Unit 1: Chemical Reactions

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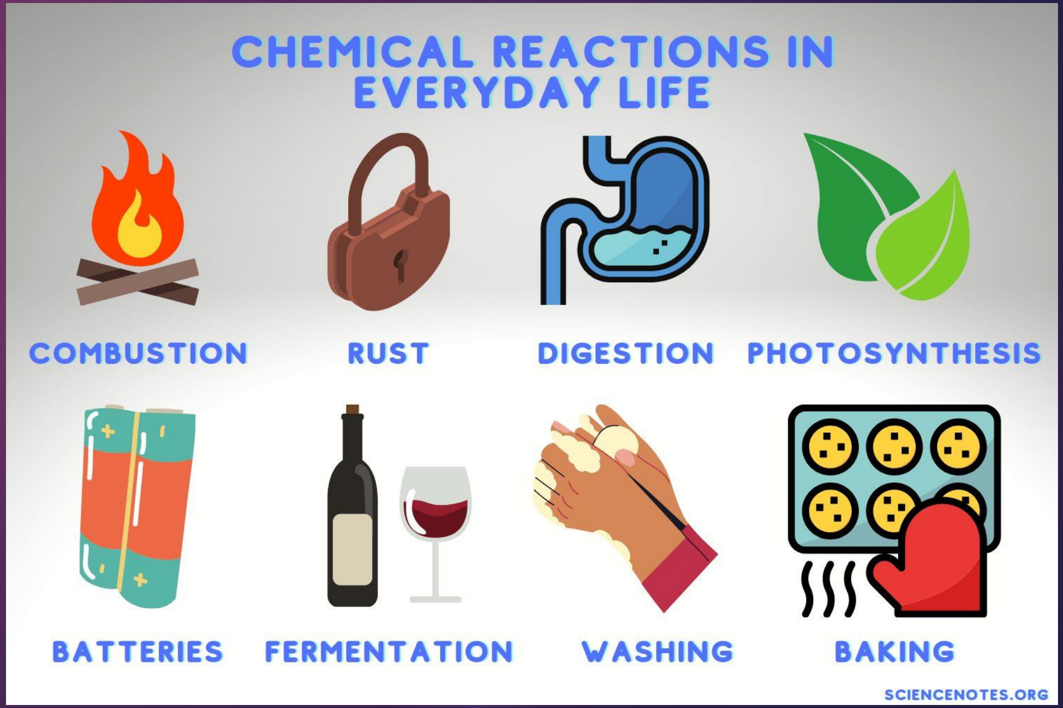
Chemistry in Everyday Life

- Chemistry has its roots well-settled in almost every aspect of our lives. It is so intricately involved in various processes, we fail to notice them at times. So, here are some interesting examples explaining the role of chemistry in everyday life:
- Cosmetics and hygiene products
- electric cells, batteries, and electronics
- foods
- fuels and transportation;
- household cleaning products;
- pharmaceuticals
- plastics.

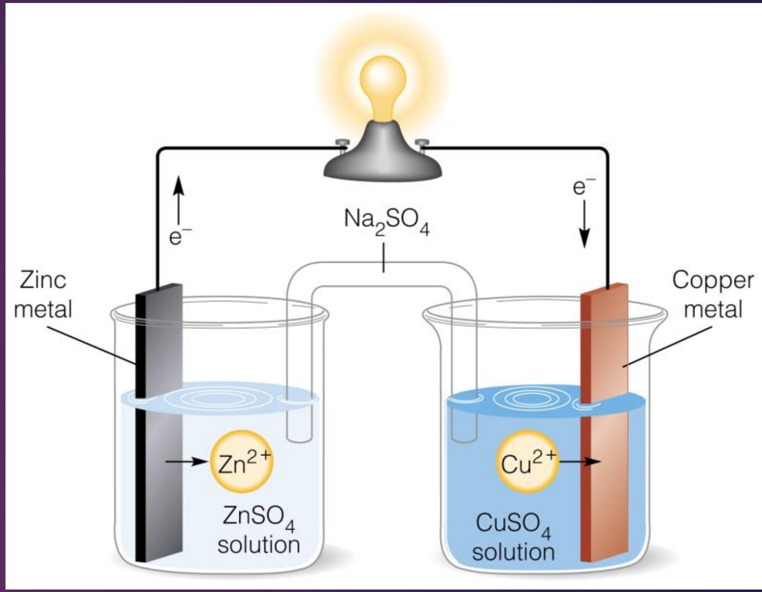


Cosmetics and Hygiene Products

- Under the law, some of the products commonly referred to as "personal care products" are cosmetics. These include,
- skin moisturizers
- Perfumes
- lipsticks
- fingernail polishes
- Eye/facial makeup preparations
- Shampoos
- permanent waves hair colors
- Toothpastes
- deodorants.

Electrical cells Batteries and Electronics

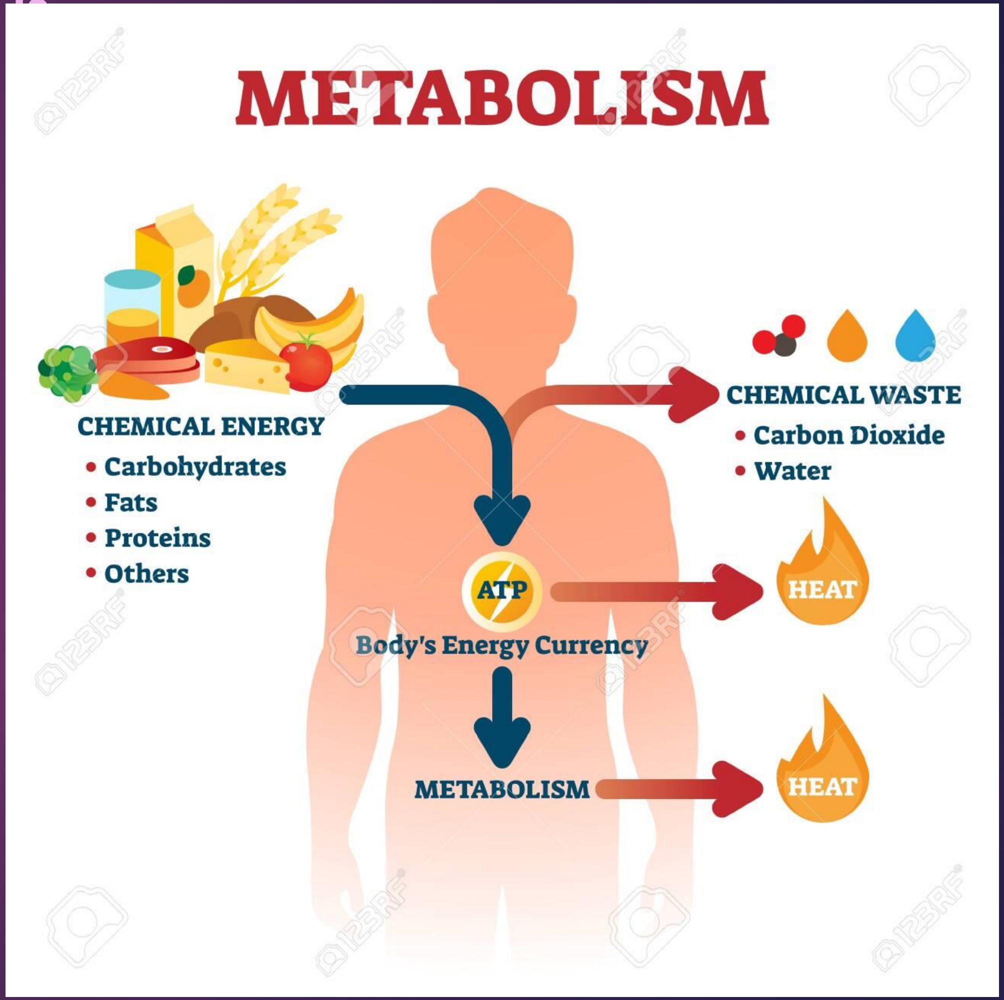
- Devices in your home, like
- phones
- computers
- Tablets
- TV sets
- game consoles
- smart kitchen appliances



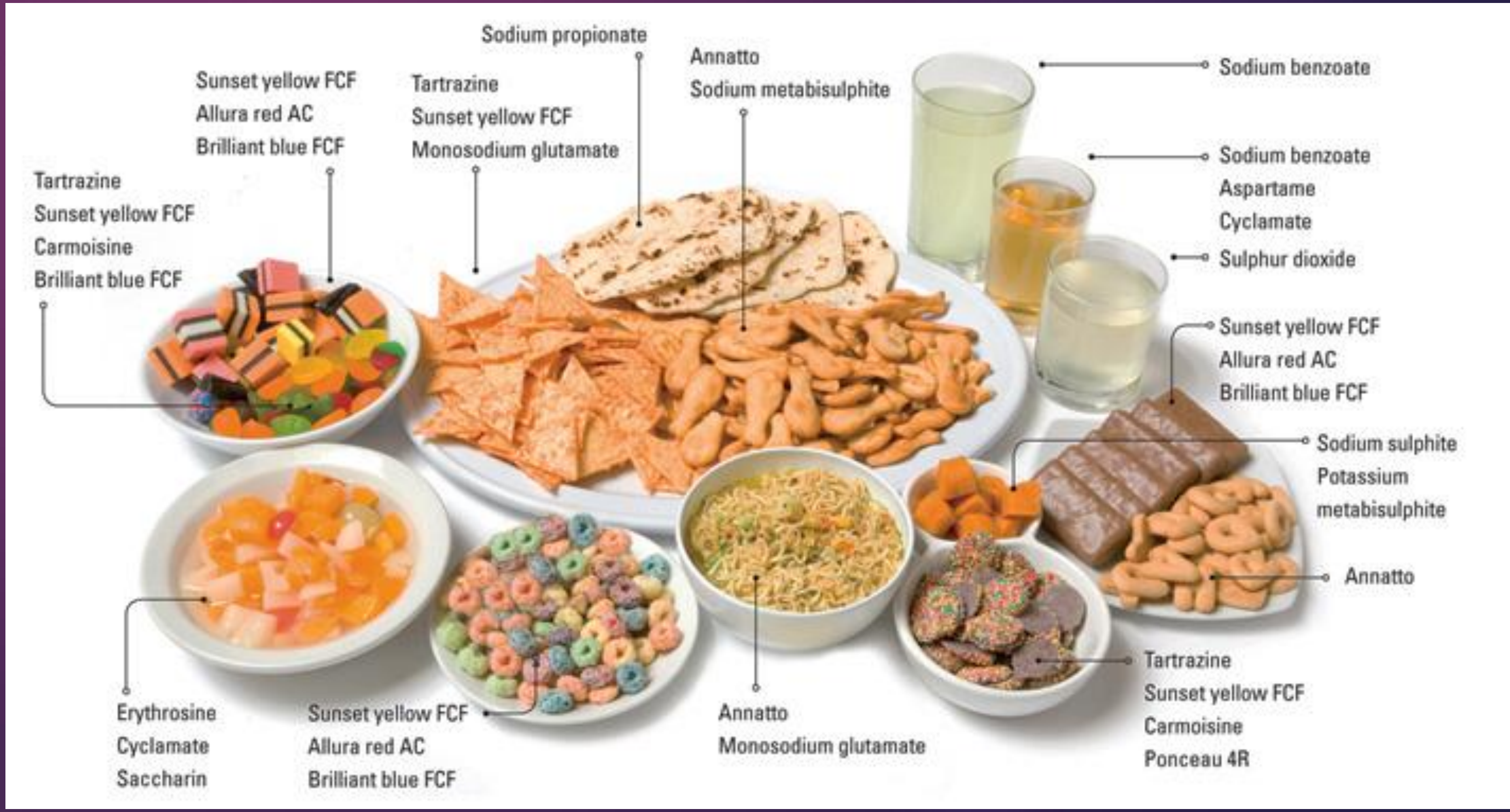
- are made of hundreds of components and thousands of chemicals.
- Some of the chemicals in electronics are toxic.

