Any unforeseen exceptions to this will be announced in class as they come up.

One of your best resources will be your computer and access to my website: ***mrthaler.net***. Important messages and resources will be posted on the start page, valuable links will be included in the course outline on the AP Chemistry page, and all homework and assignments will be posted on *Aeries*, exclusively. These sites are all linked to one another. I also recommend that you take a look at the College Board's website; there is a link to it on my AP Chemistry page. There you will find everything from exam-related fees to samples of previous exams.

Should you have questions over the summer, and do not expect an immediate response, you may email me at ***paul.thaler@simivalleyusd.org***. I will only open and respond to emails for which a student's name and the subject are clear. If you use a weird screen name and do not indicate clearly who you are in the subject, I will not respond, because I will not open the email. Additionally, I will be busy doing a variety of things this summer, so do not expect immediate responses to emails like you might otherwise get during the regular school year.

I look forward to an exciting and *challenging* (which is a good thing!) year in AP Chemistry. Have a great summer.

Sincerely,

Mr. Thaler
AP Chemistry
Santa Susana High School

Formulas and Charges of Ions

Positive Ions

1+ Group IA (1)

Li^+	Lithium
Na^+	Sodium
K^+	Potassium
Rb^+	Rubidium
Cs^+	Cesium
Fr^+	Francium
NH_4^+	Ammonium
Cu^+	Copper(I)
H^+	Hydrogen
H_3O^+	Hydronium
Ag^+	Silver

2+ Group IIA (2)

Be^{2+}	Beryllium
Mg^{2+}	Magnesium
Ca^{2+}	Calcium
Sr^{2+}	Strontium
Ba^{2+}	Barium
Ra^{2+}	Radium
Cd^{2+}	Cadmium
Cr^{2+}	Chromium(II)
Co^{2+}	Cobalt(II)
Cu^{2+}	Copper(II)
Fe^{2+}	Iron(II)
Pb^{2+}	Lead(II)
Mn^{2+}	Manganese(II)
Hg_2^{2+}	Mercury(I)
Hg^{2+}	Mercury(II)
Ni^{2+}	Nickel(II)
Sn^{2+}	Tin(II)
Zn^{2+}	Zinc

3+ Group IIIA (13)

Al^{3+}	Aluminum
Ga^{3+}	Gallium
Bi^{3+}	Bismuth(III)
Cr^{3+}	Chromium(III)
Co^{3+}	Cobalt(III)
Fe^{3+}	Iron(III)
Mn^{3+}	Manganese(III)
Ni^{3+}	Nickel(III)

4+ Group IVA (14)

Si^{4+}	Silicon
Ge^{4+}	Germanium
Sn^{2+}	Tin(IV)
Pb^{2+}	Lead(IV)

5+ Group VA (15)

As^{5+}	Arsenic(V)
Bi^{5+}	Bismuth(V)

Negative Ions

1- Group VIIA (17)

F^-	Fluoride
Cl^-	Chloride
Br^-	Bromide
I^-	Iodide
$C_2H_3O_2^-$	Acetate
CN^-	Cyanide
H^-	Hydride
OH^-	Hydroxide
NO_2^-	Nitrite
NO_3^-	Nitrate
MnO_4^-	Permanganate
ClO^-	Hypochlorite
ClO_2^-	Chlorite
ClO_3^-	Chlorate
ClO_4^-	Perchlorate

Similar for bromine and iodine;
e.g., BrO_3^- Bromate

HCO_3^-	Hydrogen carbonate
HSO_3^-	Hydrogen sulfite
HSO_4^-	Hydrogen sulfate
$H_2PO_4^-$	Dihydrogen phosphate

2- Group VIA (16)

O^{2-}	Oxide
S^{2-}	Sulfide
Se^{2-}	Selenide
CO_3^{2-}	Carbonate
CrO_4^{2-}	Chromate
$Cr_2O_7^{2-}$	Dichromate
$C_2O_4^{2-}$	Oxalate
O_2^{2-}	Peroxide
SiO_3^{2-}	Silicate
SO_3^{2-}	Sulfite
SO_4^{2-}	Sulfate
HPO_4^{2-}	Hydrogen phosphate

3- Group VA (15)

N^{3-}	Nitride
P^{3-}	Phosphide
PO_3^{3-}	Phosphite
PO_4^{3-}	Phosphate
AsO_4^{3-}	Arsenate

4- Group IVA (14)

C^{4-}	Carbide

THE CHEMISTRY CAFETERIA
What Are Isotopes?

