HONORS CHEMISTRY: INTRODUCTION TO CHEMICAL REACTIONS DATE:_____

Learning Activities: **SWBAT. . .**

…identify the visual cues of a chemical change.
…explain the basics of chemical reactions and symbols.

WHAT IS A CHEMICAL REACTION?

WHAT ARE THE VISUAL INDICATIONS THAT A CHEMICAL CHANGE HAS OCCURRED?

- -
- -

NOTE: ONLY A CHEMICAL ANALYSIS CAN DETERMINE IF A CHEMICAL CHANGE ACTUALLY TOOK PLACE!

Many physical changes can be misleading. Some examples:

- -
- -

ROYAL REACTION EXAMPLES

CHEMICAL EQUATION:

ex) $2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(g)$

REACTANTS:

PRODUCTS:

KEY IDEA:

∴ Atoms cannot be created nor destroyed in a chemical change.

∴ All atoms present before a reaction must still be there afterwards (though rearranged).

"*BALANCING THE EQUATION*":

- Many reactants and products will have symbols after them that have no effect on balancing an equation.
- These symbols simply provide us with more information as to what is actually happening.

(s) = **(cr) =** **(l) =**

(g) = **(aq) =**

↑ = **↓ =**

- The arrow between the reactants and products is called the 'yield' arrow.

- Information might be placed around the yield sign to tell you about the reaction conditions...

$\longrightarrow$ =

$\xrightarrow{\Delta}$ or $\xrightarrow{heat}$ =

$\rightleftharpoons$ =

$\xrightarrow{2.0\ atm}$ =

$\xrightarrow{0\ ^\circ C}$ =

$\xrightarrow{Pd}$ =

$\xrightarrow{e^-}$ =

REVIEW & REFLECTION

DID YOU KNOW... "Lavoisier developed a balance that could weigh to 0.0005g so that he could accurately measure changes in mass that happened during his experiments. In 1774 Lavoisier heated charcoal with a number of metal oxides in sealed containers and reported that the total mass of the container was the same before and after heating, but that when the containers were opened air rushed out under pressure...

From experiments such as these Lavoisier began to develop two new theories. He developed the theory of conservation of mass - that the mass of the reactants and products of a reaction is always the same (in other words matter is never lost or gained). He also began to try out a completely new way of explaining combustion.

A meeting with Joseph Priestley helped Lavoisier on his way. Priestley described to Lavoisier a combustion experiment which produced "dephlogisticated air". This gave Lavoisier inspiration for his own research - although unfortunately he also tried to take credit for Priestley's own discoveries. Lavoisier realized that what Priestley was describing as two different kinds of air was really one kind of air containing two or more different substances. By a series of careful experiments Lavoisier showed that air was actually made up of several different components. From air he isolated the gases we now call oxygen, nitrogen and carbon dioxide, and showed that carbon dioxide could be produced by burning charcoal in air. He found the proportion of oxygen in the air, and showed that oxygen was removed from the air during the process of burning. As a result of this work, he developed the theory that when substances burn in air they combine with oxygen from the air and form an oxide (a compound containing oxygen). He recognized that respiration in living things, the rusting of iron and burning were all forms of the same type of reaction. His ideas were backed up with large amounts of experimental evidence including detailed observations and accurate measurements." ~ www.timelinescience.org

"Behold the turtle; he makes progress only when he sticks his head out." ~ James Bryan Conant

HONORS CHEMISTRY: How To Balance an Equation DATE:_____

Objectives: **SWBAT. . .**

. . . review superscripts, subscripts and coefficients in chemical formulas.
. . . properly balance chemical equations.

REVIEW OF NUMBERS INVOLVED IN CHEMICAL FORMULAS:

Superscript:

Subscript:

Coefficient:

ex.) 5 $C_6H_{12}O_6$ How many of each element? **C =** **H =** **O =**

HOW TO BALANCE EQUATIONS:

Balanced equation has same number of each type of atom in the reactants and the products.

ex.) Try to balance this: $H_2 + O_2 \rightarrow H_2O$

It is mostly trial and error (it takes time, patience and practice!). Here are a few tips.

1.

~

2.

3.

~

(What are the diatomic elements?)

~

~

(a.k.a.).

4.

5.

A DIFFERENT TAKE

Balance these...

$C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O$

$C_2H_2 + O_2 \rightarrow CO_2 + H_2O$

$CaSi_2 + SbCl_3 \rightarrow Si + Sb + CaCl_2$

$P_4 + KClO_3 \rightarrow KCl + P_2O_5$

"The greatest thing in the world is to know how to be one's own self." ~ Montaigne

HONORS CHEMISTRY: DRIVING FORCES AND AQUEOUS BASICS DATE:_____

Learning Activities: **SWBAT. . .**

…identify the basic driving forces of a chemical reaction.
…define basic aqueous terminology.

JUST BECAUSE YOU CAN WRITE A BALANCED EQUATION FOR A REACTION, DOES NOT MEAN IT WILL ACTUALLY OCCUR! MOST REACTIONS OCCUR DUE TO SOME 'DRIVING FORCE.'

WHAT IS A DRIVING FORCE?

Without getting too deeply into the 'why' (beyond what is already understood about stability), there are some common 'driving forces' beginning chemists can be aware of:

- -
- -

If any of these things happen, then the reaction is likely to go to completion. Keep an eye out for them!

