



## ACIDS

- compounds that release hydrogen ion ( $H^+$ ), when dissolved in water.

### Properties of acids:

- Corrosive: React with most metals to give off hydrogen gas
- Cause chemical burns on contact
- Taste sour (like citrus - citric acid!)
- Changes litmus indicator to RED

## BASES

- Substances that release hydroxide ion ( $OH^-$ ) when dissolved in water

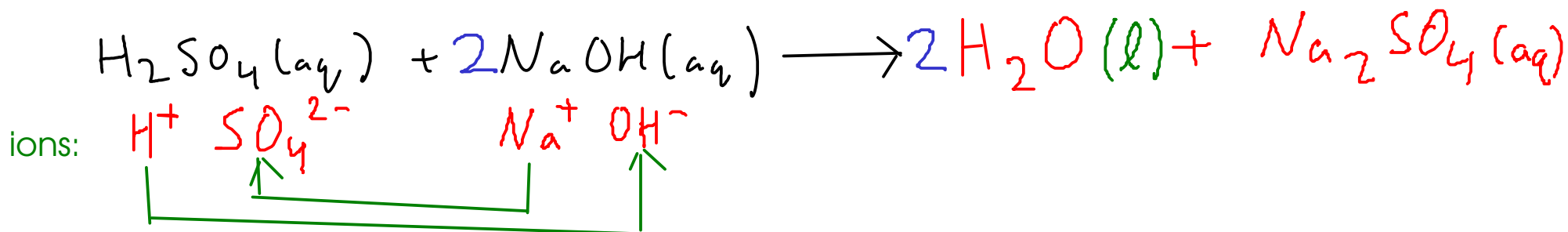
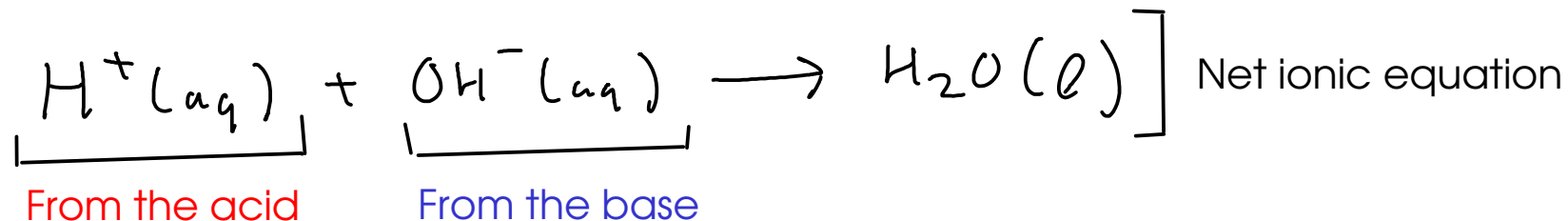
### Properties of bases:

- Caustic: Attack and dissolve organic matter (think lye, which is NaOH)
- Cause skin/eye damage on contact
- Taste bitter
- changes litmus indicator to BLUE

Due to the dissolving action of base on your skin, bases will feel "slippery". The base ITSELF is not particularly slippery, but what's left of your skin IS!

ACID/BASE or NEUTRALIZATION reactions continued

- the driving force of these reactions is the formation of water molecules.



- How can this reaction be detected?

- pH detector (indicator paper, etc.)

- do the products have similar chemical properties to the reactants?

- release of heat!

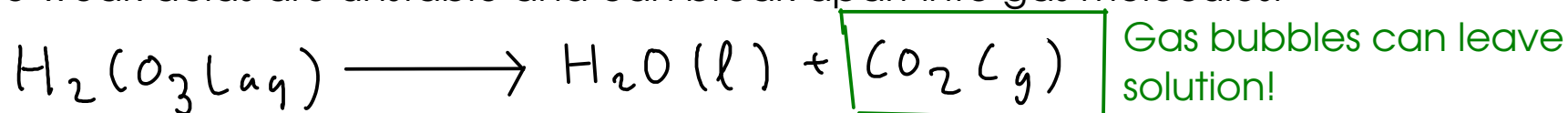
... formation of water is usually accompanied by a release of heat

## GAS FORMATION / OTHER MOLECULES

- There are a few other molecules that can be made with exchange-type chemistry.
- Most of these molecules are unstable and can break apart to form gases.

