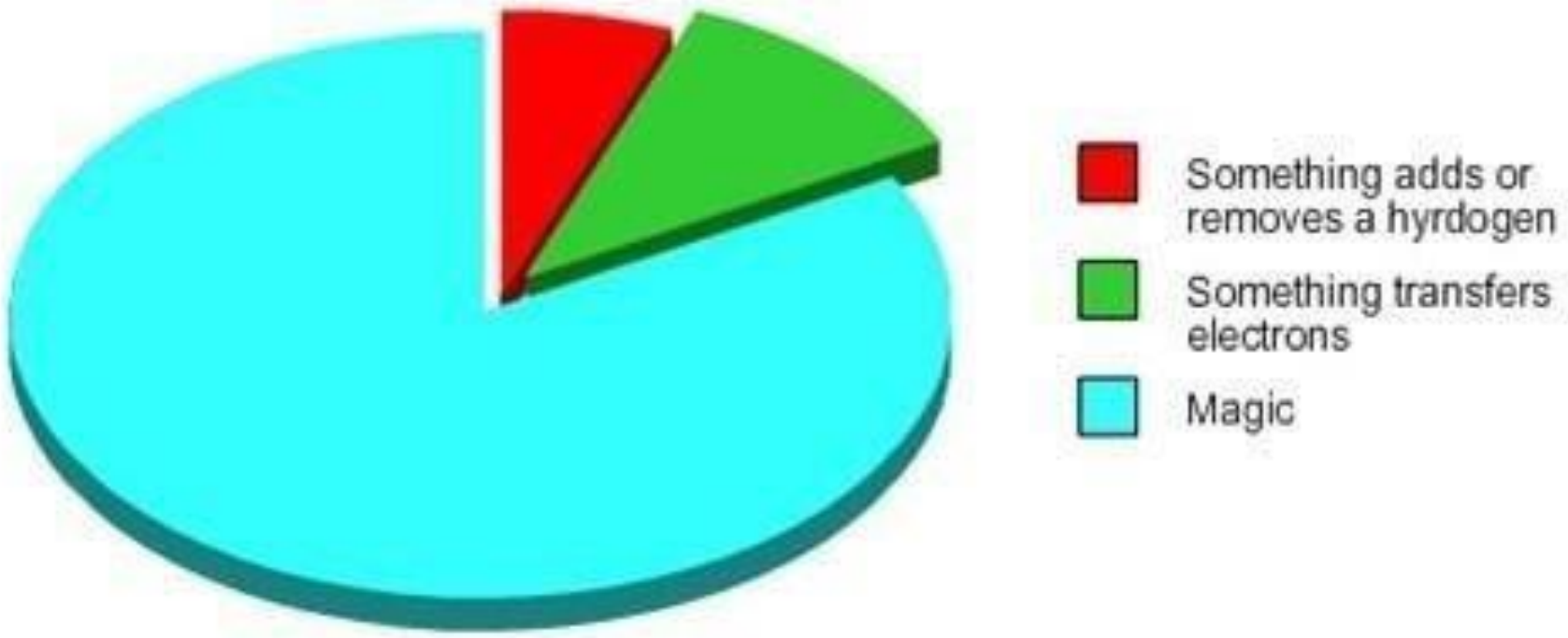
WHAT DO I NEED

NOTEBOOK

COLORED PENCILS

3

How chemical reactions occur



Guide to Balancing a Chemical Equation

STEP 1

Write an equation using the correct formulas of the reactants & products

STEP 2

Count the atoms of each element in reactants & products

STEP 3

Use COEFFICIENTS to balance each element

STEP 4

Check final equation for balance

Left Side Notes
Title:
Evidence of a Chemical Reaction

Left side Notes:

EVIDENCE OF A CHEMICAL REACTION

izzes — Did the reaction produce bubbles?

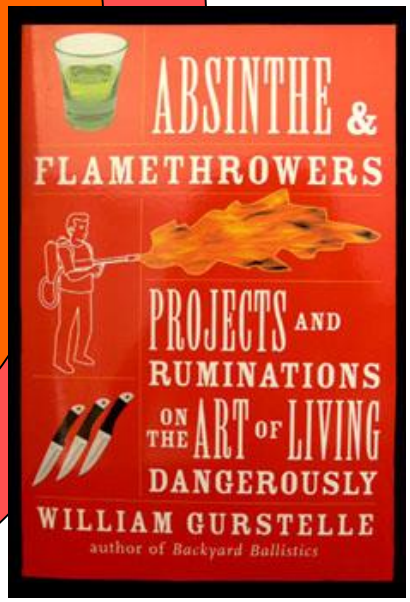
roma — Did the reaction produce a smell?

eplacement — Did the reaction replace any of the original substance?

emperature — Did the reaction produce a temperature change, either hot or cold?

new  ubstance — Did the reaction produce a new substance?

CHEMICAL REACTIONS



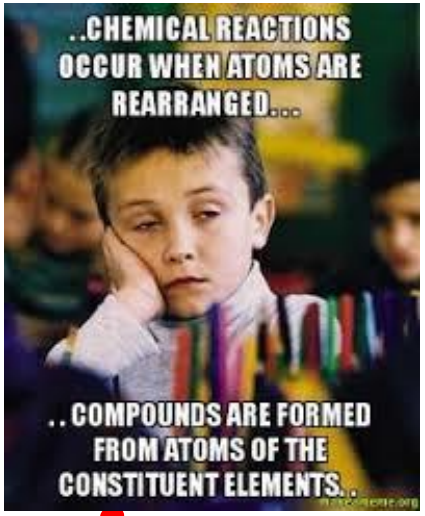
Types of Reactions

There are millions of chemical reactions. The only way to be sure what your products will be is to run the reaction in the lab!

Not very practical – or cost effective… BUT

There are 5 types of chemical reactions we can make some predictions for:

1. Synthesis reactions
2. Decomposition reactions
3. Single Replacement/Displacement reactions
4. Double Replacement/Displacement reactions
5. Combustion reactions



You need to be able to identify the type of reaction and predict the product(s)

Synthesis (combination)

aka **composition reaction**

A + B → AB

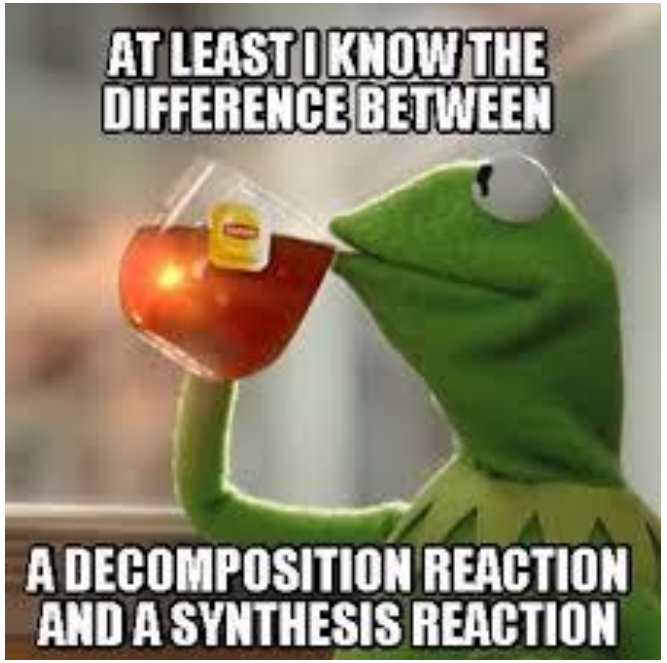
Two or more substances combine to form a new compound.

$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$

Synthesis (combination)

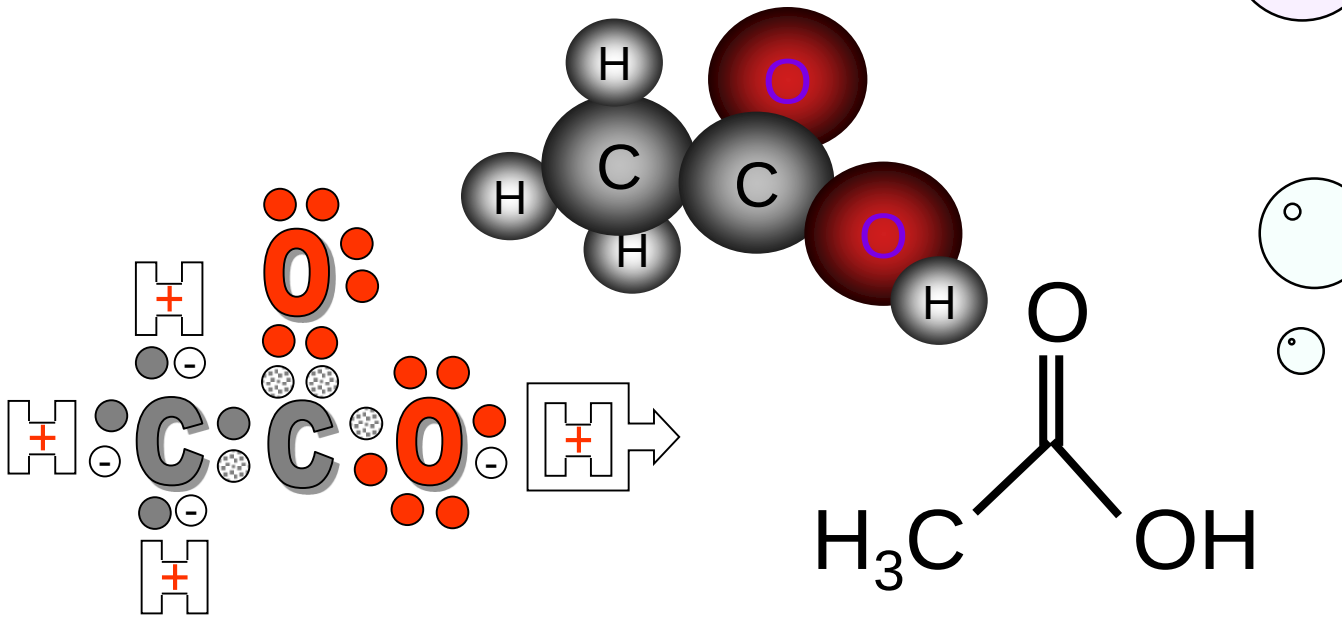
Where do we use synthesis reactions?