SOME AQUEOUS TERMINOLOGY

AQUEOUS:

ex)

SOLUTION:

DISSOLUTION:

SOLUBLE:

INSOLUBLE:

SOLUTE:

SOLVENT:

ELECTROLYTE:

-

PRECIPITATE:

SALT DISSOLVES

Substance:	**Conductivity:**	**What does this tell us (in terms of electrolytes)?**
Distilled water		
tap water		
salt water		
sugar water		
acetic acid		
dilute sulfuric acid		

IONIC VS. COVALENT DISSOLUTION

REVIEW & REFLECTION

"Don't think there are no crocodiles because the water is calm." ~ Malayan Proverb

HONORS CHEMISTRY NAME _____
THE IMPORTANCE OF DISSOCIATION

Match the definition to the term:

Dissociation **Ionization** **Dissolution**

_____: The conversion of a neutral atom or molecule to an ion.
_____: The process in which a compound separates into two or more parts.
_____: The process in which the particles of a substance move into the solvent.

All of these dissolve in water. Write out a balanced equation for each of the following processes. Include phases/qualifiers.

1. Sodium chloride

$NaCl(s) \rightarrow Na^{+}(aq) + Cl^{-}(aq)$

2. Fructose, $C_6H_{12}O_6$

3. Atmospheric oxygen

4. Calcium hydroxide

5. Sulfuric acid

Put a star next to each chemical that is an electrolyte.

"When you come back you will not be you. And I may not be I."
— E.M. Forster

HONORS CHEMISTRY: SOLUBILITY & PRECIPITATION REACTIONS DATE:_____

Learning Activities: **SWBAT. . .**

…determine the solubility of ionic compounds.
…predict products in precipitation reactions.

When two ionic compounds are mixed, a common driving force is…

Based on the reactants, we should be able to predict what the products are, specifically what the precipitate is.

RULES FOR PREDICTING PRECIPITATES WHEN SOLUTIONS OF IONIC COMPOUNDS ARE MIXED:

1.

2.

3.

BASIC SOLUBILITY RULES: These are general principles, with many exceptions.

A soluble compound is defined as creating a concentration of at least 0.1M (moles per liter) at 25°C

An insoluble compound is defined as creating a concentration less than 0.1M (moles per liter) at 25°C

(Note: Some call less than 0.01M insoluble and between 0.01M and 0.1M slightly soluble)

MOST SALTS CONTAINING THE FOLLOWING IONS ARE CONSIDERED SOLUBLE:

NO_3^-, NO_2^-, $C_2H_3O_2^-$, ClO_4^-, ClO_3^-, ClO_2^-

Group 1 ions, and NH_4^+

Cl^-, Br^-, I^- salts (Except Ag^+, Hg_2^{2+} and Pb^{2+})

SO_4^{2-} (except Ba^{2+}, Pb^{2+}, Ca^{2+}, Ag^+, Sr^{2+}, Hg_2^{2+}, Hg^{2+})

MOST SALTS CONTAINING THE FOLLOWING IONS ARE CONSIDERED INSOLUBLE (OR SLIGHTLY SOLUBLE):

Ag^+ (except NO_3^- and $C_2H_3O_2^-$)

S^{2-} (except group 1, group 2, and NH_4^+)

F^-, CO_3^{2-}, PO_4^{3-} CrO_4^{2-}(except group 1 and NH_4^+)

OH^-, O^{2-}(except group 1 which are soluble, group 2 which are slightly soluble)

AN EXAMPLE OF PREDICTING PRECIPITATES:

(Note: Don't worry about balancing the equation until you have determined the products)

The reactants in the demo are aqueous potassium chromate and aqueous barium nitrate.

Step 1: Determine formulas:

Write as ionic components:

Step 2: Swap anions:

Write formulas for products:

Step 3: Determine solubility:

THERE ARE SEVERAL DIFFERENT WAYS TO WRITE THE EQUATION FOR THIS REACTION:

Molecular equation:

ex)

Total (or complete) ionic equation:

ex)

Net ionic equation:

ex)

CRASH COURSE: PRECIPITATION

REVIEW & REFLECTION

DID YOU KNOW... "Drinking too much water can lead to a condition known as water intoxication and to a related problem resulting from the dilution of sodium in the body, hyponatremia. A baby can get water intoxication as a result of drinking several bottles of water a day or from drinking infant formula that has been diluted too much. Athletes can also suffer from water intoxication.

When too much water enters the body's cells, the tissues swell with the excess fluid. From the cell's point of view, water intoxication produces the same effects as would result from drowning in fresh water. Electrolyte imbalance and tissue swelling can cause an irregular heartbeat, allow fluid to enter the lungs, and may cause fluttering eyelids. Swelling puts pressure on the brain and nerves, which can cause behaviors resembling alcohol intoxication. Swelling of brain tissues can cause seizures, coma and ultimately death unless water intake is restricted and a hypertonic saline (salt) solution is administered. If treatment is given before tissue swelling causes too much cellular damage, then a complete recovery can be expected within a few days.

The kidneys of a healthy adult can process fifteen liters of water a day, so you are unlikely to suffer from water intoxication, even if you drink a lot of water, as long as you drink over time as opposed to intaking an enormous volume at one time. As a general guideline, most adults need about three quarts of fluid each day. Much of that water comes from food, so 8 - 12 eight ounce glasses a day is a common recommended intake. You may need more water if the weather is very warm or very dry, if you are exercising, or if you are taking certain medications.