Foods

- All Many of these occur naturally, food is made of chemical substances. some not.
- Just think of nutrients in your food like carbohydrates, protein, fat and fibre – they are made up of chemical compounds. There is no “chemicals-free” food.
- However, some chemicals may raise health concerns. This depends on their toxicity and levels in our bodies.
- Scientists advise on safe levels for their presence in food and inform decision-makers who then regulate the use of chemicals in food.

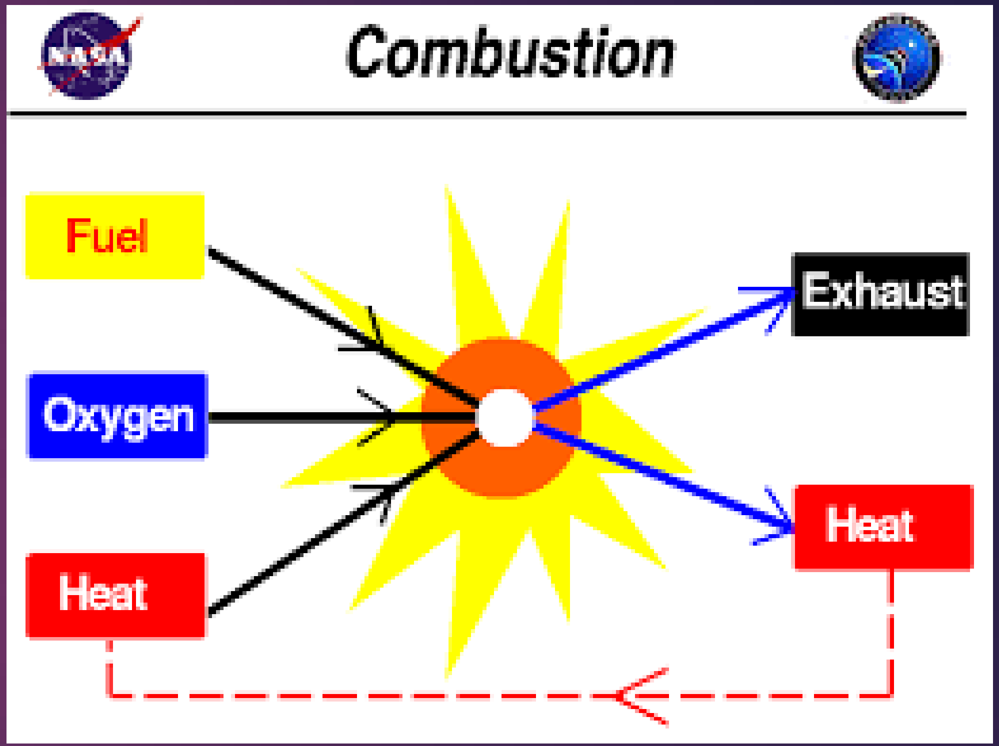


- **Food additives** are used for many purposes. These can be, for example, to colour, to sweeten or to help preserve food. In the European Union, food additives are identified by an E-number and included in the product ingredient lists. Product labels must identify the function of the additive (e.g. colour, preservative) and the specific substance that is used (e.g. E 415 or Xanthan gum).



Fuels and Transportation

- Chemical fuels are substances that release energy by reacting with substances around them, most notably by the process of combustion. Most of the chemical energy released in combustion was not stored in the chemical bonds of the fuel, but in the weak double bond of molecular oxygen.



Household Cleaning Products

- **Chemicals make your cleaning products work.**

- **Laundry detergents, all-purpose cleaners, washing-up liquids – they all contain substances called surfactants or surface active materials. They reduce the surface tension between water and grease (liquid oil or solid fat) so that the two can mix, water can get a hold of the grease and wash it away. That is why we wash dirty clothes with detergent – the detergent can remove dirt in a solid or liquid form.**

Pharmaceuticals

- A compound manufactured for use in a medicinal drug

- pharmaceuticals (products) are based on knowledge of chemical reactions within the human body.

Plastics

- a synthetic material made from a wide range of organic polymers such as **polyethylene, PVC, nylon,** that can be molded into shape while soft and then set into a rigid or slightly elastic form.

WHMIS 2015

- Workplace
- Hazardous
- Materials
- Information
- System

- The WHMIS symbols, along with safety data sheets (SDS), are used throughout Canada to identify dangerous materials. These symbols and the SDS help you understand all aspects of safe handling of hazardous materials.

Compressed Gas – Gas Cylinder

- RISK
- Materials which are gaseous usually kept in a pressurized container.
  - May explode if heated punctured or dropped

- Safe Handling Procedure
  - Store in designated areas
  - Do not drop or allow to fall
  - Protect from mechanical damage

Flammable – Flame With Line Underneath

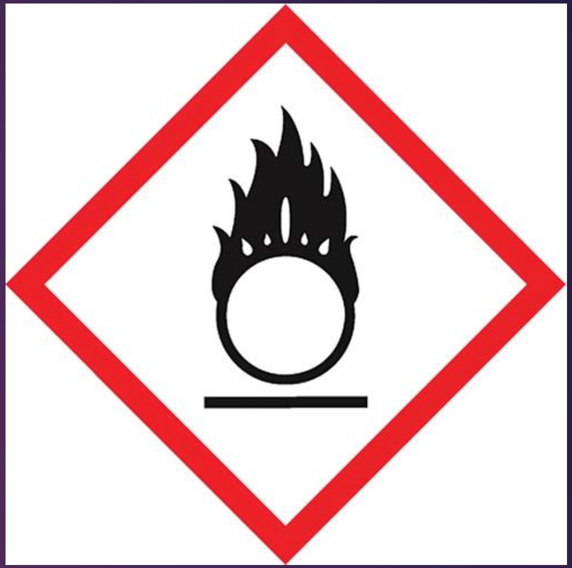
- **RISK**
- **Materials which will continue to burn after being exposed to a flame or other ignition source.**

- **Safe Handling Procedure**
  - **Store in designated areas**
  - **Keep away from heat, hot surfaces, sparks, open flames, and other ignition sources**
  - **Store in a well ventilated cool place**

Oxidizer – Flame Over Circle

- RISK
- Materials which can cause other materials to burn or support combustion

- Safe Handling Procedure
  - Store in proper containers that will not oxidize or rust
  - Store in areas away from combustibles
  - Store in a well ventilated cool place
  - Keep away from heat, hot surfaces and sparks



Acute toxicity – Human Skull and Crossbones

- RISK
  - Materials that can cause toxicity of death even in small quantities

- Safe Handling Procedure
  - Wear personal protective equipment
  - Follow manufacturers instructions for handling storage and disposal.

Health Hazard

- RISK
  - May cause or be suspected of causing serious health effects
- Safe Handling Procedure
  - Avoid direct contact
  - Avoid prolonged exposure
  - Wear personal protective equipment
  - Work in well ventilated areas

Exclamation Mark

- RISK
  - Poisonous materials which can cause immediate and sever harm
  - Can cause irritation to skin and eyes
- Safe Handling Procedure
  - Avoid contact with skin or eyes
  - Avoid prolonged exposure
  - Wear personal protective equipment
  - Work in well ventilated areas
  - Wash exposed skin after handling

Corrosive

- RISK
  - Can cause corrosive damage to metals, as well as skin and eyes
- Safe Handling Procedure
  - Use appropriate storage containers and ensure proper non venting closures.
  - Avoid contact with skin or eyes
  - Avoid prolonged exposure
  - Wear personal protective equipment including respiratory protection
  - Work in well ventilated areas
  - Wash exposed skin after handling

Explosive – Exploding bomb

- RISK
  - For explosion or reactivity hazards
  - Materials which may explode due to reaction to fire, shock, friction, heat, puncture of incompatible material.
- Safe Handling Procedure
  - Handle with care, avoiding vibration, shocks and sudden temperature changes.