- Medicine
- Flavorings
- Plastics
- High energy fuels



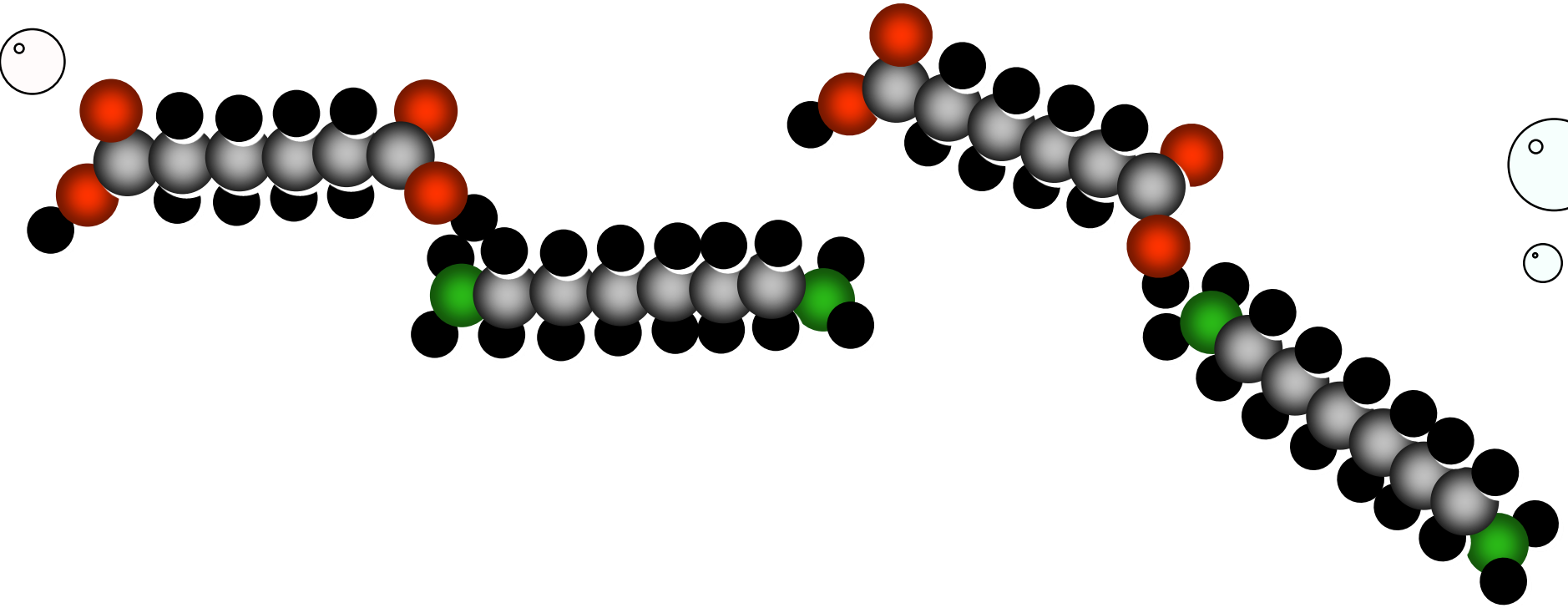
CLUE: **2 combine to make 1**

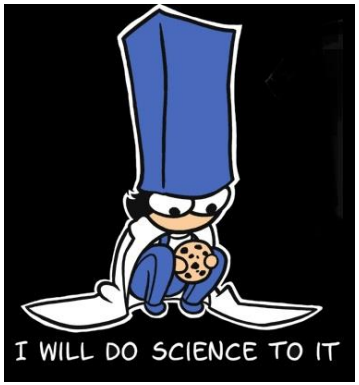
SYNTHESIS OF FLAVORINGS



A special type of synthesis reaction can be used to create many different types of flavors. Acetic acid splits into **acetate** $(C_2H_3O_2)^-$ and $\mathbf{H^+}$ and then recombines with another molecule to form a flavor molecule and a water in a reaction called **dehydration synthesis**.

How the reaction works...





+

PRACTICE

Predict the products. Write and balance the following synthesis reaction equations.

- **Sodium metal reacts with chlorine gas**

$$Na_{(s)} + Cl_{2(g)} \rightarrow$$

1) e- transfer making ions

Na^+ Cl^-

2) ions form neutral ionic compound = product

NaCl

3) balance equation

$$Na_{(s)} + Cl_{2(g)} \rightarrow 2NaCl$$

PRACTICE

Solid Magnesium reacts with fluorine gas

$Mg_{(s)} + F_{2(g)} \rightarrow$

Mg^{2+} F^- product: MgF_2

$$Mg_{(s)} + F_{2(g)} \rightarrow MgF_2$$

Balance - (already balanced)

PRACTICE

- Aluminum metal reacts with fluorine gas

$Al_{(s)} + F_{2(g)} \rightarrow$

Al^{3+} F^- product: AlF_3

$$Al_{(s)} + F_{2(g)} \rightarrow AlF_3$$

Balance

$$2Al_{(s)} + 3F_{2(g)} \rightarrow 2AlF_3$$

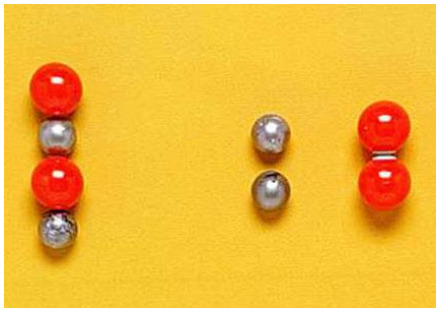
Decomposition

A single compound undergoes a reaction that produces **2** or more simpler substances.

AB → A + B

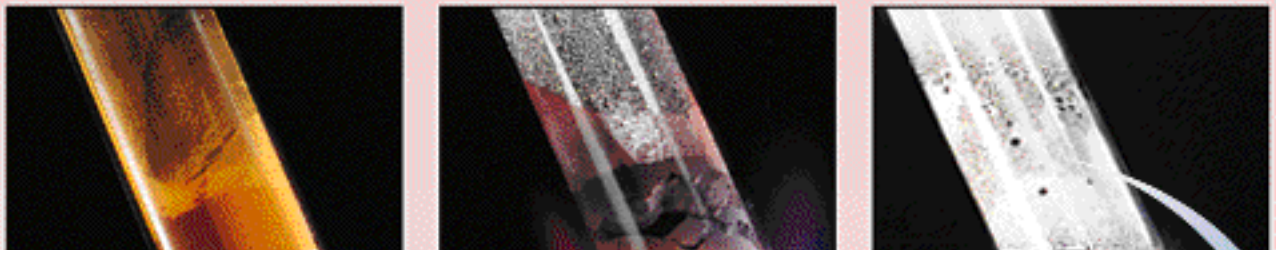
$(NH_4)_2Cr_2O_7 \rightarrow N_2 + 4H_2O + Cr_2O_3$

$$2H_2O_{(l)} \xrightarrow{\text{electricity}} 2H_{2(g)} + O_{2(g)}$$



Electrolysis– the decomposition of a substance by an electric current.