Name ____________________

Teacher ____________________

Assignment Number ____________________

Due Date ____________________

UNDERSTANDING THE CONCEPTS

All atoms of any given element have the same numbers of protons in their nucleus. However, atoms of the same element may have different numbers of neutrons and thus different weights.

Atoms are said to be isotopes if they are of the same element but they have different weights due to different numbers of neutrons. Let's look at some examples.

C-12 and C-14 are isotopes. Since both are carbon atoms they have the same number of protons... 6. (The atomic number of carbon is 6.)

Atoms of C-12, like any carbon atoms must have 6 protons. In order for these atoms to have a mass number of 12 they must also contain 6 neutrons. Atoms of C-14 must also have 6 protons (all carbon atoms do). However, in order for these atoms to have a mass of 14 they must contain 8 neutrons.

We should point out that isotopes of an element behave identically in terms of how they react with other chemicals. The only difference is in their weights. A good example of an element with different isotopes is hydrogen.

NORMAL HYDROGEN H-1

Most hydrogen atoms consist of just a single proton and an electron... no neutrons; thus they have a mass of 1. About 99.98% of all hydrogen atoms are normal hydrogen; (sometimes called protium).

HEAVY HYDROGEN H-2

Sometimes called deuterium. These atoms are twice as heavy as "normal" hydrogen atoms because they contain a neutron in addition to the proton in normal H.

TRITIUM H-3

These atoms contain a proton and two neutrons.

STUDENT PRACTICE PROBLEMS

1. Explain how atoms of U-235 and U-238 are similar and how they differ.

2. Give the number of protons and neutrons in each of the following pairs of isotopes...

O-16 p= n=

O-18 p= n=

Ba-137 p= n=

Ba-139 p= n=

Ne-20 p= n=

Ne-21 p= n=

THE CHEMISTRY CAFETERIA
Using Nuclear Symbols

Name ____________________

Teacher ____________________

Assignment Number ____________________

Due Date ____________________

UNDERSTANDING THE CONCEPTS

You are familiar with chemical symbols such as $CaSO_4$, HNO_3, and H_2. Sometimes scientists use symbols for atoms that indicate the makeup of the nucleus of the atom. There are basically three parts to such symbols...

$$^{31}_{15}P$$

The "15" is the atomic number of the atom. As you can see on your periodic table... element number 15 is Phosphorus.

The second part of the symbol is the letter(s). If you know the atomic number of the atoms you can find the symbol and vice versa.

The final part of a symbol like this is the top number. This is the mass number of the material. The mass number gives you the total number of protons and neutrons in the nucleus of the atom.

Since the bottom number (the atomic number) is the number of protons in the atom, the difference between the top and bottom numbers gives you the number of protons in the nucleus of the atom.

EXAMPLE

Give the number of protons and neutrons in the following atom...

$$^{55}_{25}Mn$$

There must be 25 protons in this atom because the atomic number is 25. The mass number of 55 tells us that there must be a total of 55 protons and neutrons. Since there are 25 protons, the number of neutrons must be 30 in this atom.

STUDENT PRACTICE PROBLEMS

1. Give the number of protons and neutrons in each of the following...

   $^{40}_{20}Ca$

   $^{20}_{10}Ne$

   $^{118}_{50}Sn$

   $^{63}_{29}Cu$

   $^{40}_{18}Ar$

2. Write the symbol for an atom with 9 protons and 10 neutrons.

3. Write the symbol for an atom of Bismuth with 125 neutrons.

4. Write the symbol for an atom of Carbon with a mass of 14.

THE CHEMISTRY CAFETERIA
Understanding Chemical Symbols

Name ____________________
Teacher ____________________
Assignment Number ____________________
Due Date ____________________

UNDERSTANDING THE CONCEPTS

In order to solve problems in chemistry we need to make sure that we understand the symbols that chemists use to represent various materials.

H

This is the symbol for the element hydrogen. This represents one atom of hydrogen.