Biohazardous Infectious Materials

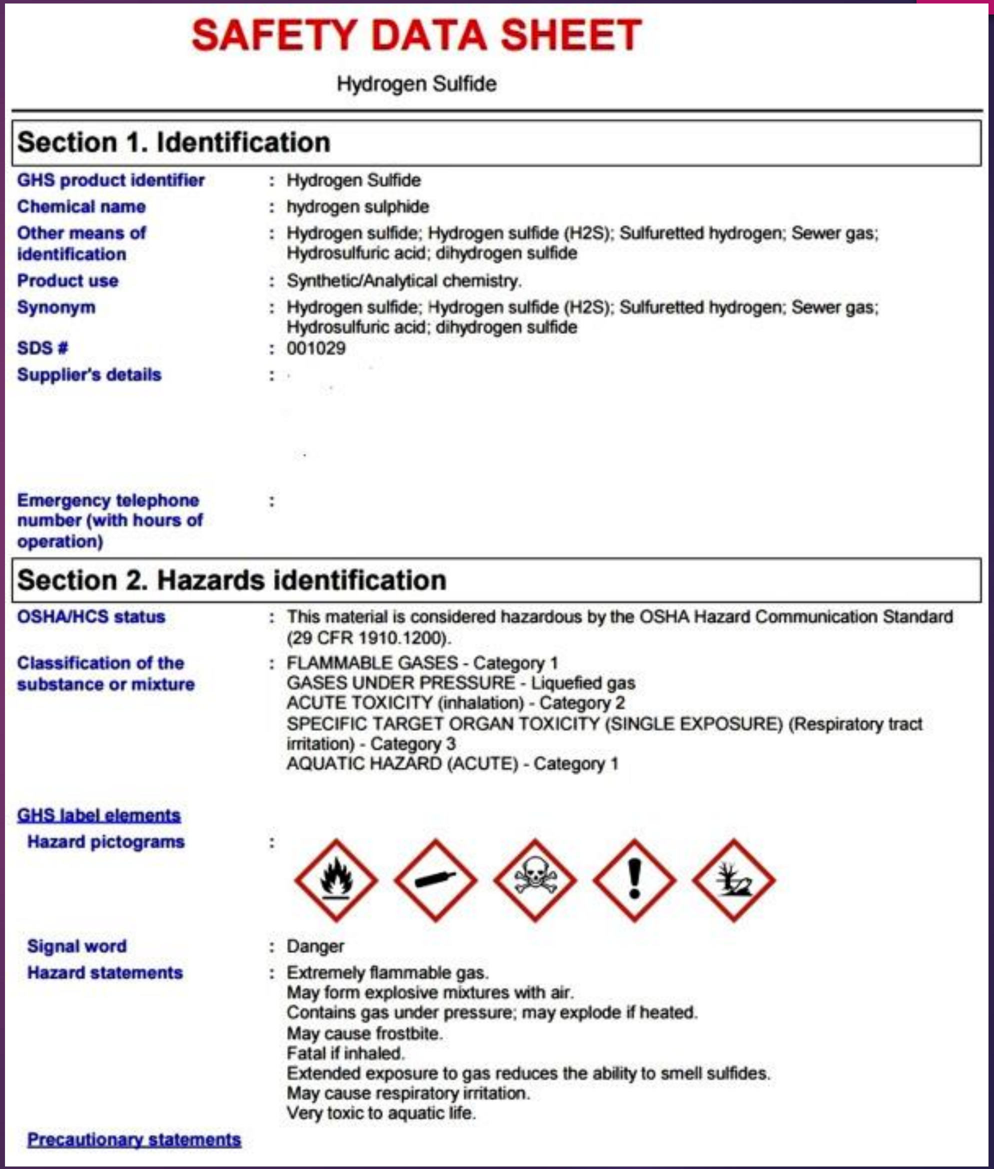
- RISK
  - For organisms or toxins that can cause diseases or death in people or animals
- Safe Handling Procedure
  - Avoid forming aerosols and breathing vapors.
  - Wear personal protective equipment

Environmental Hazard

- RISK
  - May cause damage to the environment
  - May cause long lasting effects to aquatic environments
- Safe Handling Procedure
  - Avoid release into the natural environment
  - Dispose according to regulations

SDS – Safety Data Sheet

- **Safety Data Sheets (SDSs)** are summary documents that provide information about the hazards of a product and advice about safety precautions.



SAFETY DATA SHEET

Hydrogen Sulfide

Section 1. Identification

GHS product identifier	: Hydrogen Sulfide
Chemical name	: hydrogen sulphide
Other means of identification	: Hydrogen sulfide; Hydrogen sulfide (H2S); Sulfuretted hydrogen; Sewer gas; Hydrosulfuric acid; dihydrogen sulfide
Product use	: Synthetic/Analytical chemistry.
Synonym	: Hydrogen sulfide; Hydrogen sulfide (H2S); Sulfuretted hydrogen; Sewer gas; Hydrosulfuric acid; dihydrogen sulfide
SDS #	: 001029
Supplier's details	:
Emergency telephone number (with hours of operation)	:

Section 2. Hazards identification

OSHA/HCS status	: This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).
Classification of the substance or mixture	: FLAMMABLE GASES - Category 1 GASES UNDER PRESSURE - Liquefied gas ACUTE TOXICITY (inhalation) - Category 2 SPECIFIC TARGET ORGAN TOXICITY (SINGLE EXPOSURE) (Respiratory tract irritation) - Category 3 AQUATIC HAZARD (ACUTE) - Category 1

GHS label elements

Hazard pictograms	:
Signal word	: Danger
Hazard statements	: Extremely flammable gas. May form explosive mixtures with air. Contains gas under pressure; may explode if heated. May cause frostbite. Fatal if inhaled. Extended exposure to gas reduces the ability to smell sulfides. May cause respiratory irritation. Very toxic to aquatic life.

Precautionary statements

Lab Safety

- Student Safety Contract – please complete this on the google classroom ASAP.

Exit Card #1: WHMIS

IUPAC

- **International Union of Pure and Applied Chemistry**
- Founded in 1919, IUPAC has developed a systematic method to name chemicals according to their composition.
- Today, scientists all over the world use the IUPAC system.
- This system ensures that each pure substance has a unique name, called its *systematic name*. The name of a substance describes its composition.
- It also enables scientists to write its chemical formula and predict some of its properties.

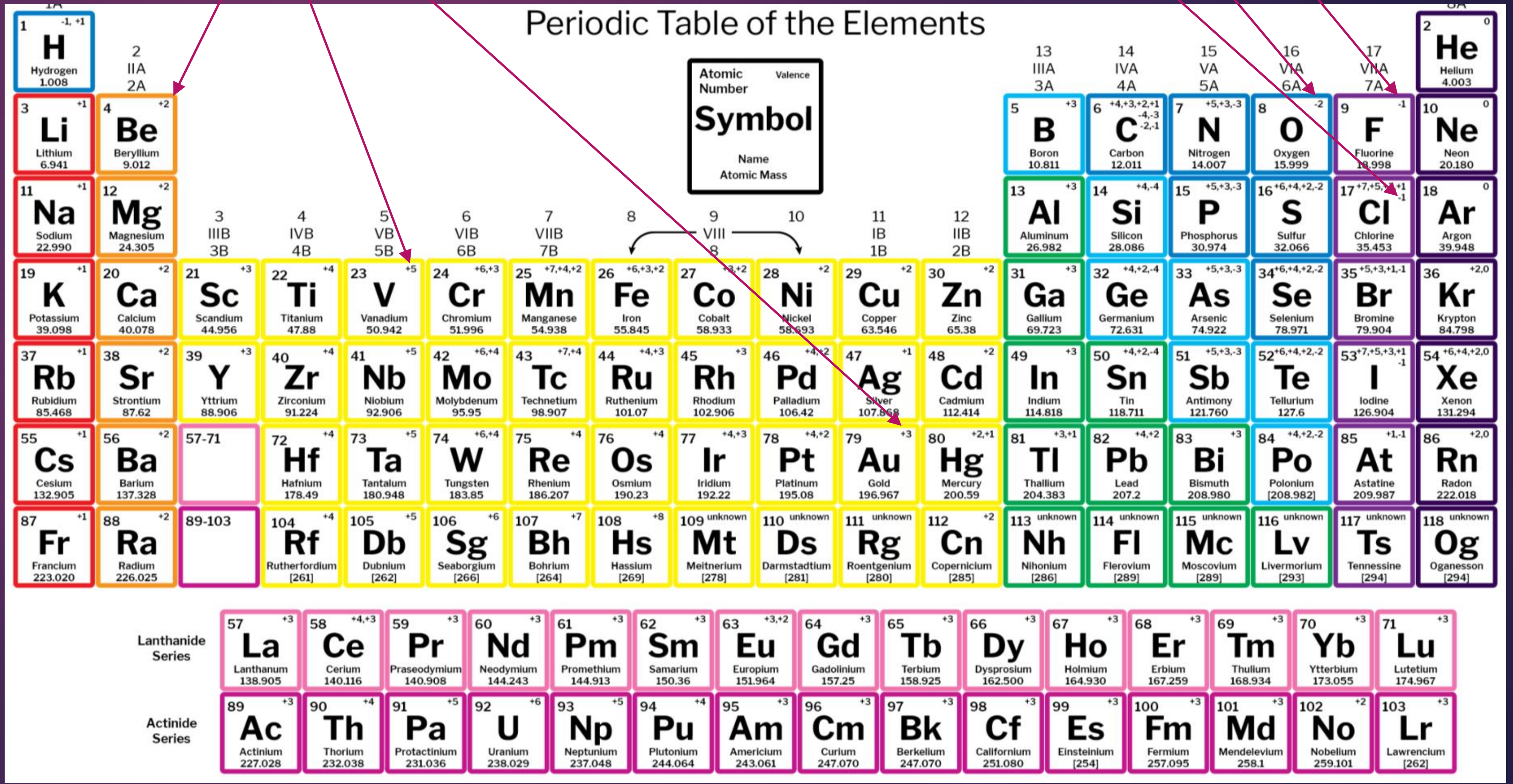
Why is it useful to have a standard set of rules for naming chemicals?