### - Formation of a weak acid:

- The formation of ANY weak acid in an exchange-type reaction can be a driving force.
- Some weak acids are unstable and can break apart into gas molecules.

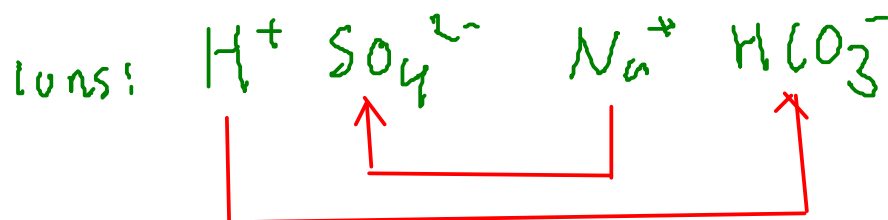


... but how would you form carbonic acid in an exchange-type reaction?

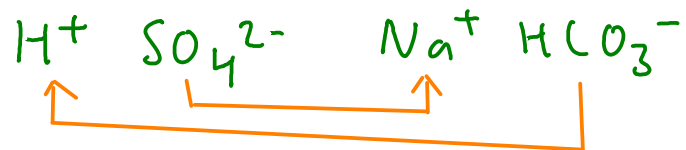
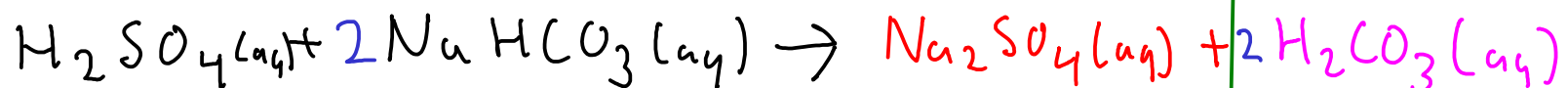
acid + carbonate  $\text{CO}_3^{2-}$

OR

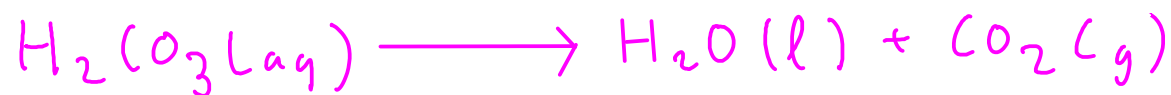
acid + bicarbonate  $\text{HCO}_3^-$



Formation of carbonic acid drives the reaction ... BUT ...

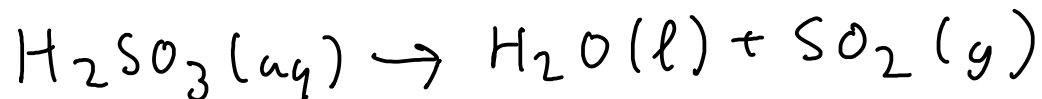


... but when we mix sulfuric acid and sodium bicarbonate, we observe BUBBLES. We need to write an equation that agrees with our observations. We know that carbonic acid decomposes, so we go ahead and put that into our equation.

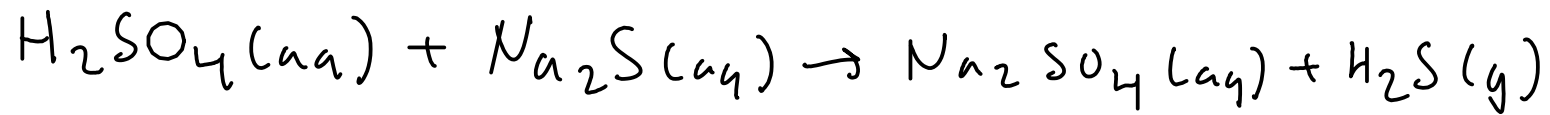


Other molecules of interest:

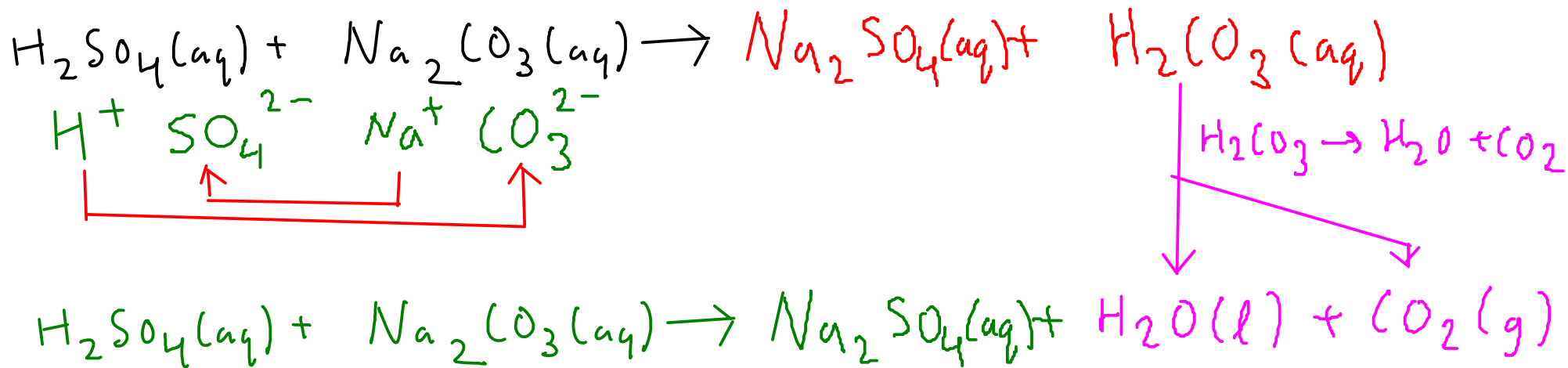
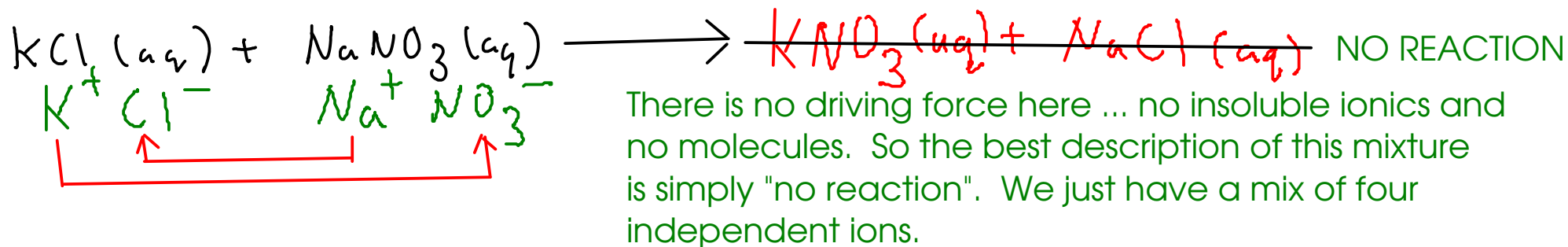
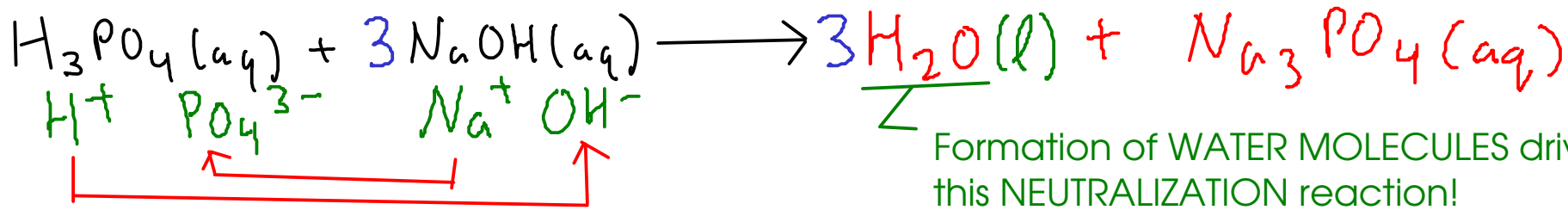
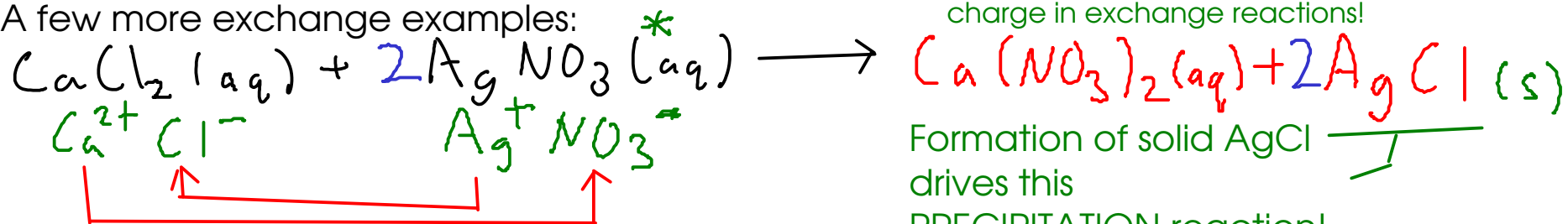
$\text{H}_2\text{SO}_3$  : sulfurous acid - React an ACID with a SULFITE