H_2

Sometimes atoms will combine with similar atoms to from groups of atoms called molecules. This molecule consists of two hydrogen atoms joined together. The small "2" that follows the H in this formula is called a subscript. The subscript tells you how many of each atom are present. If no subscript is present following a symbol then there is one of those atoms per molecule.

H_2O

Atoms can also combine with atoms of other elements as in water molecules. Here two atoms of hydrogen combine with one atom of oxygen to form one molecules of water.

$Ca(NO_3)_2$

Sometimes parentheses are used in chemical formulas. If parentheses surround part of a formula then the subscript that follows the parentheses applies to everything within the parentheses.

The formula shown above represents one atom of Ca, two atoms of N, and six atoms of O.

STUDENT PRACTICE PROBLEMS

1. Give the number of each type of atom represented by each of the following formulas...

HCN

HNO_3

$Mg(OH)_2$

$(NH_4)_2SO_4$

$KClO_3$

$CuSO_4$

$Al_3(PO_4)_2$

$GaCl_3$

PCl_5

THE CHEMISTRY CAFETERIA
The Composition of Ions

Name ______________________________

Teacher ______________________________

Assignment Number ______________________________

Due Date ______________________________

UNDERSTANDING THE CONCEPTS

As far as we are concerned in chemistry, we can think of atoms as being made from protons, neutrons, and electrons. The protons and neutrons occupy the center part of the atom that we call the nucleus. **The protons have a (+) charge and the neutrons have no overall charge.** The electrons move about in different "levels" some distance from the nucleus. **Electrons have a (-) charge.**

In ordinary chemical interactions atoms will often gain or lose electrons but they will never loose or gain protons or neutrons. When atoms collide only their outer clouds of electrons actually touch.

Each type of atom has a tendency to gain or lose a certain number of electrons. **If an atom has an equal number of protons and electrons then the atom is said to be "neutral."**

EXAMPLE 1

Ca atoms have 20 protons & 20 electrons. You can see that Ca is number 20 on the periodic table... this tells you that it has 20 protons in its nucleus. Since Ca does not have a charge... the twenty (+) protons must be balanced by 20 (-) electrons

EXAMPLE 2

Al^{+3} ions have 13 protons (its atomic number is 13) and only 10 electrons. The +3 tells you that there are 3 more positive charges than negative charges. Since atoms can only gain or loose electrons, Al atoms must loose 3 electrons to form +3 ions. Positive ions are called **"cations"**. (CAT-eye-uhns)

EXAMPLE 3

F^{-1} ions have 9 protons and 10 electrons. The atomic number of F is 9 so it must have 9 protons, and , since it has a -1 charge, it must have one more (-) charge (electron) than (+) charge (protons). Negative ions are called **"anions"**. (AN-eye-uhns)

STUDENT PRACTICE PROBLEMS

1. Put a square around any of the following that are neutral atoms. Circle any that are anions. Put a triangle around any that are cations.?

Ag^{+1}	Sn^{+4}	Br^{-1}
Fe	Ra	Cu
S^{-2}	H^{+1}	Cl^{-1}
Na	He	Mn^{+2}

2. Give the number of protons and the number of electrons in each of the following...

Ag^{+1}

Fe

S^{-2}

Na

Sn^{+4}

Ra

H^{+1}

He

Br^{-1}

Cu

Cl^{-1}

THE CHEMISTRY CAFETERIA
Understanding Simple Names

Name ____________________

Teacher ____________________

Assignment Number ____________________

Due Date ____________________

UNDERSTANDING THE CONCEPTS

Understanding how chemicals are named is a major undertaking. There are millions and millions of different compounds. Fortunately, there are rules to go by and some fairly simply ideas behind the names. In this section we will look at some fairly simple names that are based on common Greek prefixes. Here are the prefixes you will need to know...

mono	1	hexa	6
di	2	hepta	7
tri	3	octa	8
tetra	4	ennea	9
penta	5	deca	10

Here are some examples...

Carbon Dioxide CO_2
This means one carbon and two oxygen atoms in the molecule.

Carbon Tetrachloride CCl_4
This means one carbon and four chlorine atoms in a molecule.

Diphosphorus Pentoxide P_2O_5
Di means two and penta means five.

Sulfur Tioxide SO_3

You can see that frequently the mono is not used on the first element in the compound even if there is only one of them present. The "tri" means three oxygen atoms.