- A chemical nomenclature is a set of rules to generate systematic names for chemical compounds.
- The nomenclature used most frequently worldwide is the one created and developed by the International Union of Pure and Applied Chemistry (IUPAC).
- It eliminates the confusion of trivial names, and ensures everyone knows exactly what is being talked about

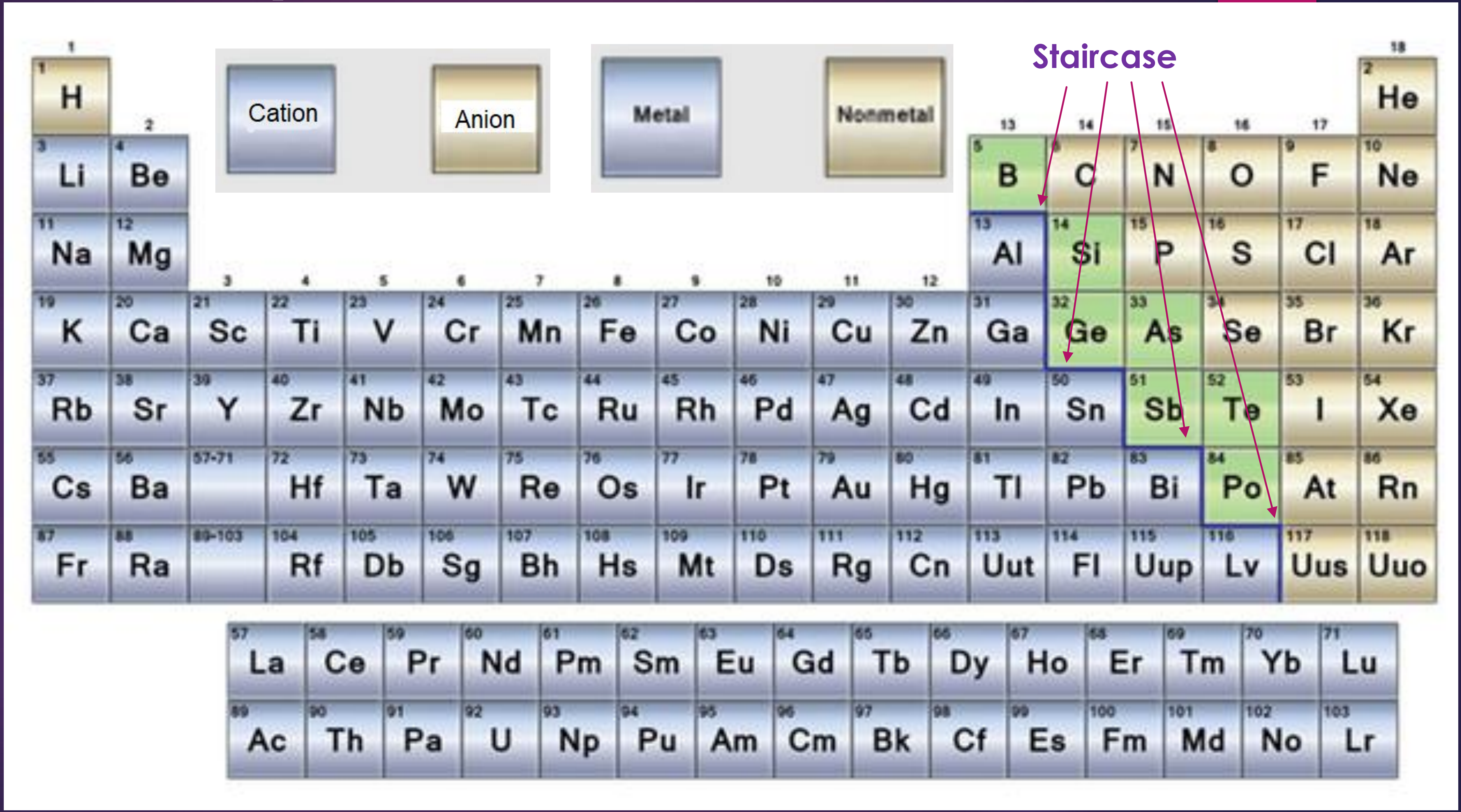
The Periodic Table

Cation - a positively charged ion

Anion - a negatively charged ion



Activity 3-2A What's in a name?



Types of Chemical Bonds

- 1. **Covalent bond** (aka molecular) – A covalent bond is a chemical bond that involves the sharing of electron pairs between atoms. **(two or more non-metals)**

- 2. **Ionic Bond** - In ionic bonding, the atoms are bound by attraction of oppositely charged ions **(a cation and an anion)** often said as metals and non metals.

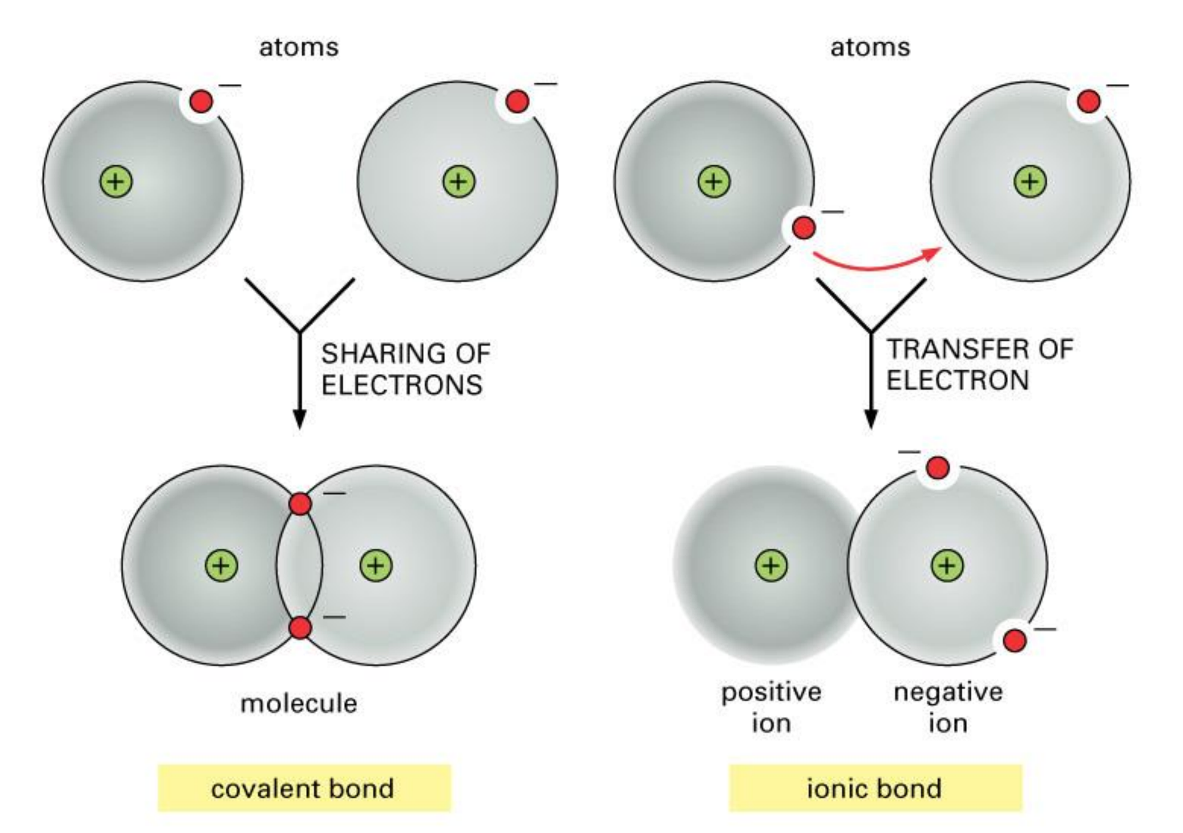
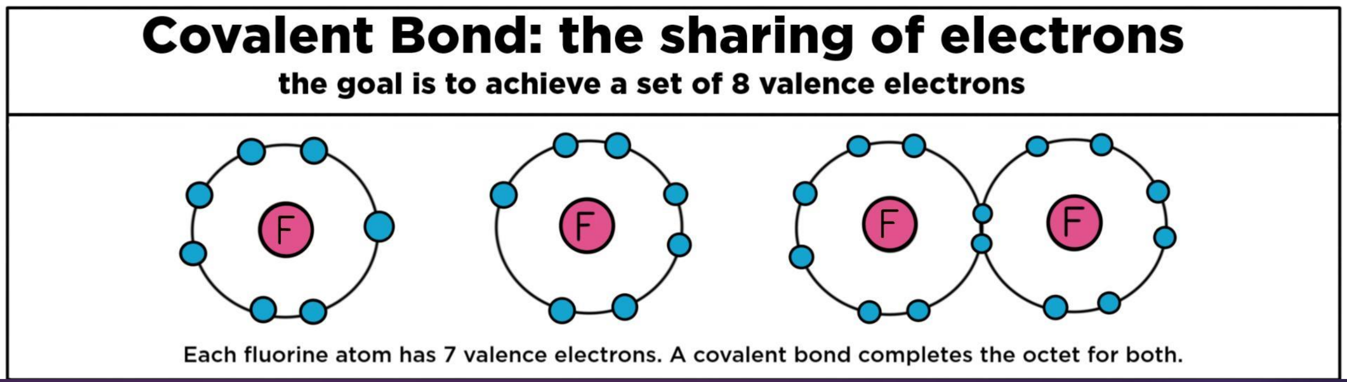


Figure 2.6 Essential Cell Biology, 2/e. (© 2004 Garland Science)

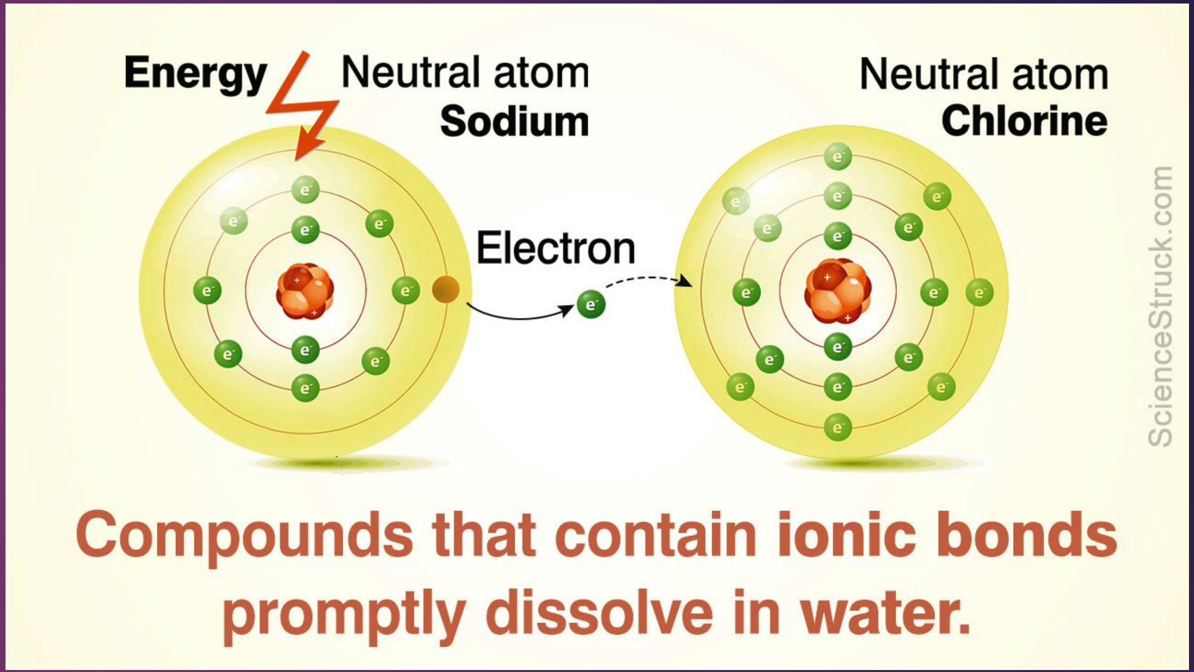
Covalent (molecular bonds)