Decomposition



CLUE:

1 Reactant falls apart into 2 or more Products

$$2HgO(s) \xrightarrow{\Delta} 2Hg(l) + O_2(g)$$

Mercury(II) oxide → Mercury + Oxygen

Decomposing Dead Body
One body falls apart into many products

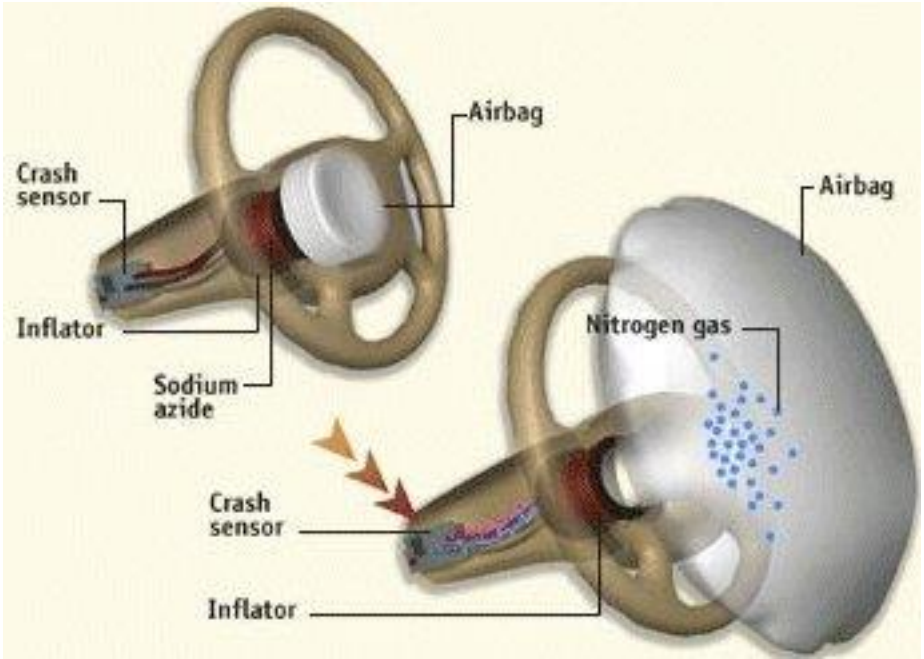
Decomposition Exceptions

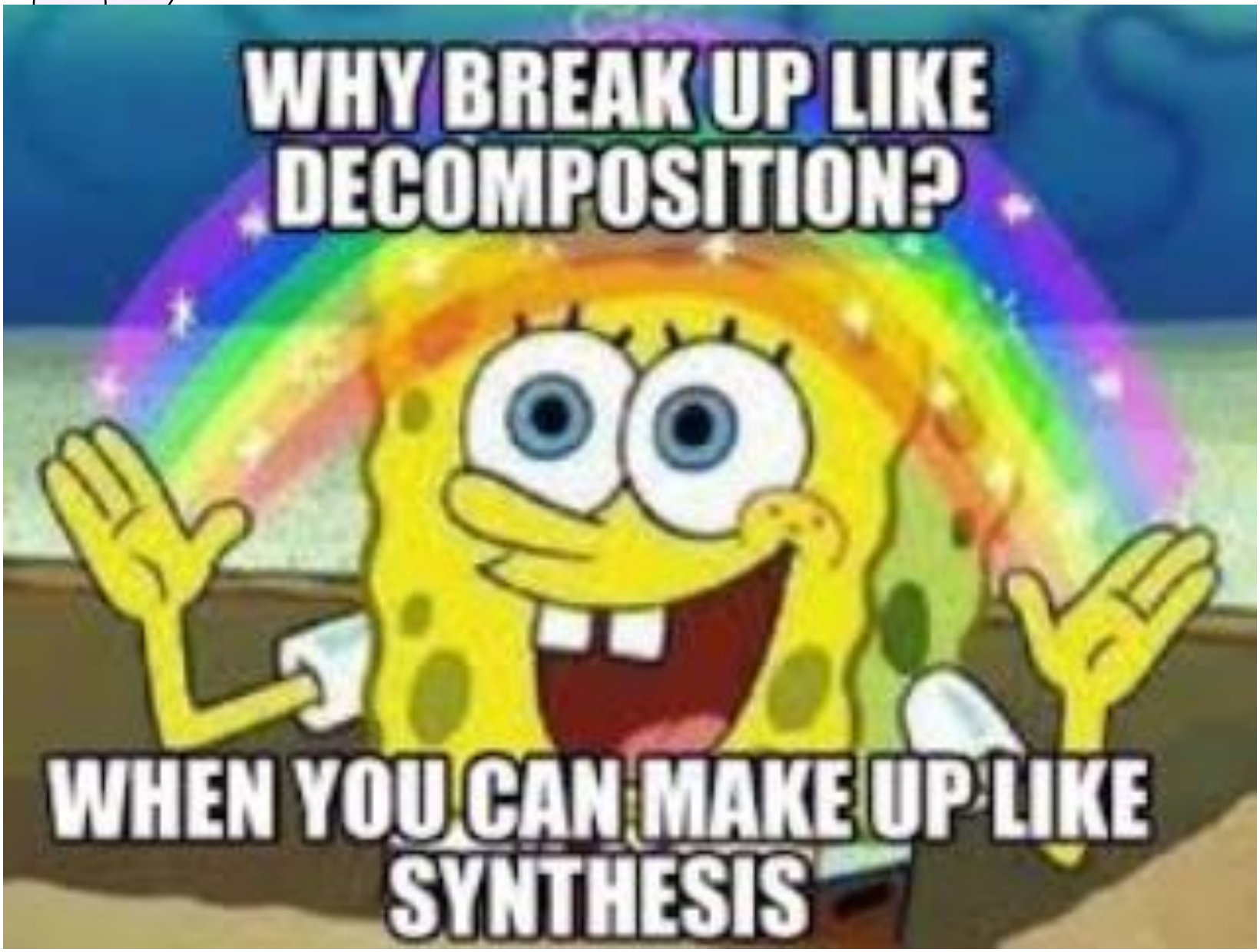
- **Carbonates** and **chlorates** are special case decomposition reactions that **do not** go to the elements.
  - **Carbonates** (CO_3^{2-}) decompose to **carbon dioxide** and a **metal oxide**
    - Example: $CaCO_3 \rightarrow CO_2 + CaO$
  - **Chlorates** (ClO_3^-) decompose to **oxygen gas** and a **metal chloride**
    - Example: $2\ Al(ClO_3)_3 \rightarrow 9\ O_2 + 2\ AlCl_3$
    - There are more… but we will not explore those in Chemistry I

- An example of decomposition reaction is an air bag. Automobile air bags inflate rapidly as sodium azide pellets decompose. A device that can provide and electric signal to start the reaction is packaged inside air bags along with sodium azide pellets

$$2NaN_3 \rightarrow 2Na + 2N_2$$

sodium azide — sodium — nitrogen gas



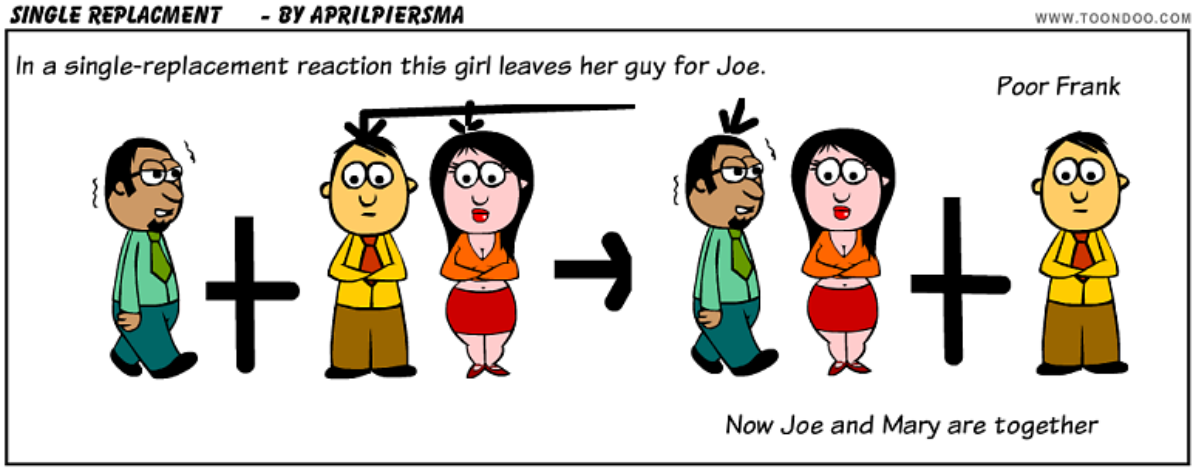

WHY BREAK UP LIKE DECOMPOSITION?
WHEN YOU CAN MAKE UP LIKE SYNTHESIS

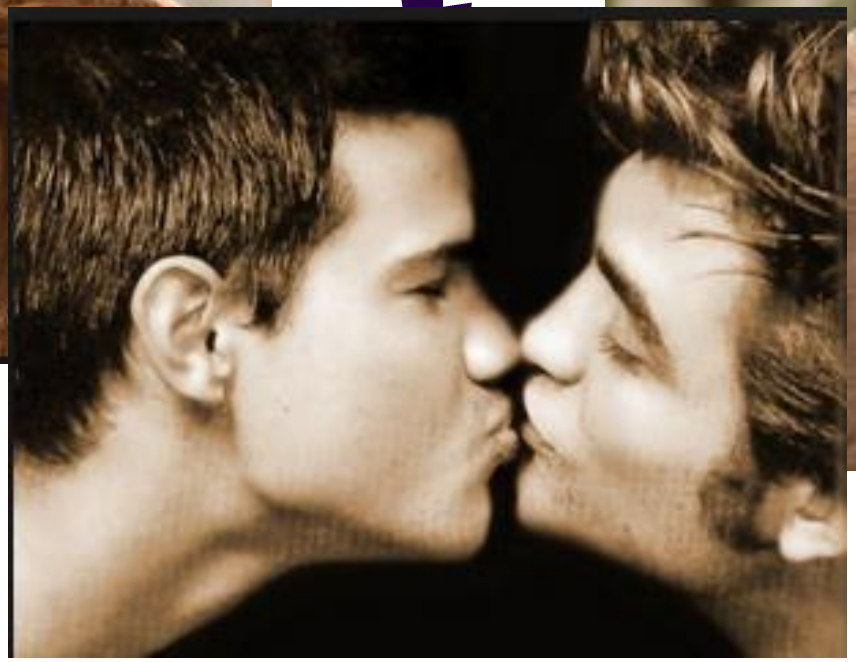
Single Replacement

aka single displacement

$$A + BC \longrightarrow B + AC$$

CLUE: one of the two reactants is an ***element*** **AND** one of the two products is another ***element***.