Another thing you may notice from this exercise is that quite often compounds with only two elements in them, "binary compounds" have an "-ide" ending.

STUDENT PRACTICE PROBLEMS

1. See if you can write the formula for the following compounds...

Manganese Dioxide

Carbon Disulfide

Phosphorus Trichloride

Dinitrogen Tetroxide

Sulfur Dichloride

Uranium Hexafluoride

Gallium Triiodide

Silicon Dioxide

Diphosphorus Pentachloride

Titanium Dioxide

THE CHEMISTRY CAFETERIA
Naming With Radicals

Name ______________________
Teacher ______________________
Assignment Number ______________________
Due Date ______________________

UNDERSTANDING THE CONCEPTS

Many chemical names have what we call radicals in them. Radicals are simply groups of atoms that carry a charge with them. There are many radicals, and you can look in the Appendix to this book for a more complete listing... but some common radicals are given below...

OH^{-1}

NO_3^{-1}

NO_3^{-1}

SO_4^{-2}

SO_3^{-2}

CO_3^{-2}

CrO_4^{-2}

PO_4^{-3}

The only common positively charged polyatomic ion or radical is the ammonium group... NH_4^{+1}.

When naming simple compounds that contain a radical simply name the entire radical using its group name rather than naming every element in it. For example...

$CaSO_4$ is calcium sulfate...

don't try to name it calcium sulfur oxide or some similar way... the entire SO_4 is names with its group name... sulfate.

Na_3PO_4 is sodium phosphate...

don't try to name this sodium phosphorus oxide or some similar way... the whole PO_4 group is called a phosphate.

STUDENT PRACTICE PROBLEMS

1. See if you can give the names for the following compounds...

$CaSO_4$

$LiNO_3$

Ag_2SO_4

$BaCrO_4$

$NaNO_3$

$(NH_4)_2CO_3$

$Cu(C_2H_3OO)_2$

$NaHCO_3$

$Ca_3(PO_4)_3$

$Al(OH)_3$

Ag_2CrO_4

THE CHEMISTRY CAFETERIA
Chemical Formulas (I)

Name ____________________
Teacher ____________________
Assignment Number ____________________
Due Date ____________________

UNDERSTANDING THE CONCEPTS

Let's look at how to write the chemical formulas for some simple compounds. The rules are quite simple; but you must know some things about how compounds are put together.

Some compounds are made from what we call ions. Ions are simply atoms, or groups of atoms, that have picked up a positive or negative charge by gaining or losing electrons. Different ions have different charges, however most ions have a charge that ranges from +4 down to -3. You will need Appendix II from this book.

The only rule is that there must be equal number of positive and negative charges in a compound.

EXAMPLE 1
What is the formula for lithium chloride?

SOLUTION
When you look in Appendix II you can see that lithium ions have a +1 charge and that chloride ions have a -1 charge. The +1 and -1 cancel each other out. Thus the formula is LiCl. (We always write the positive part of the compound first in the formula.)

EXAMPLE 2
What is the formula for calcium fluoride?

SOLUTION
You can see that Ca ions have a +2 charge and fluoride ions have a -1 charge. These charges do not balance out when simply added together. In this case we will need one Ca^{+2} ion and two F^{-1} ions. In this proportion the charges will balance out. The formula will then be CaF_2.

EXAMPLE 3
What is the formula for aluminum sulfide?

SOLUTION
Al is +3 and S is -2 in your table. The only way to balance the charges is to have two Al^{+3} ions and three S^{-2} ions. This will give six (+) charges and 6 (-) charges. The formula then would be Al_2S_3.

STUDENT PRACTICE PROBLEMS

1. Write the formulas for each of the following compounds...

silver sulfide

magnesium chloride

lead(II) bromide

calcium iodide

calcium oxide

lithium sulfide

aluminum bromide

iron(III) chloride

zinc phosphide

THE CHEMISTRY CAFETERIA
Chemical Formulas (II)

Name ______________________
Teacher ______________________
Assignment Number ______________________
Due Date ______________________

UNDERSTANDING THE CONCEPTS

In Part I of this section you learned how to write the formulas for simple compounds by making sure that the + and - charges balanced out.

In this section you will do the same thing with one exception... in these compounds there will be groups of atoms (radicals) involved as well as the simple ions that you worked with before.