$\text{H}_2\text{S}$  : hydrogen sulfide (gas) - React an ACID with a SULFIDE



A few more exchange examples:



Formation of the weak acid carbonic acid and its decomposition into water and carbon dioxide gas drives this reaction.

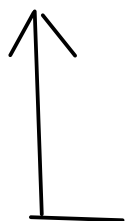
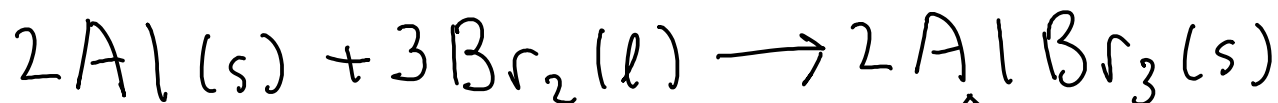
\* Transition metals DO NOT change their charge in exchange reactions!

126 OXIDATION / REDUCTION CHEMISTRY

- Exchange reactions involve ions pairing up, but the ions themselves are not formed in exchange reactions. Exchanges start with pre-existing ions.

... but the ions have to be produced somehow - through a chemistry that involves the transfer of electrons.

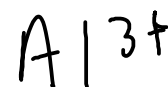
- oxidation / reduction chemistry ("redox" chemistry) involves transfer of electrons and can make ions.



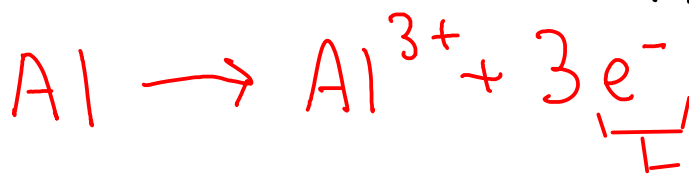
Elemental,  
metallic  
aluminum.  
Uncharged!



Aluminum  
cation



These are called  
"half-reactions"



electron

oxidation: loss  
of electrons



reduction: gain of  
electrons

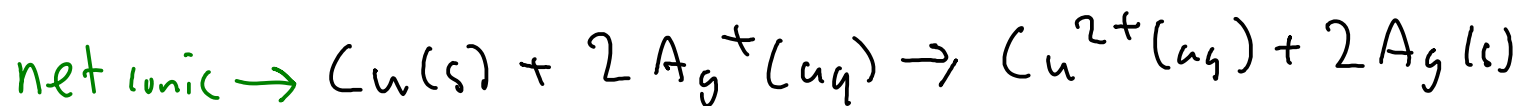
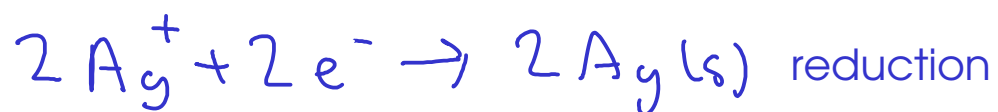
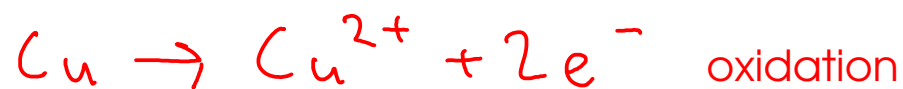
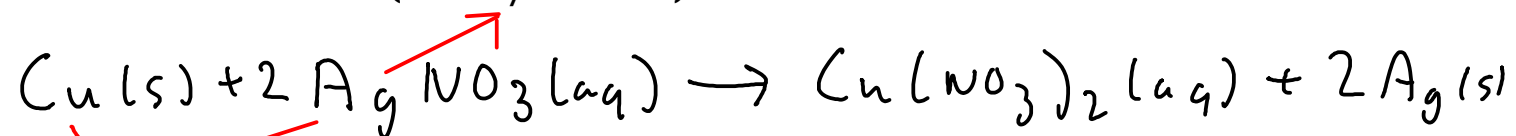
- oxidation and reduction always occur together. In other words, we can't just make free electrons using oxidation without giving them somewhere to go.