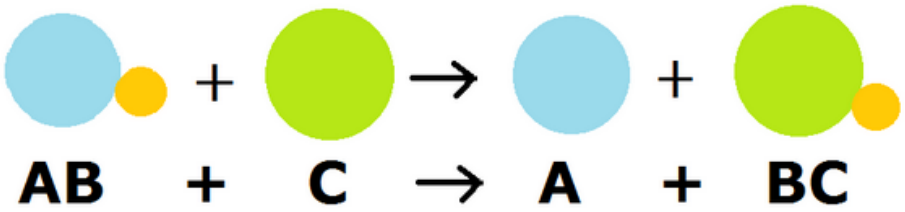
Single Replacement

- A metal can replace a metal (+) OR
  a nonmetal can replace a nonmetal (-)

A + BC → AC + B (if **A** is a **metal**) OR

A + BC → BA + C (if **A** is a **nonmetal**)

(remember the cation always goes first!)



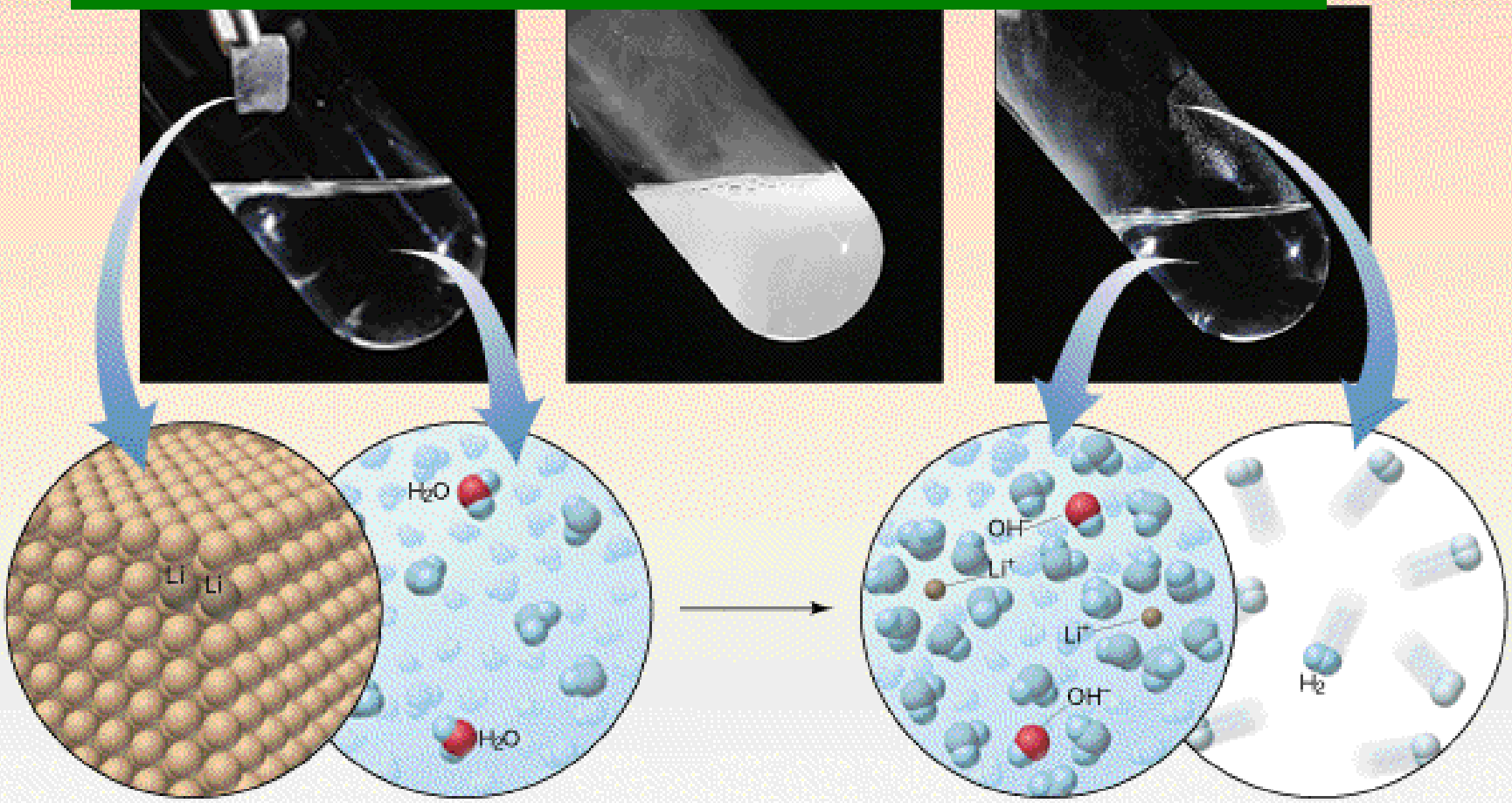
Ex. When H_2O splits into ions, it splits into H^+ and OH^- (not H+ and O^{-2} !!)

$$Mg + 2\,H_2O \rightarrow Mg(OH)_2 + H_2$$

magnesium + water → magnesium hydroxide + hydrogen gas

(H-OH)

Single Replacement

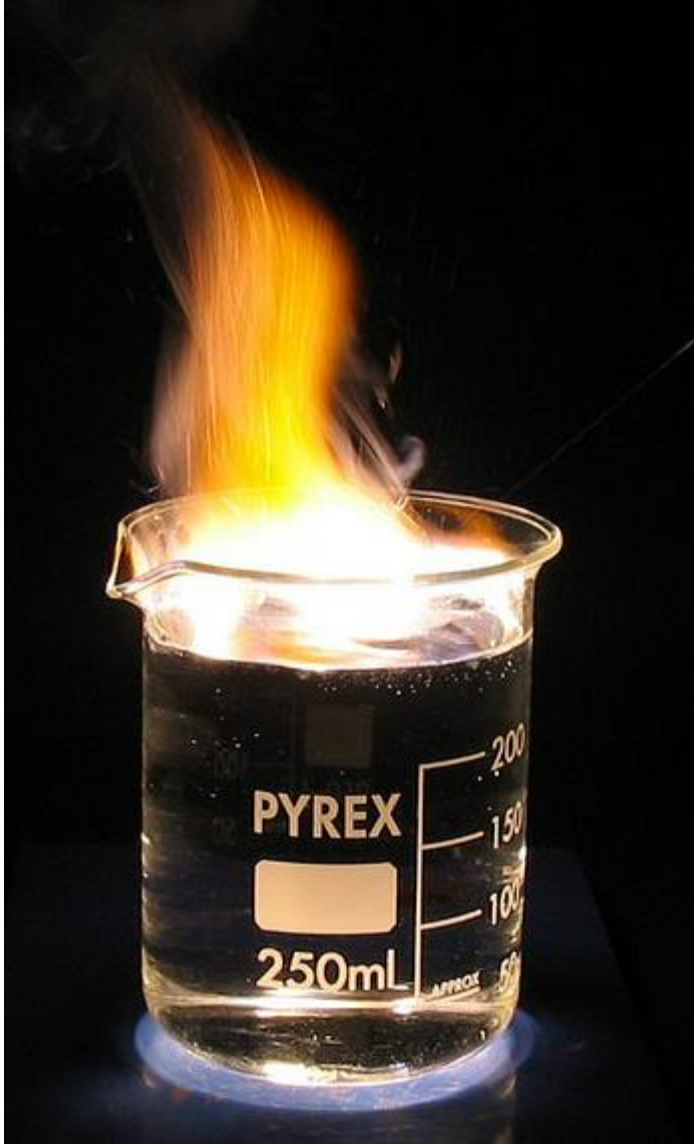


$2Li(s)$ + $2H_2O(l)$ → $2LiOH(aq)$ + $H_2(g)$

Lithium + Water → Lithium hydroxide + Hydrogen

Single Replacement

Another example of a single displacement reaction is when magnesium *replaces* hydrogen in water to make magnesium hydroxide and hydrogen gas:



$$Mg + 2\,H_2O \rightarrow Mg(OH)_2 + H_2$$

magnesium | water | magnesium hydroxide | hydrogen gas

How CAN we predict the reaction

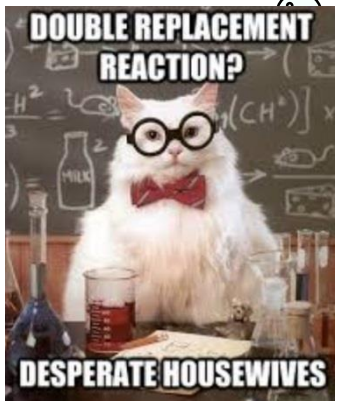
To be continued later……

Go to 4. DOUBLE REPLACEMENT

Double Replacement

aka double displacement

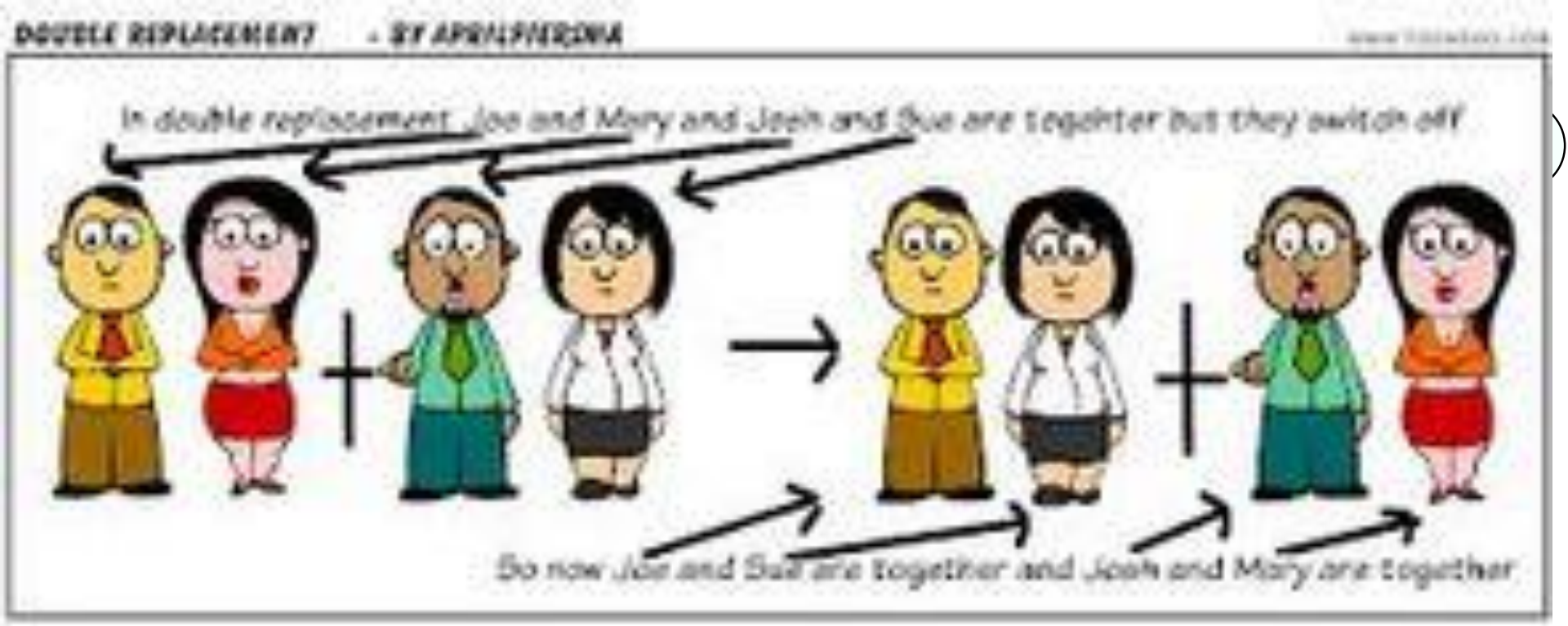
The ions of **2** compounds exchange places in an aqueous solution to form **2** new compounds.

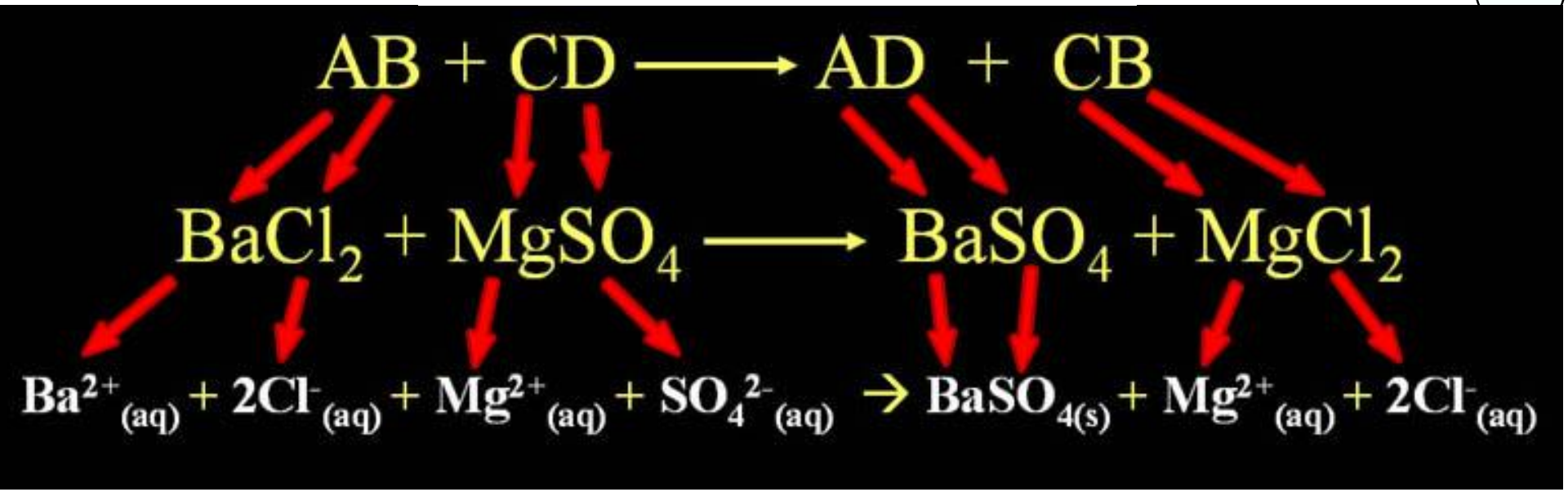


AB + CD → AD + CB

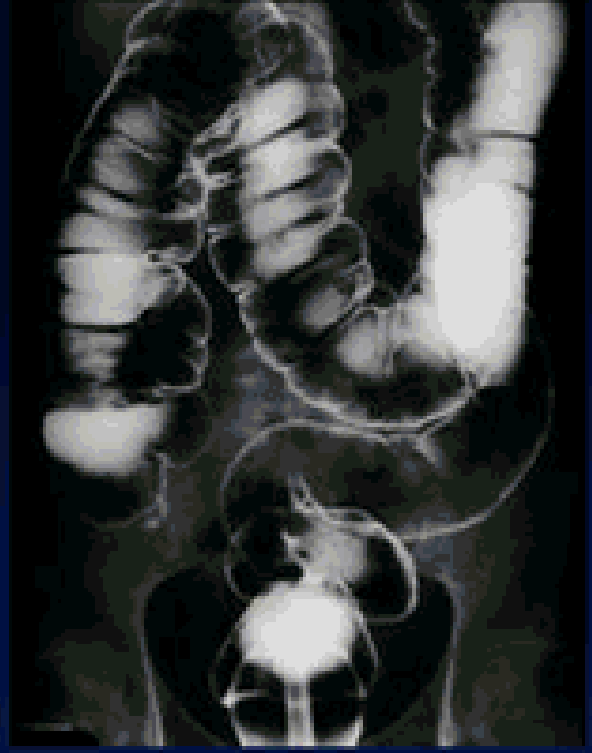
ex. Purification (barium is poisonous)

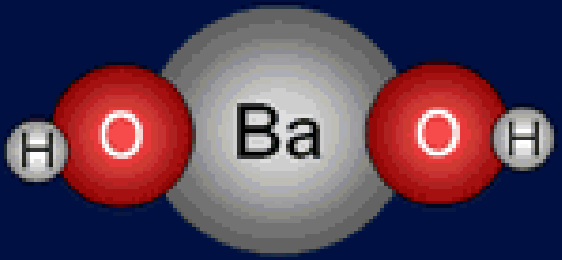
- $BaCl_2 + MgSO_4 \longrightarrow BaSO_4 + MgCl_2$
- $Ba^{2+}_{(aq)} + 2Cl^-_{(aq)} + Mg^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \longrightarrow BaSO_{4(s)} + Mg^{2+}_{(aq)} + 2Cl^-_{(aq)}$