EXAMPLE 1
Write the formula for calcium hydroxide.

This compound is made of Ca^{+2} ions and hydroxide ions which are OH^{-1}.

In order to get the charges to balance out and make a neutral compound we will need one Ca and two OH groups.

We could write $CaOH_2$; but this would be wrong. This formula doesn't give us two OH groups it only gives us two H's. To get two entire OH groups we need to use parentheses to enclose the entire OH unit. The correct formula then becomes...

$Ca(OH)_2$

EXAMPLE 2
Write the formula for ammonium phosphate.

Ammonium is NH_4^{+1} and phosphate is PO_4^{-3}. In order to get the charges to balance we need three ammonium groups for each phosphate group. We will need to use parentheses around any group we use more than one time... in this case the ammonium group.

The formula then is $(NH_4)_3PO_4$

STUDENT PRACTICE PROBLEMS

1. Write the formulas for each of the following compounds...

sodium hydroxide

potassium phosphate

aluminum hydroxide

ammonium sulfate

magnesium nitrate

sodium hydrogen carbonate

potassium dichromate

lead(II) nitrate

sodium peroxide

THE CHEMISTRY CAFETERIA
Chemical Formulas (III)

Name ______________________________
Teacher ______________________________
Assignment Number ______________________________
Due Date ______________________________

UNDERSTANDING THE CONCEPTS

You have already learned how to write the formulas for many kinds of compounds. In this section we will show you how to write the formulas for compounds containing ions that can have different charges.

For example; you could write the formula for a compound like calcium chloride. But what about iron chloride? The problem here is that when you look up the charge for the iron ion in your table you wee that iron can have either a +2 or a +3 charge... depending on the conditions it is in.

To let you know which of the two iron ions we are talking about there are a couple of things chemists do. The method we will look at here is not the preferred method, but it is still in use at times and you should understand how it works.

In this method the suffixes -ous and -ic are used to tell you which of the forms of an ion is involved. These suffixes are attached to the Greek or Latin name of the element. If the element ends in -ous it means that it has the lowest of the possible charges. If it has the -ic ending then the ion has the highest of the possible charges.

EXAMPLE 1
What is the formula for stannic chloride?

SOLUTION
Stannic pertains to tin. In your chart you see that tin can be either +2 or +4. The -ic ending on stannic means that the tin is in the higher of the two states... it is +4. If the tin is +4 and the chloride is -1, then the formula for stannic chloride must be $SnCl_4$.

EXAMPLE 2
What is the formula for cuprous nitrate?

Cuprous pertains to copper. Copper can be +1 or +2. The -ous ending on cuprous tells you that it is in the lowest state which is +1. Nitrates are -1. Thus the formula for cuprous nitrate is $CuNO_3$.

STUDENT PRACTICE PROBLEMS

The following Latin and Greek names for elements may help you determine the formulas involved...

NAME	SOURCE	ELEMENT	LOW	HIGH
ferrum	Latin	iron	+2	+3
cuprum	Latin	copper	+1	+2
stannum	Latin	tin	+2	+4
chroma	Greek	chromium	+2	+3
mercury	Named after planet		+1	+2

mercury is a bit of a problem...

Mercuric means Hg in the highest state which is +2 (Hg^{+2})

Mercurous means mercury in the lowest state which is +1. However, mercury does not form Hg^{+1} ions... it forms Hg_2^{+2} ions. In this state there are two mercury atoms and a +2 charge... thus each mercury atom has a +1 charge. A compound such as mercuric chloride would then be $HgCl_2$ while mercurous chloride would be Hg_2Cl_2.

1. Write the formula for each of the following...

chromic chloride

stannous fluoride

ferrous sulfate

mercuric nitrate

stannic oxide

cupric nitrate

cuprous carbonate

mercurous nitrate

ferric chloride

THE CHEMISTRY CAFETERIA

Chemical Formulas (IV)

Name ______________________

Teacher ______________________

Assignment Number ______________________

Due Date ______________________

UNDERSTANDING THE CONCEPTS

In Part III of this section you learned how to write the formula for compounds containing iron, chromium, copper, etc... that could have different charges. You used the method of -ic and -ous suffixes.