The bottom line is this: it's possible to drink too much water, but unless you are running a marathon or are an infant, water intoxication is a very uncommon condition." ~ chemistry.about.com

"First things first, but not necessarily in that order."~ Doctor Who

HONORS CHEMISTRY
SOLUBILITY PRACTICE

NAME _____

Take EACH cation from the left and match them up with EACH anion from the right. Write the proper chemical formulas below. Indicate (with phase/qualifiers) whether the product will be soluble or insoluble.

CATIONS	ANIONS
AMMONIUM	CARBONATE
BARIUM	CHLORIDE
CALCIUM	CHLORITE
FERRIC	FLUORIDE
PLUMBOUS	HYDROXIDE
STRONTIUM	OXIDE

"A true confession: I believe in a soluble fish."
— Charles Simic

HONORS CHEMISTRY: ARRHENIUS ACIDS & BASES DATE:_____

Learning Activities: **SWBAT. . .**

…define and give examples of Arrhenius acids and bases.
…predict the products from mixing a strong acid with a strong base.

SVANTE ARRHENIUS (late 1800's) explored why only certain solutions conduct electrical currents.

He reasoned that…

ARRHENIUS ACID:

ex)

ARRHENIUS BASE:

ex)

- Note: This is NOT the only way to define acids and bases. (We'll learn other ways later.)
- Strong acids/bases…
- Weak acids/bases…

When an Arrhenius Acid is mixed with an Arrhenius Base, they will undergo the same net reaction every time:

→ [*Production of a liquid (in this case water) is a driving force.*]

First example: hydrochloric acid and sodium hydroxide solutions are mixed.

CRASH COURSE: ACID & BASE

Molecular equation:

Total (or complete) ionic equation:

Net ionic equation:

Second example: nitric acid and potassium hydroxide solutions are mixed.

Molecular equation:

Total (or complete) ionic equation:

Net ionic equation:

NOTE: NET IONIC EQUATION REMAINS UNCHANGED IN BOTH EXAMPLES.

REVIEW & REFLECTION

"Courage is being scared to death - but saddling up anyway." ~ John Wayne

HONORS CHEMISTRY NAME _____

ACID-BASE NEUTRALIZATION AS A DRIVING FORCE

Write a balanced equation for the dissociation of hypochlorous acid.

What makes hypochlorous acid an Arrhenius acid? Can you think of another one?

Write a balanced equation for the dissociation of strontium hydroxide (assume it's soluble).

What makes strontium hydroxide an Arrhenius base? Can you think of another one?

Write out the balanced molecular equation for the reaction of these two chemicals.

Write out the total ionic equation.

Write out the net ionic equation.

"No matter how hard you work for success if your thought is saturated with the fear of failure, it will kill your efforts, neutralize your endeavors and make success impossible."
Baudjuin quote

HONORS CHEMISTRY: OXIDATION-REDUCTION INTRODUCTION DATE:_____

Learning Activities: **SWBAT. . .**

…review acid-base problems.

…identify oxidation-reduction reactions as a driving force.

Not all driving forces have to happen in an aqueous environment. One example of one that doesn't is…

OXIDATION-REDUCTION REACTION [A.K.A. REDOX REACTION]:

- If an atom/ion loses electrons, then it is…
- If an atom/ion gains electrons, then it is…

(This can be remembered with acronym:)

- The chemical causing the oxidation is called…
- The chemical causing the reduction is called…

CRASH COURSE: REDOX

Metal-nonmetal reactions can always be assumed to be a Redox reaction since ions are being formed (therefore electrons are being exchanged).

ex) $2\ Na + Cl_2(g) \rightarrow 2\ NaCl(s)$

Sodium starts with a _____ charge. Afterwards it has _____charge, so it is…

Chlorine starts with a _____ charge. Afterwards it has a _____charge, so it is...

ex) $2\ Al(s) + Fe_2O_3(s) \rightarrow 2\ Fe(l) + Al_2O_3\ (s)$ (a.k.a. The Thermite reaction)

Aluminum starts with a _____ charge. Afterwards it has _____ charge, so it is…

Iron starts with a _____ charge. Afterwards it has a _____ charge so it is...

Two nonmetals can undergo a redox reaction to form a covalent compound.

ex) $CH_4(g) + 2\ O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

For now, simply look for oxygen as a product or reactant.

We will learn later how to determine electron transfers when ions are not formed.

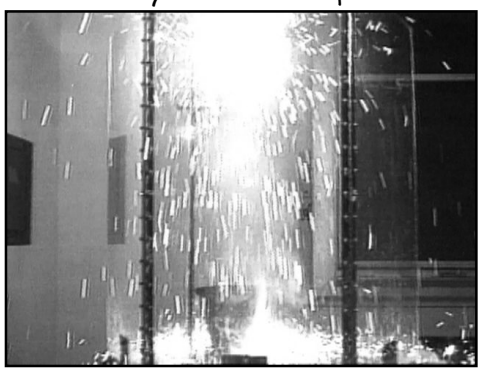
REVIEW & REFLECTION

"A goal without a plan is just a wish." ~ Antoine de Saint-Exupery (1900 - 1944)

DID YOU KNOW... "A thermite reaction is one in which aluminum metal is oxidized by the oxide of another metal, most commonly iron oxide. The name 'thermite' is also used to refer to a mixture of two such chemicals. The products are aluminum oxide, elemental iron, and a great deal of heat.

Thermite was invented in 1893 and patented in 1895 by German chemist Dr. Hans Goldschmidt, hence the reaction is sometimes called the "Goldschmidt reaction" or "Goldschmidt process". Dr. Goldschmidt was originally interested in producing high purity metals, but soon realized the value in welding. The first commercial application was the welding of tram tracks in 1899.