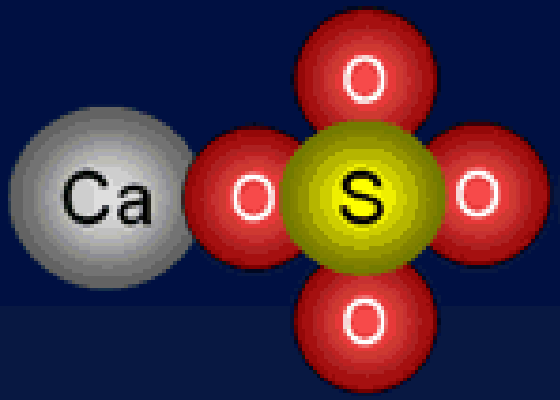

DOUBLE REPLACEMENT - BY APRILPIERSMA
In double replacement Joe and Mary and Josh and Sue are together but they switch off
So now Joe and Sue are together and Josh and Mary are together



CLUE: **Anions in 2 reactants swap their Cations**







$$Ba(OH)_{2(aq)} + CaSO_{4(aq)} \rightarrow BaSO_{4(s)} + Ca(OH)_{2(aq)}$$

Double Replacement

Double Replacement Reactions occur when a **metal replaces a metal** in a compound and a **nonmetal replaces a nonmetal** in a compound

COMPOUND + COMPOUND → COMPOUND + COMPOUND

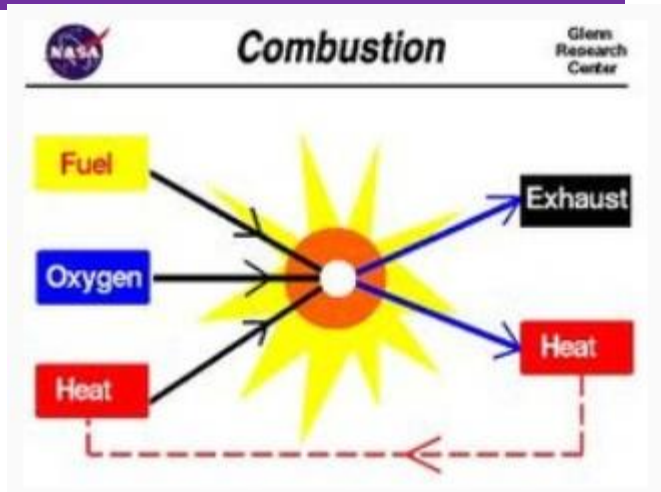
Practice

Predict the products. Balance the equation

1. $HCl_{(aq)} + AgNO_{3(aq)} \rightarrow$
2. $CaCl_{2(aq)} + Na_3PO_{4(aq)} \rightarrow$
3. $Pb(NO_3)_{2(aq)} + BaCl_{2(aq)} \rightarrow$
4. $FeCl_{3(aq)} + NaOH_{(aq)} \rightarrow$
5. **$H_2SO_{4(aq)} + NaOH_{(aq)} \rightarrow$**
6. $KOH_{(aq)} + CuSO_{4(aq)} \rightarrow$

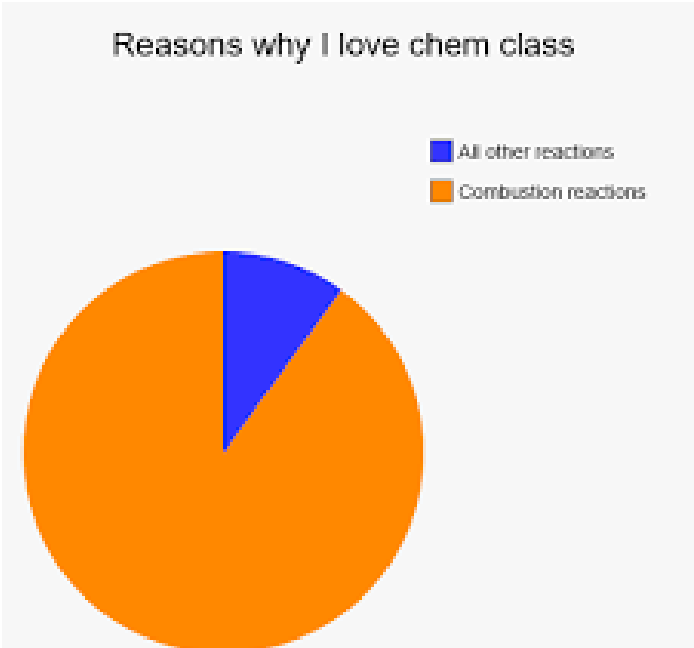
Oxidation (aka: Combustion)

- Oxidation means loss of electrons



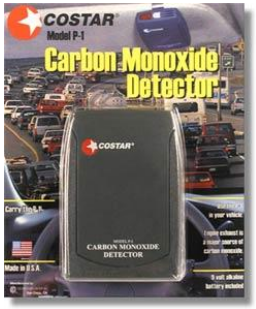
- Combustion reactions occur when a **hydrocarbon** reacts with **oxygen gas**.
- This is also called burning
- In order to burn something you need the 3 things in the "fire triangle":

1) A Fuel (hydrocarbon)
2) Oxygen to burn it with
3) Something to ignite the reaction (spark)



General Combustion Reactions

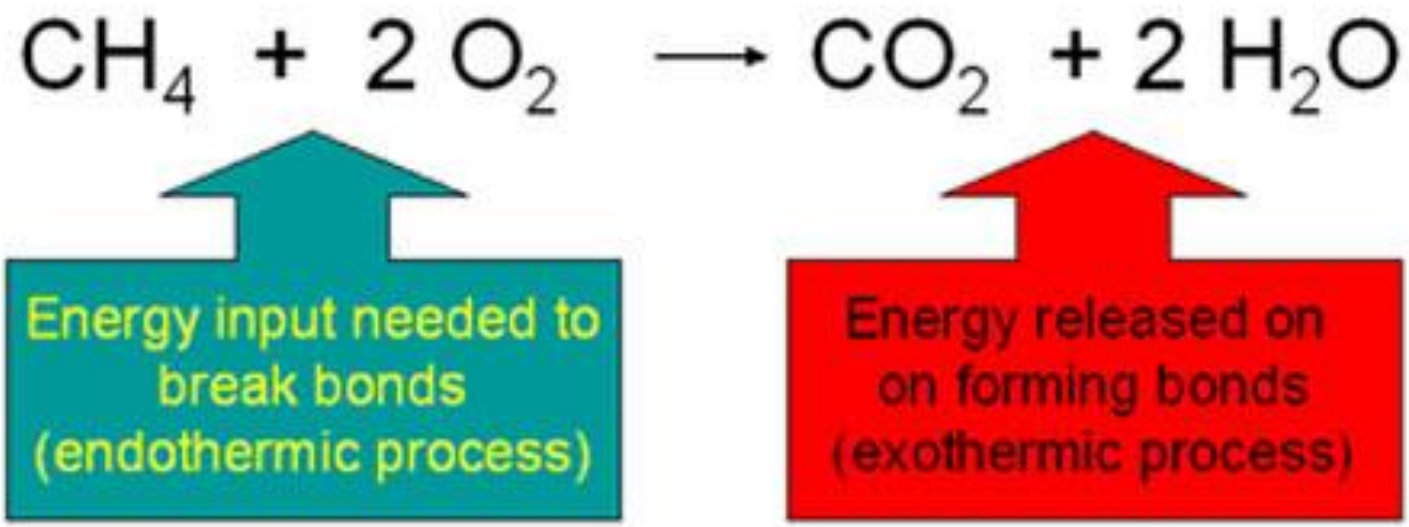
- $C_xH_Y + O_2 \rightarrow CO_2 + H_2O$



- Products in combustion are **ALWAYS** CO_2 and H_2O.
  (although incomplete burning does cause some by-products like carbon monoxide)

CLUE: 1 of the reactants is O_2

Combustion is Exothermic



$$\Delta H = \Sigma \text{ Energy of bonds broken} - \Sigma \text{ Energy of bonds made}$$

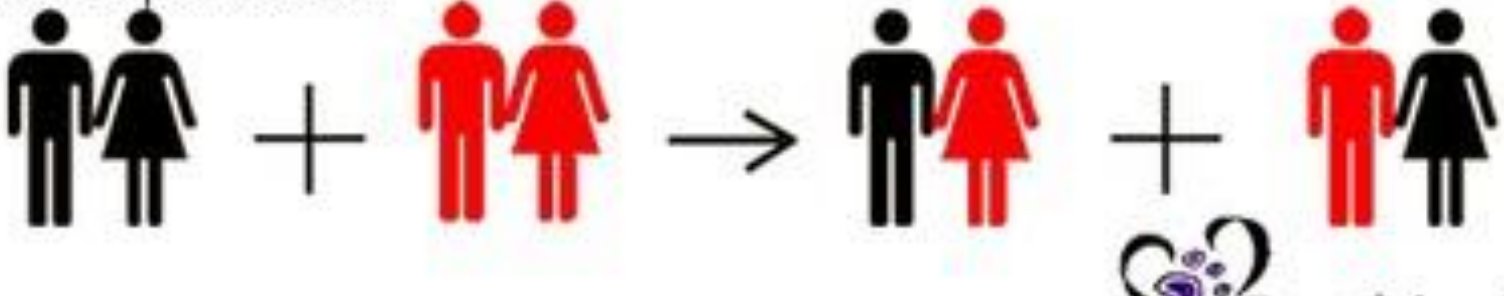
Chemical Reactions

Synthesis:

Decomposition:

Single Displacement:

Double Displacement:



Ms. Ristow's Handy Checklist for figuring out what type of reaction is taking place:

Follow this series of questions.