Another way to denote which of the charges an ion may have is to use what is called the "Stock System." (Stock was the last name of the chemist who developed this method.)

In the Stock System, Roman numerals are used to give the charge of the element in question. With this method you don't have to know what possible charges an ion may have... it will be give to you.

EXAMPLE I

Write the formula for Iron (II) Bromide.

SOLUTION

In this method the number given in Roman numerals tells you the charge on the positive ion. In this case the (II) means that iron is in the +2 state in this compound. In other words Fe^{+2}.

If you know that iron is +2 and you look up and find that a bromide is Br^{-1} ... then you can determine that the formula for Iron (II) Bromide must be $FeBr_2$.

EXAMPLE 2

Write the formula for Chromium (III) Carbonate.

SOLUTION

The (III) tells you that the chromium is Cr+3 in this compound. You can look up carbonates and find that they are -2. In order to have the same number of + and - charges we will need to have two Cr+3 ions and three CO3-2 ions...

$Cr_2(CO_2)_3$

This gives us 6 + charges and 6 - charges in the compound.

STUDENT PRACTICE PROBLEMS

1. Give the formula for each of the following...

Iron (III) Hydroxide

Copper (I) Bromide

Chromium (II) Hydroxide

Mercury (II) Sulfide

Tin (IV) Sulfide

Tin (II) Sulfide

Gold (III) Chloride

Nickel (II) Sulfate

Copper (II) Phosphate

Iron (III) Nitrate

Iron (II) Carbonate

THE CHEMISTRY CAFETERIA
Chemical Formulas (V)

Name ______________________

Teacher ______________________

Assignment Number ______________________

Due Date ______________________

UNDERSTANDING THE CONCEPTS

In this section you will practice writing formulas for compounds that are hydrates. Hydrates are salts that, when they formed, included water molecules within their chemical structure.

Different chemicals tend to form hydrates with different numbers of water molecules. All chemicals do not form hydrates. Hydrates are named using Greek prefixes to tell how many water molecules are associated with each salt unit.

EXAMPLE 1

Write the formula for Barium Chloride Dihydrate.

SOLUTION

We first check the charge on Ba and find it is +2. The charge on a chloride is -1. Thus the Barium Chloride part of the compound must be... $BaCl_2$.

Dihydrate means that there are 2 water molecules per each salt unit. We denote this by putting $\cdot 2H_2O$ behind the $BaCl_2$ as shown below...

$BaCl_2 \cdot 2H_2O$

EXAMPLE 2

Write the formula for Sodium Sulfate Decahydrate.

SOLUTION

You can determine the formula for sodium sulfate... Na_2SO_4. Deca is the Greek prefix for ten; so the formula for this compound must be... $Na_2SO_4 \cdot 10H_2O$.

STUDENT PRACTICE PROBLEMS

1. Write the formulas for each of the following hydrates...

zinc chloride dihydrate

magnesium sulfate heptahydrate

aluminum chloride hexahydrate

cobalt chloride hexahydrate

ferrous sulfate heptahydrate

cupric sulfate pentahydrate

aluminum oxide trihydrate

cuprous sulfite monohydrate

Copper (II) Perchlorate hexahydrate

ferrous nitrate tetrahydrate

THE CHEMISTRY CAFETERIA
Understanding Chemical Equations

Name ____________________

Teacher ____________________

Assignment Number ____________________

Due Date ____________________

UNDERSTANDING THE CONCEPTS

A great deal of what chemists do centers around chemical equations. In this section we will introduce you to some common terms and concepts related to simple equations.

Each chemical equation involves the chemicals that are mixed together (which we call the reactants) and the chemical that are produced (which we call the products.) The reactants are on the left side of the arrow and the products are on the right.

$Ca + S \longrightarrow CaS$

In this reaction, one atom of Ca reacts with one atom of S to make one unit of CaS. The calcium and sulfur are the reactants, and the calcium sulfide is the product.

EXAMPLE 1

What are the products and the reactants in the following reaction...