- They can be **solid, liquid or gas at SATP** (Standard atmospheric temperature and pressure : 25°C and 100Kpa)
- They contain **only non-metals**
- They do not conduct electricity **(non-electrolytic)**
- **Do not conduct heat well**
- If they dissolve in water (soluble) they are **clear colorless solutions**
- Most covalent compounds have relatively **low melting points and boiling points.**
- Covalent compounds tend to be **soft and relatively flexible.**



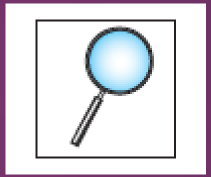
Ionic

- All are solids at SATP
- They form crystals
- They have high melting points and high boiling points.
- They're hard and brittle.
- They conduct electricity (electrolytic) when they are dissolved in water.
- Can be colored or colorless when dissolved in water



Lab 1: Activity 3-1C

- Properties of Ionic and Molecular Compounds



Types of Ions and Ionic Compounds

- **Monatomic Ions – (simple ions)**
  - Simple atoms that have gained or lost one or more electrons
  - Form Binary Ionic Compounds (2 simple ions)
  - Eg. Na^+ Cl^-

H^+						
Li^+	Be^{2+}			N^{3-}	O^{2-}	F^-
Na^+	Mg^{2+}	Al^{3+}		P^{3-}	S^{2-}	Cl^-
K^+	Ca^{2+}	Ga^{3+}		As^{3-}	Se^{2-}	Br^-
Rb^+	Sr^{2+}	In^{3+}		Sb^{3-}	Te^{2-}	I^-
Cs^+	Ba^{2+}	Tl^{3+}		Bi^{3-}	Po^{2-}	At^-
Fr^+	Ra^{2+}					

- Polyatomic Ions (complex ions)
  - Cations or anions composed of a group of atoms with a net positive or negative charge. On the back of you periodic table
  - Eg. NH_4^+ ammonium ion
    NO_2^- nitrite ion
    NO_3^- nitrate ion
    CO_3^{2-} carbonate ion

Table of Some Common Polyatomic Ions

1 – Ions

Formula	Name
$H_2PO_4^-$	dihydrogen phosphate
$H_2PO_3^-$	dihydrogen phosphite
HCO_3^-	hydrogen carbonate
HSO_4^-	hydrogen sulfate
HSO_3^-	hydrogen sulfite
BrO_3^-	bromate
CH_3COO^-	acetate
$C_6H_5COO^-$	benzoate
ClO^-	hypochlorite
ClO_2^-	chlorite
ClO_3^-	chlorate
ClO_4^-	perchlorate
CN^-	cyanide
IO_3^-	iodate
OH^-	hydroxide
NO_3^-	nitrate
NO_2^-	nitrite
MnO_4^-	permanganate
SCN^-	thiocyanate

2 – Ions

Formula	Name
HPO_4^{2-}	hydrogen phosphate
HPO_3^{2-}	hydrogen phosphite
CO_3^{2-}	carbonate
SO_4^{2-}	sulfate
SO_3^{2-}	sulfite
$C_2O_4^{2-}$	oxalate
CrO_4^{2-}	chromate
$Cr_2O_7^{2-}$	dichromate
$S_2O_3^{2-}$	thiosulfate
SiO_3^{2-}	silicate

3 – Ions

Formula	Name
PO_4^{3-}	phosphate
PO_3^{3-}	phosphite
BO_3^{3-}	borate

1 + Ions

Formula	Name
NH_4^+	ammonium
H_3O^+	hydronium

- **Multivalent Ions**
  - Certain transition metals can form more than one type of ion, each with a different charge.

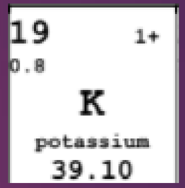
22 4+ 3+ 1.5 Ti titanium 47.90	23 5+ 4+ 1.6 V vanadium 50.94	24 3+ 2+ 1.6 Cr chromium 52.00	25 2+ 4+ 1.5 Mn manganese 54.94	26 3+ 2+ 1.8 Fe iron 55.85	27 2+ 3+ 1.8 Co cobalt 58.93	28 2+ 3+ 1.8 Ni nickel 58.71	29 2+ 1+ 1.9 Cu copper 63.55
40 4+ 1.4 Zr zirconium 91.22	41 5+ 3+ 1.6 Nb niobium 92.91	42 6+ 1.8 Mo molybdenum 95.94	43 7+ 1.9 Tc technetium 98.91	44 3+ 4+ 2.2 Ru ruthenium 101.07	45 3+ 2.2 Rh rhodium 102.91	46 2+ 4+ 2.2 Pd palladium 106.40	47 1+ 1.9 Ag silver 107.87

Naming Simple Ionic Compounds

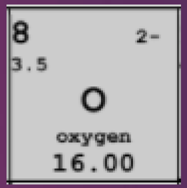
- The **metallic element (positive ion)** comes first in the name and the formula.
- The end of the name of the **non-metallic element is changed to "-ide"** (for example, sodium chloride).
- **Subscripts** in the formulas indicate the ratio of ions of each type in the compound.
- **The total charge of the ions must add to zero.**
- **They are not capitalized**

Example 1: K_2O

potassium + oxygen



Potassium is on the left of your periodic table, it is a metal and a cation



Oxygen is on the right of your periodic table above the staircase and is a non metal and an anion.

When naming Ionic compounds the number of atoms DOES NOT MATTER!

potassium oxide

Naming Simple Ionic Compounds

Example 2: $CaCl_2$

calcium + chlorine

calcium chloride

Example 5: Ta_2S_5

tantalum + sulfur

tantalum sulfide

Example 3: MgF_2

magnesium + fluorine

magnesium fluoride

Example 5: Zn_3P_2

zinc + phosphorus

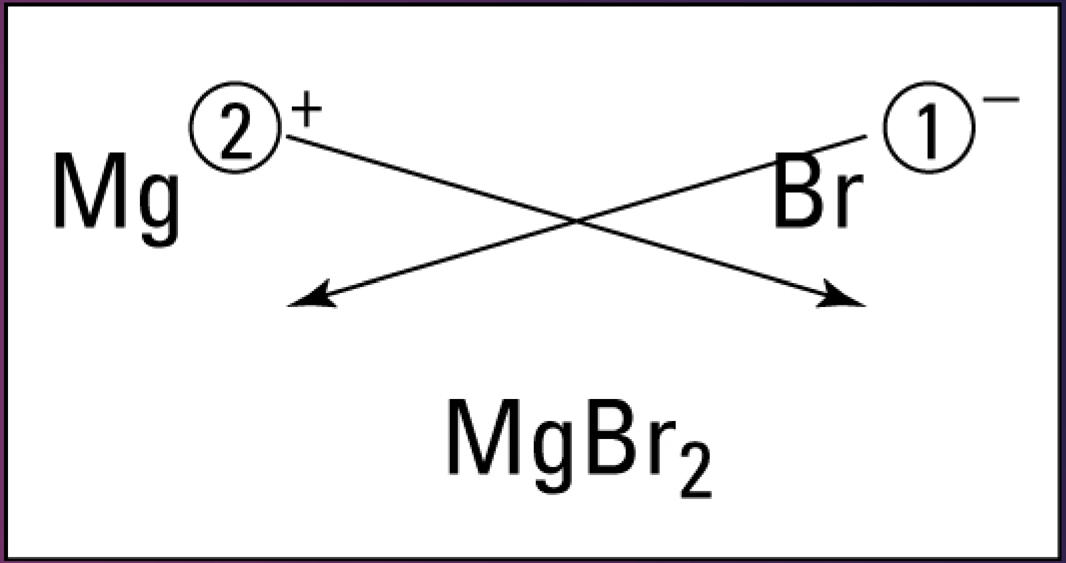
zinc phosphide

Worksheet #1

- Naming simple ionic compounds

General Rules for Writing Empirical Formulas

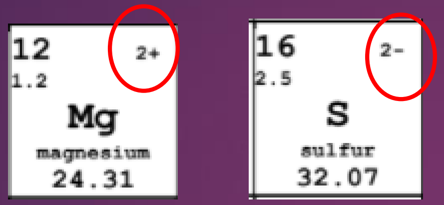
- 1. Write each ion symbol with charge next to each other
- 2. Find the lowest whole number ratio of ions that will give a net charge of zero using the criss-cross method.
- 3. Write the final formula with appropriate subscripts



Writing formulas for Ionic Compounds

Example 1: magnesium sulfide

1. Look at your periodic table and find magnesium and sulfur



2. Locate the ionic charges in the upper right corner and mark down the correct symbols and charge.

Mg^{2+} and S^{2-}

3. The charges are already balanced

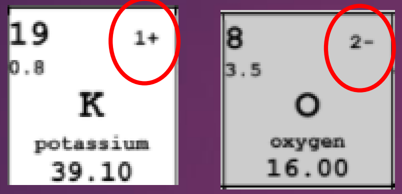
4. Now we write the correct ionic formula using subscripts if required.

MgS

Writing formulas for Ionic Compounds

Example 2: potassium oxide

1. Look at your periodic table and find potassium and oxygen



2. Locate the ionic charges in the upper right corner and mark down the correct symbols and charge.

K^{1+} and O^{2-}

3. The charges are not balanced so we need to balance them USING MULTIPLICATION.

$2K^{1+}$ and $1O^{2-}$

4. Now we write the correct ionic formula using subscripts. We do not need to use the subscript 1.

K_2O

not needed

The Criss-Cross Method

Since
potassium is 1+
Oxygen is 2-

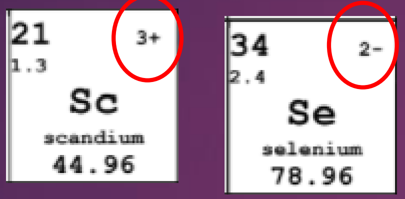
multiply potassium by 2
oxygen by 1.