- Many of the types of reactions that we learned about in previous courses are redox reactions!

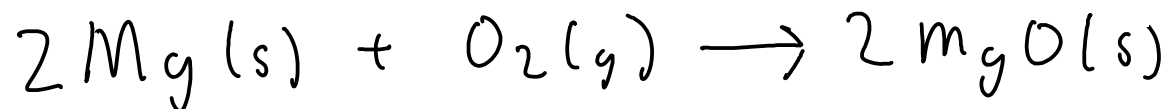
- COMBINATIONS (often but not always redox)

- DECOMPOSITIONS (often redox)

- SINGLE REPLACEMENT (always redox)



- COMBUSTION

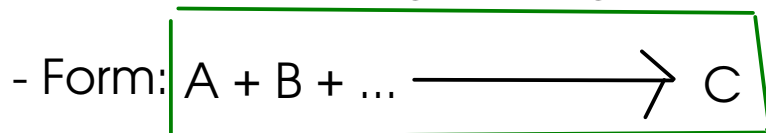




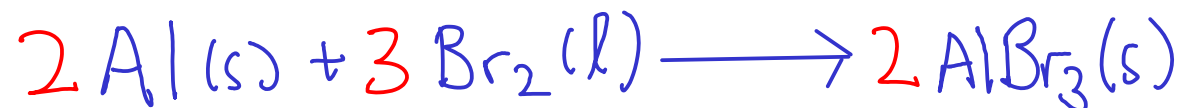
A review of the reaction types we just mentioned:

## ① COMBINATION REACTIONS

- Reactions that involve two or more simple substances COMBINING to form a SINGLE product
- Often involve large energy changes. Sometimes violent!



Example:



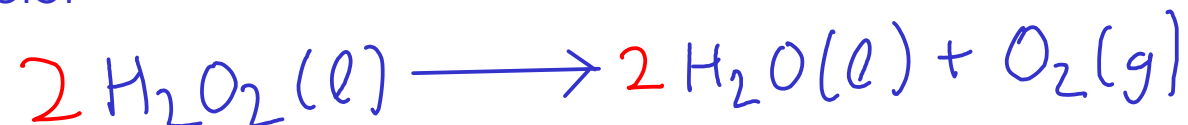
## ② DECOMPOSITION REACTIONS

- Reactions where a SINGLE REACTANT breaks apart into several products

- Form:



Example:

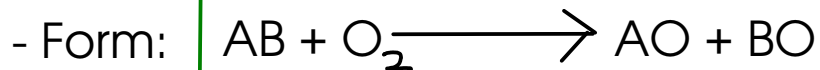


\* This reaction is NOT a combustion reaction, even though  $\text{O}_2$  is involved!

\* Combustion reactions CONSUME  $\text{O}_2$ , while this reaction PRODUCES  $\text{O}_2$

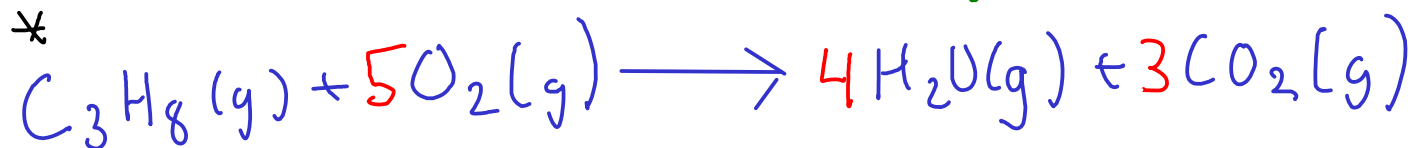
### 3 COMBUSTION REACTIONS

- Reactions of substances with MOLECULAR OXYGEN ( $O_2$ ) to form OXIDES.
- Combustion forms an OXIDE of EACH ELEMENT in the burned substance!