When you can answer "yes" to a question, then stop!

1) Does your reaction have **oxygen as one of it's reactants** and **carbon dioxide and water as products**? If yes, then it's a **COMBUSTION REACTION**

2) Does your reaction have **two (or more) chemicals combining** to **form one** chemical? If yes, then it's a **SYNTHESIS REACTION**

3) Does your reaction have one large molecule **falling apart** to make several small ones? If yes, then it's a **DECOMPOSITION REACTION**

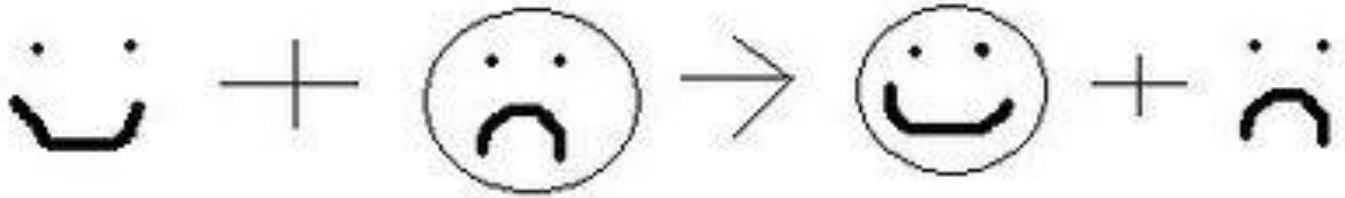
4) Does your reaction have any molecules that contain **only one element**? If yes, then it's a **SINGLE REPLACEMENT REACTION**

5) If you **haven't answered "yes"** to any of the questions above, then you've got a **DOUBLE REPLACEMENT REACTION**

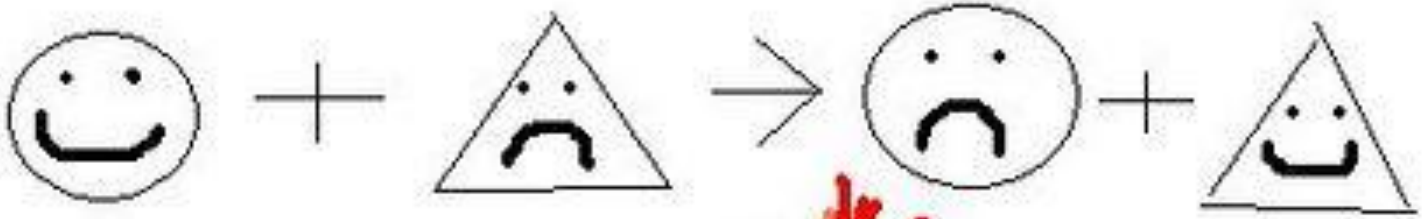
synthesis:

decomposition

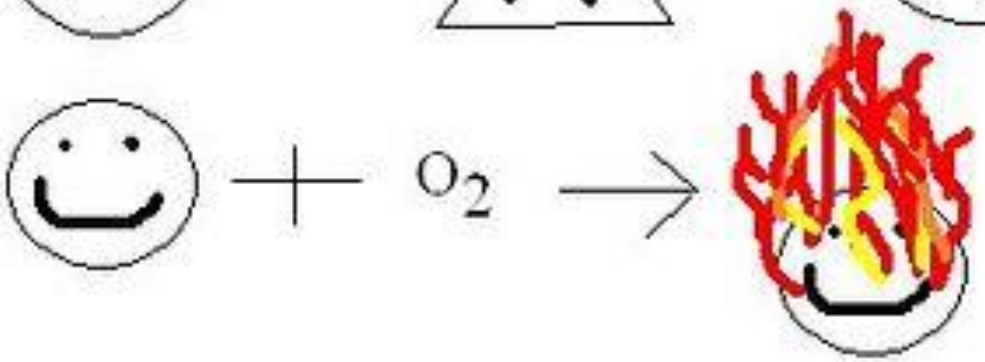
single-displacement



double-displacement



combustion



What you could put on the LEFT side of this worksheet

$$A + B \rightarrow AB$$

$$AB \rightarrow A + B$$

$$A + BC \rightarrow B + AC$$

$$AB + CD \rightarrow AD + CB$$

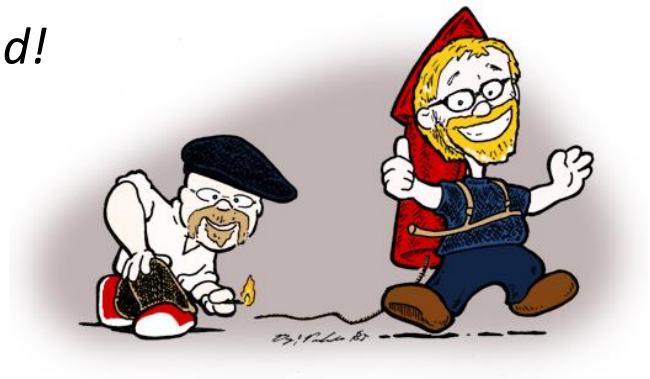
$$C_XH_Y + O_2 \rightarrow CO_2 + H_2O$$

Steps to Writing Reactions

1. Identify the **type** of reaction
2. **Predict the product(s)** using the ***type of reaction*** as a model
3. **Balance it**

*Don't forget about the **diatomic elements**!*

Remember: In a compound, it can't be a diatomic element because it's not an element anymore, it's a compound!



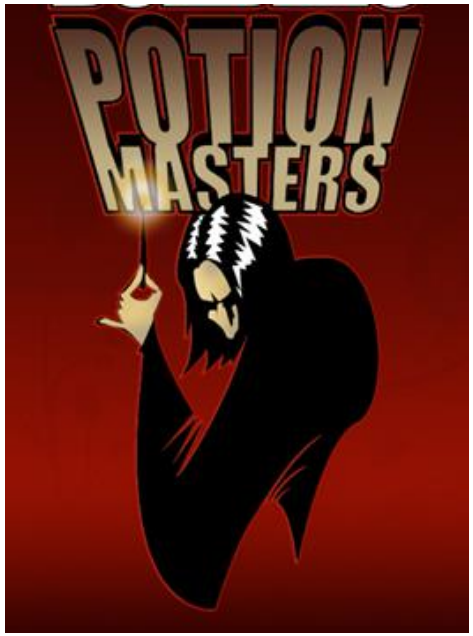
STOP
END OF DAY ONE NOTES

We CAN predict the reaction

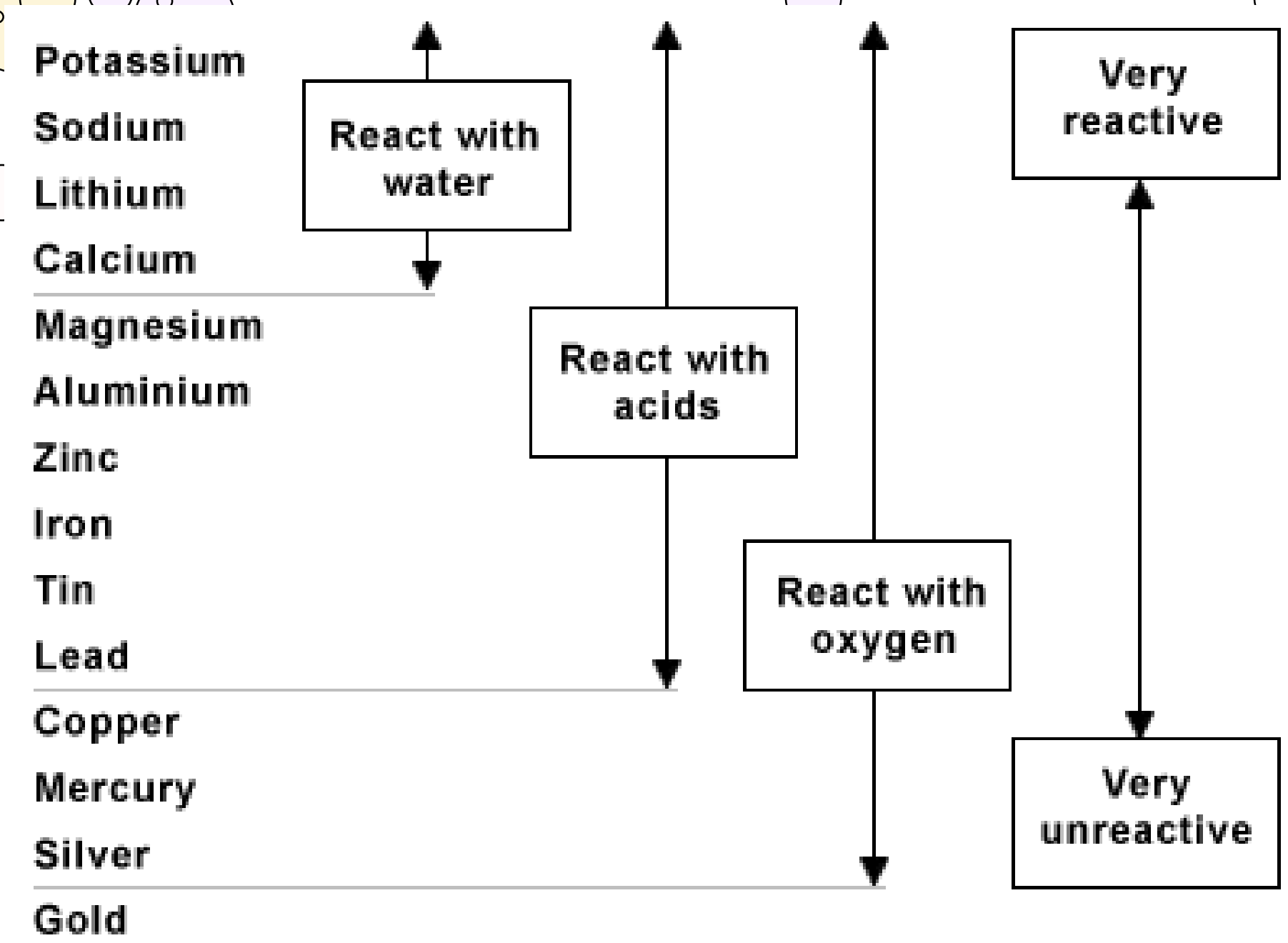
- By using an **activity series**, we can determine what elements will react, and what ***products*** they will form…