Iron oxide is the most commonly used oxide because it is inexpensive and molten iron is useful for welding. The aluminum could be replaced by any other reactive metal. However this is almost never done because the properties of aluminum are ideal for this reaction. It is by far the cheapest of the highly reactive metals and many other possible candidates candidates are much more dangerous to handle. The most most important properties of aluminum are its relatively relatively low melting point (660 °C) and very high boiling boiling point (2519°C); an usually wide range for any metal, metal, especially a highly reactive one. A low melting point point means that it is easy to melt the metal, so that the the reaction can occur mainly in the liquid phase and thus thus proceeds fairly quickly. On the other hand, a high boiling boiling point enables the reaction to reach very high temperatures.



Although the reactants are stable at room temperature, when they are exposed to sufficient heat to ignite they burn with an extremely intense exothermic reaction. The products emerge as liquids due to the high temperatures reached (with iron (III) oxide, up to 2500°C). Thermite contains its own supply of oxygen, and does not require any external source such as air. Consequently, it cannot be smothered and may ignite in any environment, given sufficient initial heat. It will burn just as well while underwater, for example, and cannot even be extinguished with water, as water sprayed on a thermite reaction will instantly be boiled into steam. This, combined with the extremely high temperatures generated, makes thermite reactions extremely hazardous even when appropriate precautions are taken. The thermite reaction can take place by accident in industrial locations where abrasive grinding and cutting wheels are used with ferrous metals.

Thermite reactions have many uses. It was originally used for quickly cutting or welding metal such as rail tracks, without requiring complex or heavy equipment. Thermite grenades are used in war to destroy sensitive equipment or documents when at imminent risk of capture by the enemy. Thermite grenades and bombs have been used in combat as incendiary devices, able to burn through heavy armor or other fireproof barriers. This type of reaction is used to purify the ores of some metals. An adaptation of the thermite reaction, used to obtain pure uranium, was developed as part of the Manhattan Project. "

~ http://en.wikipedia.org/wiki/Thermite

HONORS CHEMISTRY NAME _____
OXIDATION-REDUCTION AS A DRIVING FORCE

Write the charges above each element in these unbalanced equations. Then look at the change in charge from side to side to determine which elements, if any, where oxidized and which were reduced. THEN BALANCE ALL THE EQUATIONS.

$$Fe + CuSO_4 \rightarrow Cu + FeSO_4$$

Who is being oxidized? Who is being reduced?

$$KI + Pb(NO_3)_2 \rightarrow PbI_2 + KNO_3$$

Who is being oxidized? Who is being reduced?

$$Cu + AgNO_3 \rightarrow Ag + Cu(NO_3)_2$$

Who is being oxidized? Who is being reduced?

$$MnO_2 + HCl \rightarrow MnCl_2 + Cl_2 + H_2O$$

Who is being oxidized? Who is being reduced?

$$Na_2CO_3 + HCl \rightarrow NaCl + CO_2 + H_2O$$

Who is being oxidized? Who is being reduced?

"The first principle is that you must not fool yourself - and you are the easiest person to fool."
~ Richard Feynman

HONORS CHEMISTRY: OXIDATION STATES/NUMBERS DATE:_____

Objectives: **SWBAT. . .**

… define oxidation numbers or oxidation state.
... determine the oxidation number of pure elements, ions, and compounds.

REMEMBER... OXIDATION:

- When atoms/ions are oxidized...
- E.g.) $Mg \rightarrow Mg^{2+} + 2e^-$ Magnesium went from an oxidation state of _____ to _____

REMEMBER... REDUCTION:

- When atoms/ions are reduced...
- E.g.) $O + 2e^- \rightarrow O^{2-}$ Oxygen went from an oxidation state of _____ to _____

OXIDATION NUMBER/STATE:

THE RULES:

- **In free elements,** (uncombined elements) the oxidation state ...
  - E.g**.)** Fe, O_2, O_3, S_8, Au
- **neutral compounds,** the sum of the constituent atoms' oxidation states ...
  - E.g.) NaCl
- **monatomic ions** , the oxidation state ...
  - E.g.) Alkali metals
  - E.g.) Alkaline earth metals
- **polyatomic ions,** the sum of the constituent atoms' oxidation states...
  - E.g.) Nitrate

WAIT! HOW DID YOU KNOW WHAT THOSE NON-METAL'S OXIDATION STATES WERE ?!?

Non-metals can get a little tricky. Their oxidation states are determined by how badly they want electrons relative to each other. This is called **electronegativity.**

We'll talk a lot more about it later, but what does that mean now?

- **Fluorine is always -1** when bonded to anyone else (it wants electrons more than anyone else)
- **Halogens are typically -1** (Exception: When bonded to N, O, or halogens higher in the family)
- **Hydrogen is typically +1** (Exception: when it is a hydride with an active metal it is -1)
- **Oxygen is typically -2** (Exception: In peroxides, it is -1. With fluorine it is +2, OF_2)
- Everyone else's oxidations states can be figured out from there (just like ion charges).
- Don't worry too much about the exceptions right now.

Interesting Note #1: Most elements have more than one oxidation state.

- e.g. carbon has nine integer oxidation states from -4 through +4.

Interesting note #2: Oxidation states typically range from +8 to -4 (fractions are rare, but possible).

Determine the oxidation state of each element in this reaction.

$$CH_4(g) + 2\ O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

Who is being oxidized?

Who is being reduced?