Oxide: a compound containing OXYGEN and one other element!

Examples:



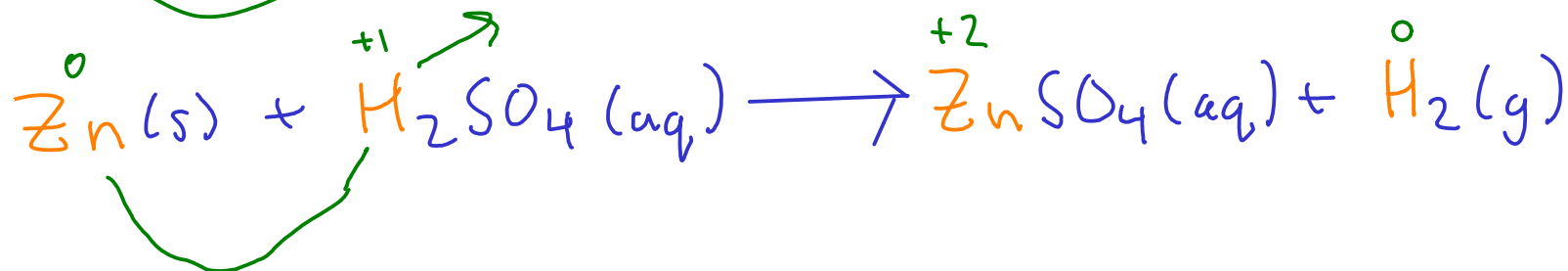
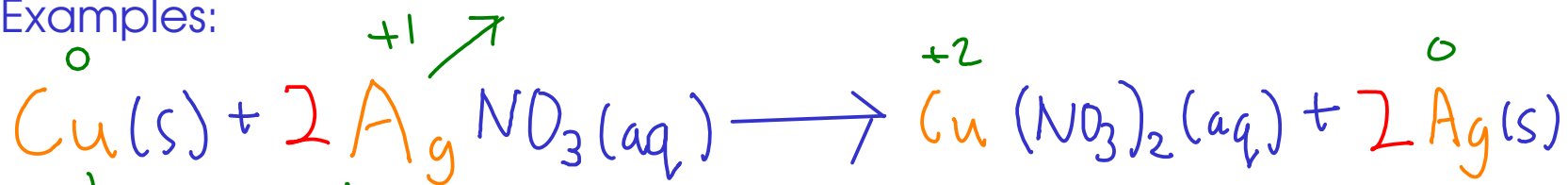
This reaction can also be called a combination!  
Two reactants form a single product.

\* Combustion of hydrocarbons makes carbon dioxide and water, if enough oxygen is present. In low-oxygen environments, carbon monoxide is made instead!

## 4 SINGLE REPLACEMENT REACTIONS

- Reactions where one element REPLACES another element in a compound.
- Can be predicted via an ACTIVITY SERIES (p151, 9th edition) (p153, 10th ed)
- Form:  $A + BC \longrightarrow AC + B$  "A" and "B" are elements., often metals.
- Easy to spot, since there is an element "by itself" on each side of the equation.

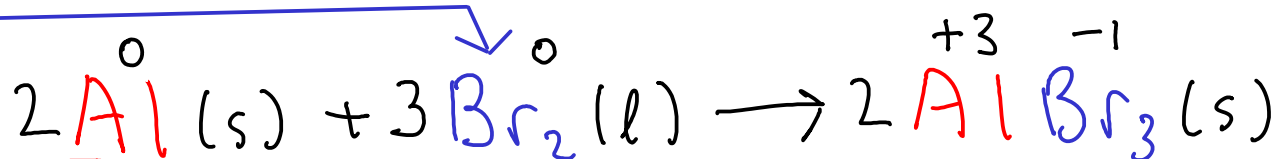
Examples:



REDOX LANGUAGE

"oxidizer"

- "Oxidation" is loss of electrons, but an OXIDIZING AGENT is something that causes ANOTHER substance to lose electrons. An oxidizing agent is itself reduced during a redox reaction.
- "Reduction" is gain of electrons, but a REDUCING AGENT is something that causes ANOTHER substance to gain electrons. Reducing agents are themselves oxidized during a redox reaction.



Aluminum is OXIDIZED during this process. We say that metallic aluminum is a REDUCING AGENT!