$2xK^{1+}$ and $1xO^{2-}$

Writing formulas for Ionic Compounds

Example 3: scandium selenide

1. Look at your periodic table and find scandium and selenium



2. Locate the ionic charges in the upper right corner and mark down the correct symbols and charge.

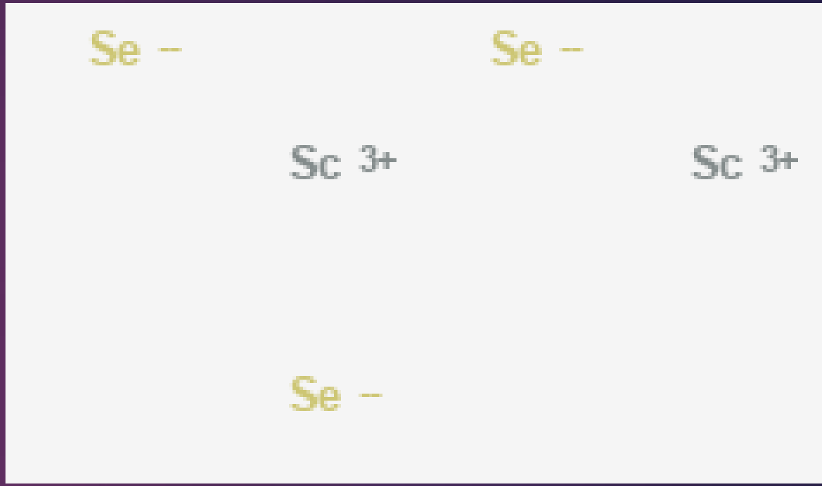
Sc^{3+} and Se^{2-}

3. The charges are not balanced so we need to balance them using the criss-cross method

$2Sc^{3+}$ and $3Se^{2-}$

4. Now we write the correct ionic formula using subscripts

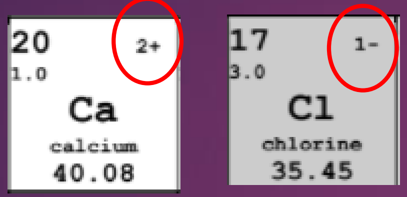
Sc_2Se_3



Writing formulas for Ionic Compounds

Example 4: calcium chloride

1. Look at your periodic table and find calcium and chlorine



2. Locate the ionic charges in the upper right corner and mark down the correct symbols and charge.

Ca^{2+} and Cl^{1-}

3. The charges are not balanced so we need to balance them using the criss-cross method

$1Ca^{2+}$ and $2Cl^{1-}$

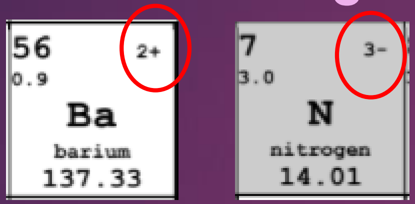
4. Now we write the correct ionic formula using subscripts

$CaCl_2$

Writing formulas for Ionic Compounds

Example 5: barium nitride

1. Look at your periodic table and find barium and nitrogen



2. Locate the ionic charges in the upper right corner and mark down the correct symbols and charge.

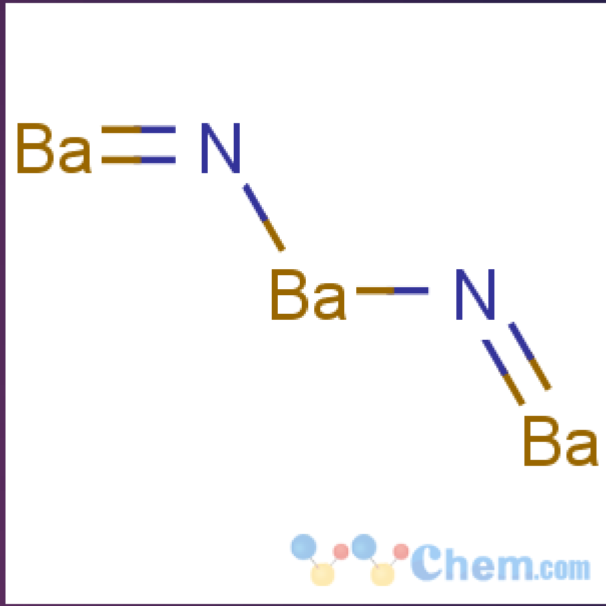
Ba^{2+} and N^{3-}

3. The charges are not balanced so we need to balance them using the criss-cross method

$3Ba^{2+}$ and $2N^{3-}$

4. Now we write the correct ionic formula using subscripts

Ba_3N_2



Worksheet #2

- Writing simple ionic compounds

Naming Polyatomic Compounds

- The same rules apply as with simple ionic PLUS
- Look up the names and charges of polyatomic ions
- Polyatomic ions are located on the back of your periodic table
- When writing formulas, treat polyatomic ions as a unit. Include brackets around the formula of the ion if the ion as a whole has a subscript.

Table of Some Common Polyatomic Ions

1 – Ions		2 – Ions		3 – Ions	
Formula	Name	Formula	Name	Formula	Name
$H_2PO_4^-$	dihydrogen phosphate	HPO_4^{2-}	hydrogen phosphate	PO_4^{3-}	phosphate
$H_2PO_3^-$	dihydrogen phosphite	[illegible]	[illegible]osphite	PO_3^{3-}	phosphite
HCO_3^-	hydrogen carbonate	CO_3^{2-}	carbonate	BO_3^{3-}	borate
HSO_4^-	hydrogen sulfate	[illegible]	[illegible]		
HSO_3^-	hydrogen sulfite	SO_3^{2-}	sulfite		
BrO_3^-	bromate	$C_2O_4^{2-}$	oxalate		
CH_3COO^-	acetate	CrO_4^{2-}	chromate		
$C_6H_5COO^-$	benzoate	$Cr_2O_7^{2-}$	dichromate		
ClO^-	hypochlorite	$S_2O_3^{2-}$	thiosulfate		
ClO_2^-	chlorite	SiO_3^{2-}	silicate		
ClO_3^-	chlorate				
ClO_4^-	perchlorate				
CN^-	cyanide				
IO_3^-	iodate				
OH^-	hydroxide				
NO_3^-	nitrate				
NO_2^-	nitrite				
MnO_4^-	permanganate				
SCN^-	thiocyanate				

1 + I[illegible]	
Formula	[illegible]
NH_4^+	[illegible]
H_3O^+	[illegible]

Example 1: $CaCO_3$

20	2+
1.0	
Ca	
calcium	
40.08	

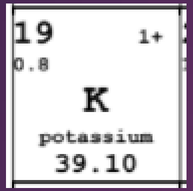
Ca^{2+} : calcium ion

CO_3^{2-} : carbonate ion

calcium carbonate

Naming Polyatomic Compounds

Example 2: $KMnO_4$



K^+ : potassium ion

MnO_4^- : permanganate ion

potassium permanganate

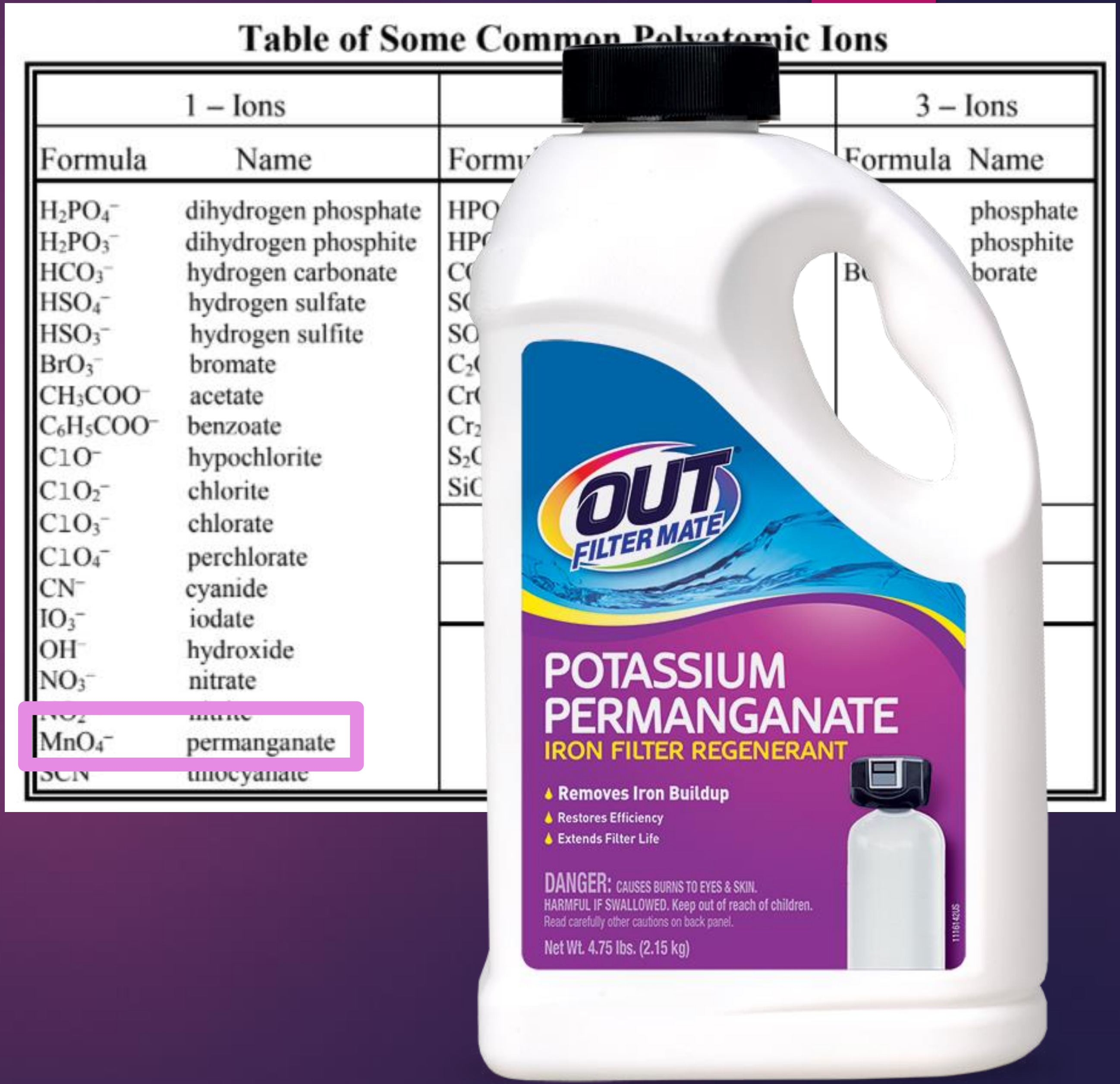
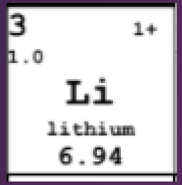