ANOTHER TAKE ON ALL THIS

Interesting note #3: Oxidation states can be used to help balance reactions.

More practice! Determine the formula for each substance and then determine the oxidation state of each element.

Calcium hydroxide:

Nitrate ion:

Silver sulfide:

Copper (II) phosphide:

Ammonium ion:

Formaldehyde:

Lead (IV) ion:

Iodine:

Nitrous acid:

Hydrogen peroxide:

Ozone:

Potassium Permanganate:

Carbon dioxide:

Ammonium nitrate*:

*HINT: Determine the oxidation numbers of each nitrogen separately.

DID YOU KNOW... "Oxidation itself was first studied by Antoine Lavoisier, who believed that oxidation was always the result of reactions with oxygen, thus the name. Although Lavoisier's idea has been shown to be incorrect, the name he proposed is still used, albeit more generally.

DID YOU KNOW... Oxidation states were one of the intellectual "stepping stones" that Mendeleev used to derive the periodic table."

- http://en.wikipedia.org/wiki/Oxidation_state

"Never throughout history has a man who lived a life of ease left a name worth remembering."
— Theodore Roosevelt

HONORS CHEMISTRY: Reaction Classifications DATE:_____

Learning Activities: **SWBAT. . .**

…review the basic driving forces in chemical reactions.
…classify reactions by several different methods.

THERE ARE OFTEN MULTIPLE WAYS TO CLASSIFY THE SAME CHEMICAL REACTION!

We can classify them based on the driving forces we've learned so far:

1) Precipitation reactions:

2) Acid-base neutralization reactions:

3) Oxidation-Reduction reactions:

*(Note: The final driving force, **production of a gas** in aqueous solutions, isn't usually used as a way to classify reactions.)*

Besides the driving forces, there are other ways to classify reactions:

4) Synthesis/combination reactions: $A + B \rightarrow AB$

- A reaction where…
- Usually involves a single product, but could produce one very complex product along with one or more less complex ones. Example:
- **Polymerization:** A type of synthesis where…

5) Combustion Reactions: $A + O_2 \rightarrow AO$ or $AB + O_2 \rightarrow AO + BO$ … etc.

- An exothermic reaction which…
- Is both an _____ and a _____ reaction.

6) Decomposition reaction: $AB \rightarrow A + B$

- A reaction where…

7) Single replacement/displacement: $A + BC \rightarrow AC + B$

- A reaction where…
- These are often_____reactions.

More chemically active elements will replace the less active ones.

ex.)

ex.)

8) Double replacement/displacement: AB + CD → AD + CB

A reaction where…

These are often precipitations, acid-base neutralizations, or gas production reactions.

Balance and categorize the following reactions. (Can be in more than one category).

ex) $Li(s) + Br_2(l) \rightarrow LiBr(s)$

-

ex) $S_8(s) + O_2(g) \rightarrow SO_2(g)$

-

ex) $H_2O(l) \rightarrow H_2(g) + O_2(g)$

-

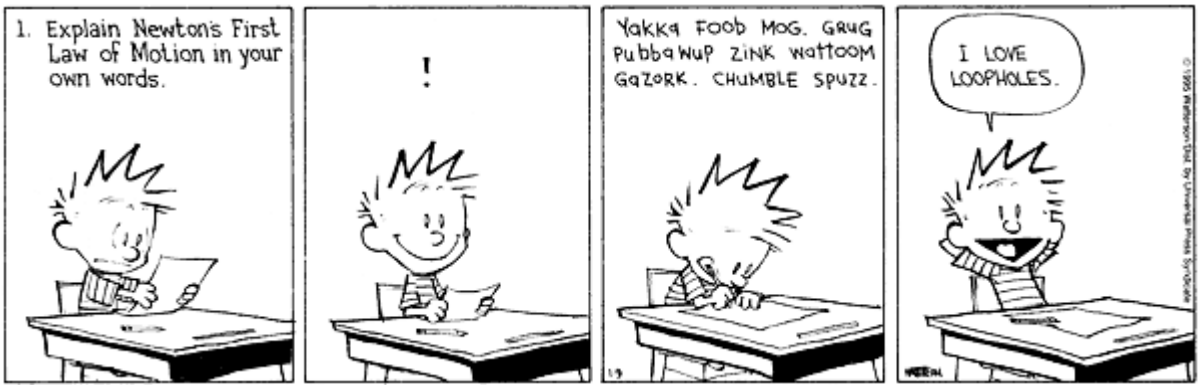
ex) $Al(s) + CuCl_2(aq) \rightarrow AlCl_3(aq) + Cu(s)$

-

ex) $KI(aq) + Pb(NO_3)_2(aq) \rightarrow PbI_2(s) + KNO_3(aq)$

-

Review & Reflection



"If I had my life to live over... I'd dare to make more mistakes next time." ~ Nadine Stair

HONORS CHEMISTRY CLASSIFICATION

NAME _____

Classify the following reaction. Choose among: synthesis, decomposition, single replacement, double replacement, precipitation, acid-base neutralization, redox, combustion (can use more than one). Fill in any blanks, including qualifiers. Then balance.