Bromine is REDUCED during this process. We say that bromine is an OXIDIZING AGENT!

\* Strong oxidizers (oxidizing agents) can cause spontaneous fires if placed into contact with combustibles (safety issue!).

\* Reactive metals tend to be REDUCING AGENTS, while oxygen-rich ions like NITRATES tend to be OXIDIZING AGENTS. HALOGENS (Group VIIA) also tend to be OXIDIZING AGENTS

END OF CHAPTER 4 MATERIAL

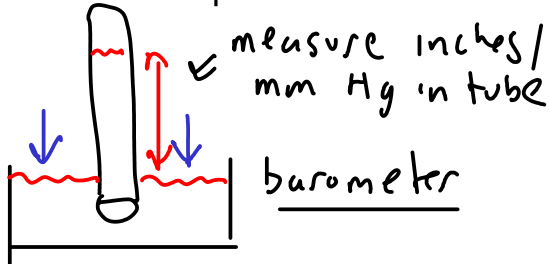
## GASES

- Gases differ from the other two phases of matter in many ways:
    - They have very low viscosity (resistance to flow), so they flow from one place to another very easily.
    - They will take the volume of their container. In other words, gas volumes are variable.
    - They are the least dense of all three phases.
    - Most gases are transparent, and many are invisible.
    - Gases show a much larger change of volume on heating or cooling than the other phases.
- ↙ thermal expansion!
- Gases react to changes in temperature and pressure in a very similar way. This reaction often does not depend on what the gas is actually made of.

## KINETIC THEORY

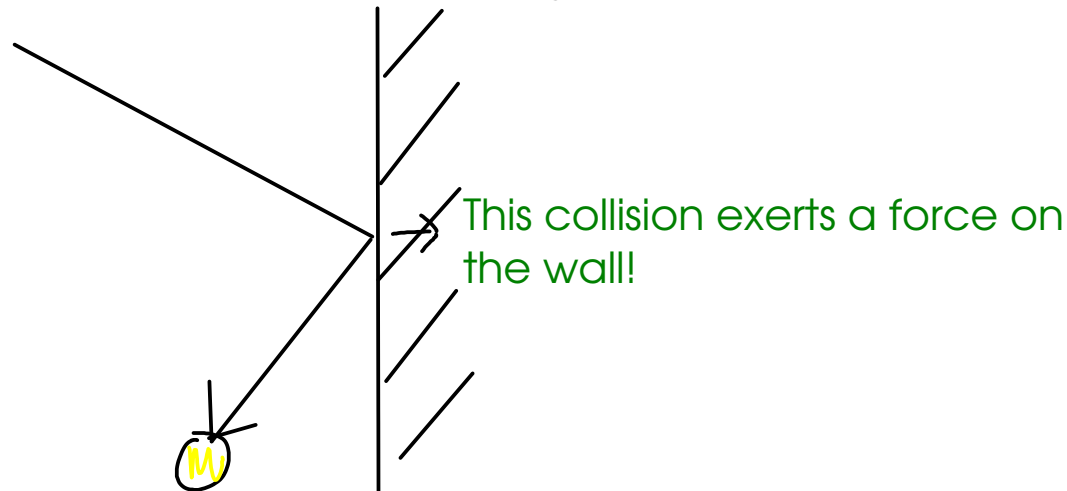
- is a way to explain the behavior of gases.
  - views the properties of gases as arising from them being molecules in motion.
- 

- Pressure: force per unit area. Units: Pascal, bar, mm Hg, in Hg, atm, etc.



$$760 \text{ mm Hg} = 1 \text{ atm}$$

- According to kinetic theory, pressure is caused by collisions of gas molecules with each other and the walls of the container the gas is in.





## 136- Temperature:

- a measure of the average kinetic energy of the molecules of the gas

$$E_k = \frac{1}{2} m v^2$$

velocity  
mass

- The faster the gas molecules move, the higher the temperature!
- The temperature scales used when working with gases are ABSOLUTE scales.
  - ABSOLUTE: scales which have no values less than zero.
  - KELVIN: metric absolute temperature scale.

Quick comparison of temperature scales!

$$K = 273.15 + ^\circ C$$

212	100	373	Water boils
77	25	298	Room temperature
32	0	273	Water freezes
-460	-273	0	Absolute zero!
$^{\circ}F$	$^{\circ}C$	K	