The Activity Series

is a chart of metals listed in order of declining relative reactivity. The top metals are *more reactive* than the metals on the bottom.



The ***first five elements*** are highly reactive metals that will react with cold water, hot water, and steam to form **hydrogen gas** and **hydroxides**.


Potassium
Sodium
Lithium
Calcium
Magnesium
Aluminium
Zinc
Iron
Tin
Lead
Copper
Mercury
Silver
Gold
React with water
React with acids
React with oxygen
Very reactive
Very unreactive

Activity Series of Metals

Metal	Symbol	Reactivity
Lithium	Li	displaces H_2 gas from water, steam and acids and forms hydroxides
Potassium	K	
Strontium	Sr	
Calcium	Ca	
Sodium	Na	
Magnesium	Mg	displaces H_2 gas from steam and acids and forms hydroxides
Aluminum	Al	
Zinc	Zn	
Chromium	Cr	
Iron	Fe	displaces H_2 gas from acids only and forms hydroxides
Cadmium	Cd	
Cobalt	Co	
Nickel	Ni	
Tin	Sn	
Lead	Pb	
Hydrogen gas	H_2	included for comparison
Antimony	Sb	combines with O_2 to form oxides and cannot displace H_2
Arsenic	As	
Bismuth	Bi	
Copper	Cu	
Mercury	Hg	found free in nature, oxides decompose with heating
Silver	Ag	
Paladium	Pd	
Platinum	Pt	
Gold	Au	

Activity Series of Metals

Li, Rb, K, Ba, Sr, Ca, Na —React with cold water and acids, replacing hydrogen. React with oxygen, forming oxides.

Mg, Al, Mn, Zn, Cr, Fe, Cd —React with steam (but not cold water) and acids, replacing hydrogen. React with oxygen, forming oxides.

Co, Ni, Sn, Pb – Do not react with water. React with acids, replacing hydrogen. React with oxygen, forming oxides.

H_2, Sb, Bi, Cu, Hg - React with oxygen, forming oxides.

Ag, Pt, Au —Fairly unreactive, forming oxides only indirectly.

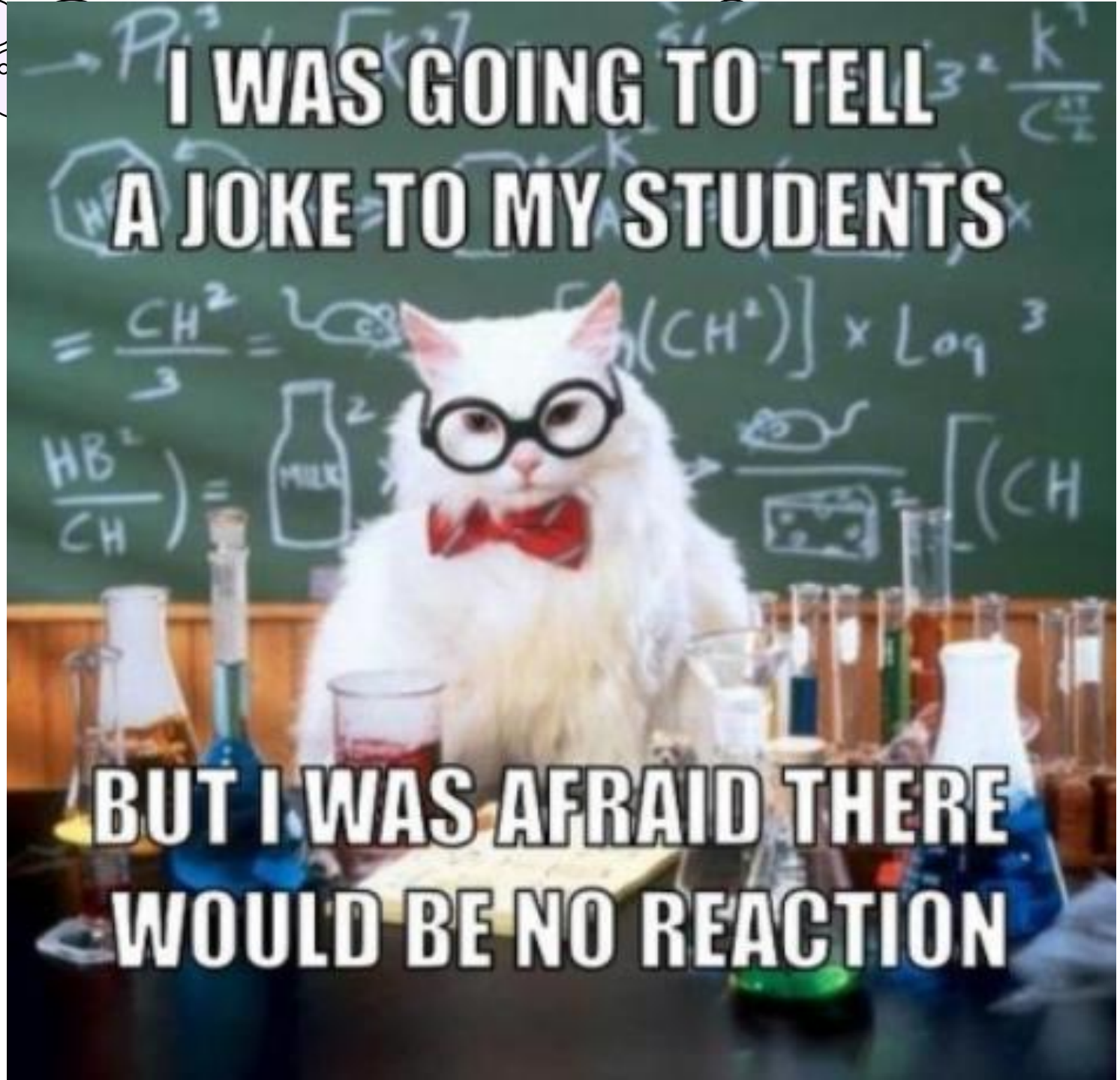
So, how do you use it?

$Fe_{(s)}$ + $NaNO_{3\ (aq)}$ → NR

Activity Series of Metals

Metal	Symbol	Reactivity
Lithium	Li	displaces H_2 gas from water,
Potassium	K	
Strontium	Sr	
Calcium	Ca	
Sodium	Na	
Magnesium	Mg	disp
Aluminum	Al	
Zinc	Zn	
Chromium	Cr	
Iron	Fe	displa nly and forms hydroxides
Cadmium	Cd	

Fe is LOWER so it CAN'T push Na out of the way


I WAS GOING TO TELL
A JOKE TO MY STUDENTS
BUT I WAS AFRAID THERE
WOULD BE NO REACTION

So, how do you use it?

$$Fe_{(s)} + PbSO_{4\,(aq)} \rightarrow Pb_{(s)} + FeSO_{4(aq)}$$

Sodium	Na
Magnesium	Mg
Aluminum	Al
Zinc	Zn
Chromium	Cr
Iron	Fe
Cadmium	Cd
Cobalt	Co
Nickel	Ni
Tin	Sn
Lead	Pb

displaces H_2 gas fro

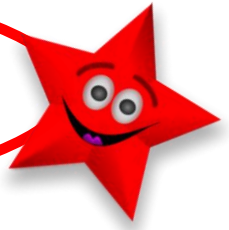
Fe is HIGHER so it CAN push Pb out of the way

SYN $A + B \rightarrow AB$

DECOMP $AB \rightarrow A + B$

Activity Series

SR $A + BC \rightarrow B + AC$



DR $AB + CD \rightarrow AD + CB$

comb $C_xH_y + O_2 \rightarrow CO_2 + H_2O$