Table of Some Common Polyatomic Ions

1 – Ions				3 – Ions	
Formula	Name	Formu		Formula	Name
$H_2PO_4^-$	dihydrogen phosphate	HPO			phosphate
$H_2PO_3^-$	dihydrogen phosphite	HP			phosphite
HCO_3^-	hydrogen carbonate	C		B	borate
HSO_4^-	hydrogen sulfate	S			
HSO_3^-	hydrogen sulfite	SO			
BrO_3^-	bromate	C_2			
CH_3COO^-	acetate	Cr			
$C_6H_5COO^-$	benzoate	Cr_2			
ClO^-	hypochlorite	S_2			
ClO_2^-	chlorite	Si			
ClO_3^-	chlorate				
ClO_4^-	perchlorate				
CN^-	cyanide				
IO_3^-	iodate				
OH^-	hydroxide				
NO_3^-	nitrate				
NO_2^-	nitrite				
MnO_4^-	permanganate				
SCN^-	thiocyanate				

Naming Polyatomic Compounds

Example 3: Li_2SiO_3



Li^+ : lithium ion

SiO_3^{2-} : silicate ion

lithium silicate

Table of Some Common Polyatomic Ions

1 – Ions		2 – Ions		3 – Ions	
Formula	Name	Formula	Name	Formula	Name
$H_2PO_4^-$	dihydrogen phosphate	HPO_4^{2-}	hydrogen phosphate	PO_4^{3-}	phosphate
$H_2PO_3^-$	dihydrogen phosphite	HPO_3^{2-}	hydrogen phosphite	PO_3^{3-}	phosphite
HCO_3^-	hydrogen carbonate	CO_3^{2-}	carbonate	BO_3^{3-}	borate
HSO_4^-	hydrogen sulfate	SO_4^{2-}	sulfate		
HSO_3^-	hydrogen sulfite	SO_3^{2-}	sulfite		
BrO_3^-	bromate	$C_2O_4^{2-}$	oxalate		
CH_3COO^-	acetate	CrO_4^{2-}	chromate		
$C_6H_5COO^-$	benzoate	$Cr_2O_7^{2-}$	dichromate		
ClO^-	hypochlorite	[illegible]	[illegible]		
ClO_2^-	chlorite	SiO_3^{2-}	silicate		
ClO_3^-	chlorate				
ClO_4^-	perchlorate				
CN^-	cyanide				
IO_3^-	iodate				
OH^-	hydroxide				
NO_3^-	nitrate				
NO_2^-	nitrite				
MnO_4^-	permanganate				
SCN^-	thiocyanate				

1 + Ions

Formula	Name
NH_4^+	ammonium
H_3O^+	hydronium

Naming Polyatomic Compounds

Example 4: $(NH_4)_2CrO_4$

Both are Polyatomic!

NH_4^+ : ammonium ion

CrO_4^{2-} : chromate ion

ammonium chromate

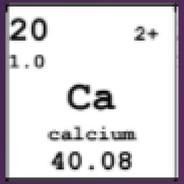
Table of Some Common Polyatomic Ions

1 – Ions		2 – Ions		3 – Ions	
Formula	Name	Formula	Name	Formula	Name
$H_2PO_4^-$	dihydrogen phosphate	HPO_4^{2-}	hydrogen phosphate	PO_4^{3-}	phosphate
$H_2PO_3^-$	dihydrogen phosphite	HPO_3^{2-}	hydrogen phosphite	PO_3^{3-}	phosphite
HCO_3^-	hydrogen carbonate	CO_3^{2-}	carbonate	BO_3^{3-}	borate
HSO_4^-	hydrogen sulfate	SO_4^{2-}	sulfate		
HSO_3^-	hydrogen sulfite	SO_3^{2-}	sulfite		
BrO_3^-	bromate	$C_2O_4^{2-}$	oxalate		
CH_3COO^-	acetate	CrO_4^{2-}	chromate		
$C_6H_5COO^-$	benzoate	$Cr_2O_7^{2-}$	dichromate		
ClO^-	hypochlorite	$S_2O_3^{2-}$	thiosulfate		
ClO_2^-	chlorite	SiO_3^{2-}	silicate		
ClO_3^-	chlorate				
ClO_4^-	perchlorate				
CN^-	cyanide				
IO_3^-	iodate				
OH^-	hydroxide				
NO_3^-	nitrate				
NO_2^-	nitrite				
MnO_4^-	permanganate				
SCN^-	thiocyanate				

1 + Ions	
Formula	Name
NH_4^+	ammonium
H_3O^+	hydronium

Naming Polyatomic Compounds

Example 5: $Ca(CN)_2$



Ca^{2+} : calcium ion

CN^- : cyanide ion

calcium cyanide

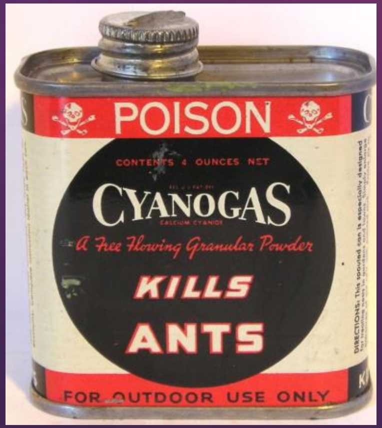


Table of Some Common Polyatomic Ions

1 – Ions		2 – Ions		3 – Ions	
Formula	Name	Formula	Name	Formula	Name
$H_2PO_4^-$	dihydrogen phosphate	HPO_4^{2-}	hydrogen phosphate	PO_4^{3-}	phosphate
$H_2PO_3^-$	dihydrogen phosphite	HPO_3^{2-}	hydrogen phosphite	PO_3^{3-}	phosphite
HCO_3^-	hydrogen carbonate	CO_3^{2-}	carbonate	BO_3^{3-}	borate
HSO_4^-	hydrogen sulfate	SO_4^{2-}	sulfate		
HSO_3^-	hydrogen sulfite	SO_3^{2-}	sulfite		
BrO_3^-	bromate	$C_2O_4^{2-}$	oxalate		
CH_3COO^-	acetate	CrO_4^{2-}	chromate		
$C_6H_5COO^-$	benzoate	$Cr_2O_7^{2-}$	dichromate		
ClO^-	hypochlorite	$S_2O_3^{2-}$	thiosulfate		
ClO_2^-	chlorite	SiO_3^{2-}	silicate		
ClO_3^-	chlorate				
ClO_4^-	perchlorate				
CN^-	cyanide				
IO_3^-	iodate				
OH^-	hydroxide				
NO_3^-	nitrate				
NO_2^-	nitrite				
MnO_4^-	permanganate				
SCN^-	thiocyanate				

1 + Ions	
Formula	Name
NH_4^+	ammonium
H_3O^+	hydronium

Worksheet #3

- Naming Polyatomic Compounds

Writing Polyatomic Chemical Formulas

Example 1: barium sulfite

1. Look at your periodic table and find barium and sulfite

2. Write down the correct symbols and charge.

Ba^{2+} and SO_3^{2-}

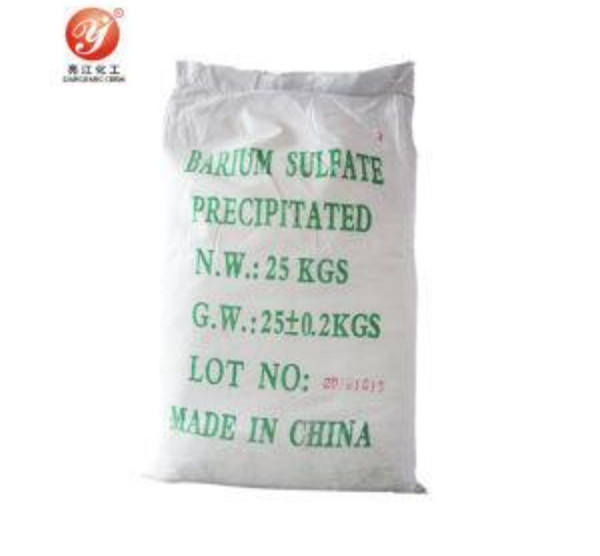
3. The charges are balanced

4. Now we write the correct ionic formula

$BaSO_3$

Table of Some Common Polyatomic Ions

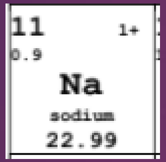
1 – Ions		2 – Ions		3 – Ions	
Formula	Name	Formula	Name	Formula	Name
$H_2PO_4^-$	dihydrogen phosphate	HPO_4^{2-}	hydrogen phosphate	PO_4^{3-}	phosphate
$H_2PO_3^-$	dihydrogen phosphite	HPO_3^{2-}	hydrogen phosphite	PO_3^{3-}	phosphite
HCO_3^-	hydrogen carbonate	CO_3^{2-}	carbonate	BO_3^{3-}	borate
HSO_4^-	hydrogen sulfate	SO_4^{2-}	sulfate		
HSO_3^-	hydrogen sulfite	SO_3^{2-}	sulfite		
BrO_3^-	bromate	$C_2O_4^{2-}$	oxalate		
CH_3COO^-	acetate	CrO_4^{2-}	chromate		
$C_6H_5COO^-$	benzoate	$Cr_2O_7^{2-}$	dichromate		
ClO^-	hypochlorite	$S_2O_3^{2-}$	thiosulfate		
ClO_2^-	chlorite	SiO_3^{2-}	silicate		
ClO_3^-	chlorate				
ClO_4^-	perchlorate				
CN^-	cyanide				
IO_3^-	iodate				
OH^-	hydroxide				
NO_3^-	nitrate				
NO_2^-	nitrite				
MnO_4^-	permanganate				
SCN^-	thiocyanate				