___ $N_{2(g)}$ + ___ $H_{2(g)}$ → ___ $NH_{3(g)}$

___ $SO_{2(g)}$ + ___ $H_2O_{(l)}$ → ___ $H_2SO_{3(aq)}$

___ $H_2SO_{4(aq)}$ → ___ $H_2O_{(l)}$ + ___ $SO_{3(g)}$

___ $N_{2(g)}$ + ___ $O_{2(g)}$ → ___ $NO_{(g)}$

___ $MgCO_{3(s)}$ + ___ $MgO_{(s)}$ + ___ $CO_{2(g)}$

___ $Sr(OH)_{2(s)}$ → ___ $SrO_{(s)}$ + ___ $H_2O_{(g)}$

___ $Li_{(s)}$ + ___ $O_{2(g)}$ → ___ $LiO_{(s)}$

___ $K_{(s)}$ + ___ $Br_{2(g)}$ → ___ $KBr_{(s)}$

___ $NaClO_{3(s)}$ → ___ $NaCl_{(s)}$ + ___ $O_{2(g)}$

___ $H_2O_{(l)}$ → ___ $H_{2(g)}$ + ___ $O_{2(g)}$

___ $S_{8(s)}$ + ___ $O_{2(g)}$ → ___ $SO_{2(g)}$

___ $AlCl_{3(l)}$ → ___ $Al_{(l)}$ + ___ $Cl_{2(g}$

___ $C_2H_{6(g)}$ + ___ $O_{2(g)}$ → ___ $CO_{2(g)}$ + ___ $H_2O_{(g)}$

___ $CaCl_{2(aq)}$ + ___ $AgNO_{3(aq)}$ → ___ $AgCl_{(s)}$ + ___ $Ca(NO_3)_{2(aq)}$

___ $Zn(s)$ + ___ $HCl_{(aq)}$ → ___ $ZnCl_{2(aq)}$ + ___ $H_{2(g)}$

___ $CaO_{(s)}$ + ___ $H_2O_{(l)}$ → ___ $Ca(OH)_{2(s)}$

___ $Rb_{(s)}$ + ___ $H_2O_{(l)}$ → ___ $RbOH_{(aq)}$ + ___ $H_{2(g}$

___ $HCl_{(aq)}$ + ___ $Na_2CO_{3(aq)}$ → ___ $NaCl_{(aq)}$ + ___ $H_2O_{(l)}$ + ___ $CO_{2(g)}$

___ $Zn_{(s)}$ + ___ $CuSO_{4(aq)}$ → ___ $ZnSO_{4(aq)}$ + ___ $Cu_{(s)}$

___ $NH_{3(g)}$ + ___ $H_2O_{(l)}$ → ___ $NH_4OH_{(aq)}$

___ $H_2SO_{4(aq)}$ + ___ $Ca(OH)_{2\ (aq)}$ → ___ $H_2O_{(l)}$ + ___ $CaSO_{4(s)}$

___ $Cl_{2(g)}$ + ___ $NaI_{(aq)}$ → ___ $NaCl_{(aq)}$ + ___ $I_{2(g)}$

"It's not what happens to you, but how you react to it that matters."
Epictetus

HONORS CHEMISTRY CLASSIFICATION

NAME _____

Fill in any blanks, including qualifiers and classify the following reaction. Choose among: synthesis, decomposition, single replacement, double replacement, precipitation, acid-base neutralization, redox, combustion (can use more than one). Then balance.

___ $N_{2(g)}$ + _____ → ___ $NH_{3(g)}$

___ $SO_{2(g)}$ + _____ → ___ $H_2SO_{3(aq)}$

___ $H_2SO_{4(aq)}$ → _____ + ___ $SO_{3(g)}$

_____ + ___ $O_{2(g)}$ → ___ $NO_{(g)}$

___ $MgCO_{3(s)}$ → _____ + ___ $CO_{2(g)}$

___ $Sr(OH)_{2(s)}$ → _____ + ___ $H_2O_{(g)}$

___ $Li_{(s)}$ + ___ $O_{2(g)}$ → _____

___ $K_{(s)}$ + _____ → ___ $KBr_{(s)}$

_____ → ___ $NaCl_{(s)}$ + ___ $O_{2(g)}$

___ $H_2O_{(l)}$ → ___ $H_{2(g)}$ + _____

___ $S_{8(s)}$ + _____ → ___ $SO_{2(g)}$

_____ → ___ $Al_{(l)}$ + ___ $Cl_{2(g}$

___ $C_2H_{6(g)}$ + ___ $O_{2(g)}$ → _____ + ___ $H_2O_{(g)}$

___ $CaCl_{2(aq)}$ + ___ $AgNO_{3(aq)}$ → _____ + ___ $CaNO_{3(aq)}$

_____ + ___ $HCl_{(aq)}$ → ___ $ZnCl_{2(aq)}$ + ___ $H_{2(g)}$

___ $CaO_{(s)}$ + ___ $H_2O_{(l)}$ → _____

___ $Rb_{(s)}$ + _____ → ___ $RbOH_{(aq)}$ + ___ $H_{2(g}$

___ $HCl_{(aq)}$ + ___ $Na_2CO_{3(aq)}$ → ___ $NaCl_{(aq)}$ + ___ $H_2O_{(l)}$ + _____

___ $Zn_{(s)}$ + _____ → ___ $ZnSO_{4(aq)}$ + ___ $Cu_{(s)}$

___ $NH_{3(g)}$ + _____ → ___ $NH_4OH_{(aq)}$

_____ + ___ $CaOH_{(aq)}$ → ___ $H_2O_{(l)}$ + ___ $CaSO_{4(s)}$

___ $Cl_{2(g)}$ + ___ $NaI_{(aq)}$ → ___ $NaCl_{(aq)}$ + _____

"It's not what happens to you, but how you react to it that matters."
Epictetus

HONORS CHEMISTRY: Activity Series For Metals DATE:_____

Learning Activities: **SWBAT. . .**

… use an activity series to predict reactions involving metals.