$C_2H_6 + O_2 \longrightarrow CO_2 + H_2O$

reactants... C_2H_6 and O_2
products... CO_2 and H_2O

EXAMPLE 2

How many atoms of carbon are found on the reactant side of the above equation?
Answer: 2

How many atoms of carbon are found on the product side of the above equation?
Answer: 1

How many atoms of oxygen are found on the reactant side of the above equations?
Answer: 2

How many oxygen atoms are found on the product side of the above reaction?
Answer: 3 (2 in the CO_2 and one in the H_2O)

STUDENT PRACTICE PROBLEMS

1. Tell which chemicals are the reactants and which are the products in each of the following reactions?

   $NH_3 + O_2 \longrightarrow NO + H_2O$

   $HCl + NaHCO_3 \longrightarrow NaCl + CO_2 + H_2O$

2. How many atoms of H are on the reactant side of the first equation?

3. How many H atoms are on the product side of the first equation.

4. How many oxygen atoms are on the reactant side of the first equation?

5. How many oxygen atoms are on the product side of the first equation?

6. How many H atoms are on the reactant side of the second equation?

7. How many H atoms are on the product side of the second equation?

THE CHEMISTRY CAFETERIA

Balancing Chemical Equations (I)

Name ____________________

Teacher ____________________

Assignment Number ____________________

Due Date ____________________

UNDERSTANDING THE CONCEPTS

Here we will look at how to "balance" an equation. Let's look at the following example...

$$H_2 + O_2 \longrightarrow H_2O$$

On the reactant side of the equation there are 2 H's; on the product side there are also 2. We would say that the hydrogen atoms are balanced... there are equal numbers on each side.

Now let's look at the O's. There are two O's on the reactant side of the equation; however there is only one O on the product side. Since atoms can't just vanish, the reaction can not occur as written... it must be balanced.

We can not change the subscripts (the little numbers following the symbols, because that would change the chemicals involved) we can only add what we call coefficients. Here is how we would balance the above equation.

STEP 1

First we need to get 2 O's on the right (because we have 2 O's on the reactant side). We can get 2 O's on the right be adding a coefficient of 2 in front of the H_2O.

$$H_2 + O_2 \longrightarrow 2\,H_2O$$

The 2 tells us to double everything that follows it. The $2H_2O$ means that we now have 4 H's and 2 O's in the H_2O. This balances the number of O's on each side.

STEP 2

The O's are now balanced, but by putting the 2 in front of the H_2O we have caused the H's to become unbalanced. We have 4 H's on the right and only two on the left. To solve this problem we will simply put a coefficient of 2 in front of the H_2.

$$2\,H_2 + O_2 \longrightarrow 2\,H_2O$$

STUDENT PRACTICE PROBLEMS

KEY POINT

When balancing equations remember; you can only add or change coefficients... NEVER THE SUBSCRIPTS.

1. Balance each of the following reactions...

$$N_2 + O_2 \longrightarrow NO_2$$

$$Ag + S \longrightarrow Ag_2S$$

$$Mg + HCl \longrightarrow MgCl_2 + H_2$$

$$Al + O_2 \longrightarrow Al_2O_3$$

$$CH_4 + O_2 \longrightarrow CO_2 + H_2O$$

$$O_2 \longrightarrow O_3$$

$$H_2SO_4 + NaOH \longrightarrow Na_2SO_4 + H_2O$$

THE CHEMISTRY CAFETERIA
Balancing Chemical Equations (II)

Name ____________________

Teacher ____________________

Assignment Number ____________________

Due Date ____________________

UNDERSTANDING THE CONCEPTS

You have already learned how to balance simple chemical equations. Sometimes you will find that you may need a few "tricks" to balance a particular equation. Let's look at an example.

$C_2H_6 + O_2 \longrightarrow CO_2 + H_2O$

We can begin by looking at the carbon atoms. We have two carbon atoms on the left side and only one on the right. We can easily balance the carbons...

$C_2H_6 + O_2 \longrightarrow 2CO_2 + H_2O$

Now we have two carbon atoms on each side of the equation. Let's go on to the hydrogen atoms... we have six on the left side and only two on the right. We can correct that by adding a coefficient of 3.

$C_2H_6 + O_2 \longrightarrow 2CO_2 + 3H_2O$

We now have six hydrogen atoms on each side of the reaction. Finally let's look at the number of oxygen atoms on each side. On the left we have only two... on the right we have three.

There are two ways to proceed. First, in order to get 3 oxygen atoms on the left we could try using a fraction such as 1-1/2... let's try this...

C_2H_6 + 1-1/2 $O_2 \longrightarrow 2CO_2 + 3H_2O$

Generally we don't like to use fractions to balance equations since at the molecular level we obviously can't have fractions of molecules. How can we get rid of the fraction in the above reaction?

If you use a fraction to balance an equation that contains a "1/2" in it, then simply multiply all of the coefficients by 2. This will eliminate the fraction and yet keep the atoms in the same proportion. To get rid of a fraction with a 1/3rd, simply multiply by 3 and so on.

$2C_2H_6 + 3O_2 \longrightarrow 4CO_2 + 6H_2O$

STUDENT PRACTICE PROBLEMS

1. Balance each of the following reactions...

$Al + O_2 \longrightarrow Al_2O_3$

$ZnS + O_2 \longrightarrow ZnO + SO_2$

$C_7H_6O_2 + O_2 \longrightarrow CO_2 + H_2O$

$NH_3 + O_2 \longrightarrow N_2 + H_2O$

$C_3H_6 + O_2 \longrightarrow CO_2 + H_2O$

$H_2S + O_2 \longrightarrow H_2O + SO_2$

$NH_3 + O_2 \longrightarrow NO + H_2O$

THE CHEMISTRY CAFETERIA
Balancing Chemical Equations (III)

Name ____________________
Teacher ____________________
Assignment Number ____________________
Due Date ____________________

UNDERSTANDING THE CONCEPTS

You have balanced equations in two previous sections. The equations in this section are just further practice. We have included two reactions that you may have difficulty with, only to show you that all equations are not easy to balance... we will give you tools to balance more difficult equations in the section on oxidation-reduction. The two reactions with the "*" are the hard ones.

Also, you will find that some of these equations contain radicals with parentheses... you already understand what this means, but we will do one example for you here.

$Ba(NO_3)_2 + Na_2SO_4 \longrightarrow$
$BaSO_4 + NaNO_3$

On both sides you can see that we have one Ba. On the left side you can see that we have two N's while we only have one on the right. We can fix that...

$Ba(NO_3)_2 + Na_2SO_4 \longrightarrow$
$BaSO_4 + 2NaNO_3$

We now have two N's on the left (remember... the subscript of 2 outside of the parentheses doubles everything inside) and two N's on the product side. You can see that we also have two Na's on each side.

Finally, you can see that there are ten O's on each side of the equation... the above reaction is thus balanced.

STUDENT PRACTICE PROBLEMS

1. Balance each of the following reactions...

$KOH + HCl \longrightarrow KCl + H_2O$

$CuO + NH_3 \longrightarrow N_2 + H_2O + Cu$

$FeS_2 + O_2 \longrightarrow Fe_2O_3 + SO_2$

* $H_2SO_4 + KMnO_4 + KCl \longrightarrow$
$MnSO_4 + K_2SO_4 + Cl_2 + H_2O$

$Al_2(SO_4)_3 + CaCl_2 \longrightarrow$
$AlCl_3 + CaSO_4$

$Al(OH)_3 \longrightarrow Al_2O_3 + H_2O$

The Periodic Table of the Elements

	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIIIB			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H Hydrogen 1.008																	2 He Helium 4.002
2	3 Li Lithium 6.94	4 Be Beryllium 9.01											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
3	11 Na Sodium 22.99	12 Mg Magnesium 24.31											13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95
4	19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.54	30 Zn Zinc 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80
5	37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.90	54 Xe Xenon 131.3
6	55 Cs Cesium 132.9	56 Ba Barium 137.3	71 * Lu Lutetium 175.0	72 Hf Hafnium 178.5	73 Ta Tantalum 180.9	74 W Tungsten 183.8	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
7	87 Fr Francium (223)	88 Ra Radium 226.0	103 # Lr Lawrencium (260)	104 Unq Unnilquadium (261)	105 Unp Unnilpentium (262)	106 Unh Unnilhexium (263)	107 Uns Unnilseptium (262)	108 Uno Unniloctium (265)	109 Une Unnilennium (266)	110 Uun Ununnilium (269)								

*	57 La Lanthanum 138.9	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium (145)	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.2	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0
#	89 Ac Actinium (227)	90 Th Thorium 232.0	91 Pa Protactinium 231.0	92 U Uranium 238.0	93 Np Neptunium 237.0	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)