Activity:

- For metals, the greater the activity...
- Metals can be arranged in a series, most reactive metals at:

acids

Can be used to predict extraction techniques for ores.

Ore:

Ex.) Magnetite (Fe_3O_4) and hematite (Fe_2O_3) are iron ores.

Metals beneath hydrogen are relatively easy to extract.

- They are less reactive, form fewer compounds, corrode and tarnish less than other metals.
- Some, like gold may even be found _____(though not necessarily pure) in nature.

Metals in the middle (but still below carbon) can be purified through smelting.

- The ore is heated in the presence of:
- Carbon ends up reducing the metal, driving it to an uncombined, elemental form.

Metals above carbon must be purified through electrolysis.

- _____ and _____

Can be used to predict reactivity with common substances.

Metals at the bottom of the series only react with oxygen, if at all.

- Metals below iron but above silver will react with oxygen when heated.

  Ex.) 2 Pb (s) + O_2 (g) →

- Silver, gold and platinum don't react with oxygen in the air.

Metals above hydrogen in the series will react with acids and liberate H_2(g).

Ex.) Ni (s) + H^+ (aq) →

- Note: those H+ ions come from some acid. This equation leaves out the spectators.

  Ex.) Ni (s) + HCl (aq) →

- They will also react with_____as described above.

Metals above nickel in the series will react with steam and liberate H_2(g).

Ex.) Fe(s) + 2 H_2O (g) →

- These metals also react with _____and_____as describe above.

Metals above magnesium in the series will react with water and liberate H_2(g).

Ex.) Na(s) + 2 H_2O (l) →

- These metals also react with _____and _____ and _____as describe above.

Can be used to predict a metal's success at single replacement.

Activity series often list the half-reaction resulting from the oxidation of each metal.

Any metal will _____ elements listed below it.

- This means that it will donate electrons and become a cation.

  Ex.)

Any metal will _____ elements listed above it.

- This means that it will instead accept electrons.
- This will reverse the half-reaction and reform the uncombined metal.

  Ex.)

TRY IT OUT YOURSELF

If the more active metal has to donate electrons, you can predict a single replacement will occur.
If the less active metal has to donate electrons, you can predict no reaction will occur.

Ex) Write the balanced equation for copper metal plus a silver nitrate solution. Will the reaction occur?

Ex) Write the balanced equation for silver metal plus copper (II) nitrate solution. Will the reaction occur?

- Note: Activity series are useful, but not perfect. Generally speaking, the most active metals are the ones with the largest atoms with the least number of valence electrons.

- Note: An activity series for NON-METALS would be set up much differently. Since they would rather GAIN electrons, the most powerful oxidizing agents will be at the top. (The opposite of the metal list.)

DID YOU KNOW... Electrolysis of aluminum ores wasn't developed until 1886. Pre - 1886, aluminum could only be extracted by heating its bauxite ores with elemental sodium or potassium in a vacuum. This made aluminum more expensive than gold at the time. To show you how expensive it was, consider the Washington Monument in Washington DC. In 1884, the monument was capped with an an aluminum pyramid only 22.6 cm in height, 13.9 cm at its base, weighing 2.85 Kg. Its Its final cost? $225 (about $5,500 in 2014 dollars). How much would that much aluminum cost you today? About $5.35.

"Don't mistake activity with achievement." — John Wooden

HONORS CHEMISTRY: ACTIVITY SERIES FOR METALS DATE:_____

Learning Activities: **SWBAT. . .**

… use an activity series to predict reactions involving metals.

ACTIVITY: *The ability of an element to react with another element. (Easier the reaction, greater the activity)*

- For metals, the greater the activity... *the easier they lose electrons, forming positive ions.*
- Metals can be arranged in a series, most reactive metals at: *the top.*

CAN BE USED TO PREDICT EXTRACTION TECHNIQUES FOR ORES.

Ore: *A mineral or rock containing compounds of a desired metal.*

Ex.) Magnetite (Fe_3O_4) and hematite (Fe_2O_3) are iron ores.

Metals beneath hydrogen are relatively easy to extract.

- They are less reactive, form fewer compounds, corrode and tarnish less than other metals.
- Some, like gold may even be found __*uncombined*__(though not necessarily pure) in nature.

Metals in the middle (but still below carbon) can be purified through smelting.

- The ore is heated in the presence of: *carbon or carbon monoxide.*
- Carbon ends up reducing the metal, driving it to an uncombined, elemental form.

Metals above carbon must be purified through electrolysis.

- _____*Expensive*_____ and ___*energy intensive.*_____

CAN BE USED TO PREDICT REACTIVITY WITH COMMON SUBSTANCES.

Metals at the bottom of the series only react with oxygen, if at all.

- Metals below iron but above silver will react with oxygen when heated.

  Ex.) $2\ Pb\ (s) + O_2\ (g) \rightarrow 2\ PbO\ (s)$

- Silver, gold and platinum don't react with oxygen in the air.

Metals above hydrogen in the series will react with acids and liberate H_2(g).

Ex.) $Ni\ (s) + H^+\ (aq) \rightarrow Ni^{2+}\ (aq) + H_2\ (g)$

- Note: those H+ ions come from some acid. This equation leaves out the spectators.

  Ex.) $Ni\ (s) + HCl\ (aq) \rightarrow NiCl_2\ (aq) + H_2\ (g)$

- They will also react with___*oxygen*___as described above.

Metals above nickel in the series will react with steam and liberate H_2(g).

Ex.) $Fe(s) + 2\ H_2O\ (g) \rightarrow Fe(OH)_2\ (s) + H_2\ (g)$

- These metals also react with ___*acid*___and___*oxygen*___as describe above.

Metals above magnesium in the series will react with water and liberate H_2(g).

Ex.) $Na(s) + 2\ H_2O\ (l) \rightarrow NaOH\ (aq) + H_2\ (g)$

- These metals also react with ___*steam*___and ___*acid*___ and ___*oxygen*___as describe above.

CAN BE USED TO PREDICT A METAL'S SUCCESS AT SINGLE REPLACEMENT.

Activity series often list the half-reaction resulting from the oxidation of each metal.

Any metal will _____*reduce*_____ elements listed below it.

- This means that it will donate electrons and become a cation.

  Ex.) $Fe \rightarrow Fe^{2+} + 2e^-$

Any metal will _____*oxidize*_____ elements listed above it.

- This means that it will instead accept electrons.
- This will reverse the half-reaction and reform the uncombined metal.

  Ex.) $Fe^{2+} + 2e^- \rightarrow Fe$

TRY IT OUT YOURSELF

If the more active metal has to donate electrons, you can predict a single replacement will occur.

If the less active metal has to donate electrons, you can predict no reaction will occur.

Ex) Write the balanced equation for copper metal plus a silver nitrate solution. Will the reaction occur?

$Cu\ (s) + 2\ AgNO_3\ (aq) \rightarrow 2\ Ag\ (s) + Cu(NO_3)_2\ (aq)$

Copper is more active than silver, so it would be willing to go from Cu (s) to Cu^{2+} (aq)

Ex) Write the balanced equation for silver metal plus copper (II) nitrate solution. Will the reaction occur?

$2\ Ag\ (s) + Cu(NO_3)_2\ (aq) \rightarrow Cu\ (s) + 2\ AgNO_3\ (aq)$ NO REACTION

Copper is more active than silver, so it would not be willing to go from Cu^{2+} (aq) back to Cu (s)

- Note: Activity series are useful, but not perfect. Generally speaking, the most active metals are the ones with the largest atoms with the least number of valence electrons.

- Note: An activity series for NON-METALS would be set up much differently. Since they would rather GAIN electrons, the most powerful oxidizing agents will be at the top. (The opposite of this metal list.)

DID YOU KNOW... Electrolysis of aluminum ores wasn't developed until 1886.

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"Don't mistake activity with achievement." — John Wooden

EXTRACTION REQUIRES ELECTROLYSIS

$K \rightarrow K^+ + e^-$

$Na \rightarrow Na^+ + e^-$

$Li \rightarrow Li^+ + e^-$

$Ba \rightarrow Ba^{2+} + 2e^-$

$Sr \rightarrow Sr^{2+} + 2e^-$

$Ca \rightarrow Ca^{2+} + 2e^-$

REACTS WITH WATER

$Mg \rightarrow Mg^{2+} + 2e^-$

$Al \rightarrow Al^{3+} + 3e^-$

C (for reference)

EXTRACTION REQUIRES SMELTING

$Mn \rightarrow Mn^{2+} + 2e^-$

$Zn \rightarrow Zn^{2+} + 2e^-$

$Cr \rightarrow Cr^{2+} + 2e^-$

$Fe \rightarrow Fe^{2+} + 2e^-$

$Co \rightarrow Co^{2+} + 2e^-$

REACTS WITH STEAM

$Ni \rightarrow Ni^{2+} + 2e^-$

$Sn \rightarrow Sn^{2+} + 2e^-$

$Pb \rightarrow Pb^{2+} + 2e^-$

REACTS WITH ACIDS

$H_2 \rightarrow 2H^+ + 2e^-$ (for reference)

EXTRACTION REQUIRES ONLY HEAT OR PHYSICAL SEPARATION

$Cu \rightarrow Cu^{2+} + 2e^-$

$Hg \rightarrow Hg^{2+} + 2e^-$

REACTS WITH OXYGEN

$Ag \rightarrow Ag^+ + e^-$

$Pt \rightarrow Pt^+ + e^-$

$Au \rightarrow Au^{3+} + 3e^-$

ACTIVITY SERIES

The most active metals are at the top. They will oxidize at the expense of any metal below it in the series.

HONORS CHEMISTRY
ACTIVITY SERIES

NAME _____

Write the formula of the reactants on the left of the yield sign. Determine if the replacement can happen. If not, write N.R. (no reaction). If so, complete and balance it.

1. Silver nitrate + nickel →

2. Zinc acetate + lead →

3. Calcium + hydrochloric acid →

4. Potassium + water →

5. Copper + water →

That last equation demonstrates why we use copper to carry water through our houses. Write an equation showing why magnesium would be a less wise choice for pipes.

For fun, arrange these hypothetical chemicals in order of decreasing activity (most to least reactive).

$A + B^+ \rightarrow A^+ + B$
$F + G^+ \rightarrow$ N.R.
$D + B^+ \rightarrow$ N.R.

$C + B^+ \rightarrow$ N.R.
$A + F^+ \rightarrow$ N.R.
$G + A^+ \rightarrow G^+ + A$

$D + C^+ \rightarrow D^+ + C$
$F + D^+ \rightarrow F^+ + D$

"We forfeit three-fourths of ourselves in order to be like other people."
- Arthur Schopenhauer