Writing Polyatomic Chemical Formulas

Example 2: sodium phosphate

1. Look at your periodic table and find sodium and phosphate



2. Write down the correct symbols and charge.

Na^+ and PO_4^{3-}

3. The charges are not balanced so we have to use the criss-cross method

$3Na^+$ and $1PO_4^{3-}$

4. Now we write the correct ionic formula using subscripts

Na_3PO_4

Table of Some Common Polyatomic Ions

1 – Ions		2 – Ions		3 – Ions	
Formula	Name	Formula	Name	Formula	Name
$H_2PO_4^-$	dihydrogen phosphate	HPO_4^{2-}	hydrogen phosphate	PO_4^{3-}	phosphate
$H_2PO_3^-$	dihydrogen phosphite	HPO_3^{2-}	hydrogen phosphite	PO_3^{3-}	phosphite
HCO_3^-	hydrogen carbonate	CO_3^{2-}	carbonate	BO_3^{3-}	borate
HSO_4^-	hydrogen sulfate	SO_4^{2-}	sulfate		
HSO_3^-	hydrogen sulfite	SO_3^{2-}	sulfite		
BrO_3^-	bromate	$C_2O_4^{2-}$	oxalate		
CH_3COO^-	acetate	CrO_4^{2-}	chromate		
$C_6H_5COO^-$	benzoate	$Cr_2O_7^{2-}$	dichromate		
ClO^-	hypochlorite	$S_2O_3^{2-}$	thiosulfate		
ClO_2^-	chlorite	SiO_3^{2-}	silicate		
ClO_3^-	chlorate				
ClO_4^-	perchlorate				
CN^-	cyanide				
IO_3^-	iodate				
OH^-	hydroxide				
NO_3^-	nitrate				
NO_2^-	nitrite				
MnO_4^-	permanganate				
SCN^-	thiocyanate				

1 + Ions	
Formula	Name
NH_4^+	ammonium
H_3O^+	hydronium

Writing Polyatomic Chemical Formulas

Example 3: ammonium borate

1. Look at your periodic table and find ammonium and borate

Both are Polyatomic!

2. Write down the correct symbols and charge.

NH_4^+ and BO_3^{3-}

3. The charges are not balanced so we have to use the criss-cross method

$3NH_4^+$ and $1BO_3^{3-}$

4. Now we write the correct ionic formula using subscripts and brackets because we need 3 ammoniums

$(NH_4)_3BO_3$

Table of Some Common Polyatomic Ions

1 – Ions		2 – Ions		3 – Ions	
Formula	Name	Formula	Name	Formula	Name
$H_2PO_4^-$	dihydrogen phosphate	HPO_4^{2-}	hydrogen phosphate	PO_4^{3-}	phosphate
$H_2PO_3^-$	dihydrogen phosphite	HPO_3^{2-}	hydrogen phosphite	PO_3^{3-}	phosphite
HCO_3^-	hydrogen carbonate	CO_3^{2-}	carbonate	BO_3^{3-}	borate
HSO_4^-	hydrogen sulfate	SO_4^{2-}	sulfate		
HSO_3^-	hydrogen sulfite	SO_3^{2-}	sulfite		
BrO_3^-	bromate	$C_2O_4^{2-}$	oxalate		
CH_3COO^-	acetate	CrO_4^{2-}	chromate		
$C_6H_5COO^-$	benzoate	$Cr_2O_7^{2-}$	dichromate		
ClO^-	hypochlorite	$S_2O_3^{2-}$	thiosulfate		
ClO_2^-	chlorite	SiO_3^{2-}	silicate		
ClO_3^-	chlorate				
ClO_4^-	perchlorate				
CN^-	cyanide				
IO_3^-	iodate				
OH^-	hydroxide				
NO_3^-	nitrate				
NO_2^-	nitrite				
MnO_4^-	permanganate				
SCN^-	thiocyanate				

1 + Ions	
Formula	Name
NH_4^+	ammonium
H_3O^+	hydronium

Writing Polyatomic Chemical Formulas

Example 4: radium acetate

1. Look at your periodic table and find radium and acetate

88 2+
0.9
Ra
radium
(226)

2. Write down the correct symbols and charge.

Ra^{2+} and CH_3COO^-

3. The charges are not balanced so we have to use the criss-cross method Ra^{2+} and $2CH_3COO^-$

4. Now we write the correct ionic formula using subscripts and brackets because we need 2 acetate

$Ra(CH_3COO)_2$

Table of Some Common Polyatomic Ions

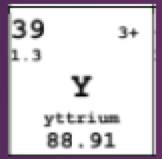
1 – Ions		2 – Ions		3 – Ions	
Formula	Name	Formula	Name	Formula	Name
$H_2PO_4^-$	dihydrogen phosphate	HPO_4^{2-}	hydrogen phosphate	PO_4^{3-}	phosphate
$H_2PO_3^-$	dihydrogen phosphite	HPO_3^{2-}	hydrogen phosphite	PO_3^{3-}	phosphite
HCO_3^-	hydrogen carbonate	CO_3^{2-}	carbonate	BO_3^{3-}	borate
HSO_4^-	hydrogen sulfate	SO_4^{2-}	sulfate		
HSO_3^-	hydrogen sulfite	SO_3^{2-}	sulfite		
BrO_3^-	bromate	$C_2O_4^{2-}$	oxalate		
CH_3COO^-	acetate	CrO_4^{2-}	chromate		
$C_6H_5COO^-$	benzoate	$Cr_2O_7^{2-}$	dichromate		
ClO^-	hypochlorite	$S_2O_3^{2-}$	thiosulfate		
ClO_2^-	chlorite	SiO_3^{2-}	silicate		
ClO_3^-	chlorate				
ClO_4^-	perchlorate				
CN^-	cyanide				
IO_3^-	iodate				
OH^-	hydroxide				
NO_3^-	nitrate				
NO_2^-	nitrite				
MnO_4^-	permanganate				
SCN^-	thiocyanate				

1 + Ions	
Formula	Name
NH_4^+	ammonium
H_3O^+	hydronium

Writing Polyatomic Chemical Formulas

Example 5: yttrium phosphite

1. Look at your periodic table and find yttrium and phosphite



2. Write down the correct symbols and charge.

Y^{3+} and PO_3^{3-}

3. The charges are balanced

4. Now we write the correct ionic formula

YPO_3

Table of Some Common Polyatomic Ions

1 – Ions Formula	1 – Ions Name	2 – Ions Formula	2 – Ions Name	3 – Ions Formula	3 – Ions Name
$H_2PO_4^-$	dihydrogen phosphate	HPO_4^{2-}	hydrogen phosphate	PO_4^{3-}	phosphate
$H_2PO_3^-$	dihydrogen phosphite	HPO_3^{2-}	hydrogen phosphite	PO_3^{3-}	phosphite
HCO_3^-	hydrogen carbonate	CO_3^{2-}	carbonate	BO_3^{3-}	borate
HSO_4^-	hydrogen sulfate	SO_4^{2-}	sulfate		
HSO_3^-	hydrogen sulfite	SO_3^{2-}	sulfite		
BrO_3^-	bromate	$C_2O_4^{2-}$	oxalate		
CH_3COO^-	acetate	CrO_4^{2-}	chromate		
$C_6H_5COO^-$	benzoate	$Cr_2O_7^{2-}$	dichromate		
ClO^-	hypochlorite	$S_2O_3^{2-}$	thiosulfate		
ClO_2^-	chlorite	SiO_3^{2-}	silicate		
ClO_3^-	chlorate				
ClO_4^-	perchlorate				
CN^-	cyanide				
IO_3^-	iodate				
OH^-	hydroxide				
NO_3^-	nitrate				
NO_2^-	nitrite				
MnO_4^-	permanganate				
SCN^-	thiocyanate				

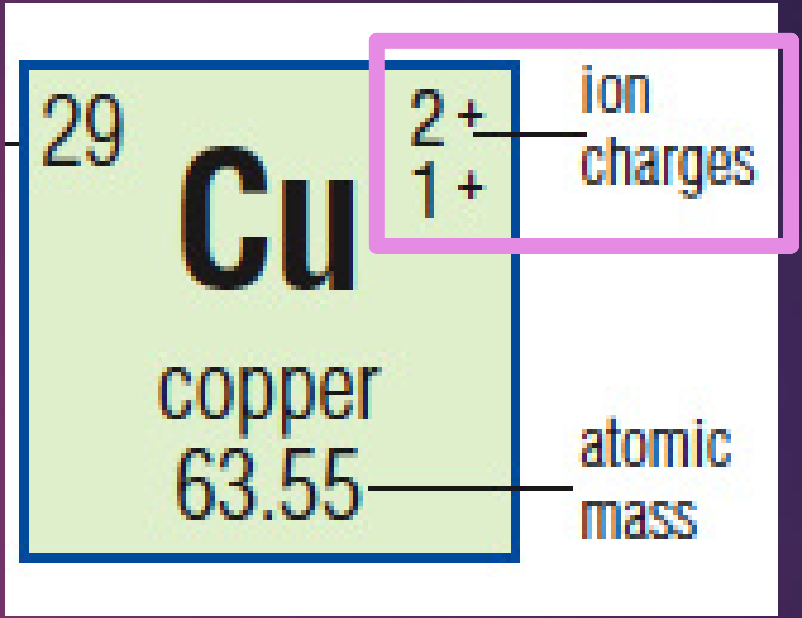
1 + Ions Formula	1 + Ions Name
NH_4^+	ammonium
H_3O^+	hydronium

Worksheet #4

- Writing Polyatomic Chemical Formulas

Naming Multivalent Ionic Compounds

- Ions of multivalent metals are named by adding Roman numerals in brackets to indicate their charges.
- some metals form more than one type of ion. Such metals are called multivalent metals.
- For example, copper can form ions with a 1+ or 2+ charge.

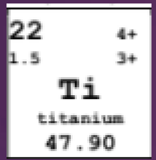


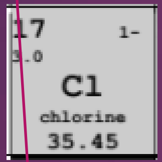
Roman numeral	Charge
I	+1
II	+2
III	+3
IV	+4
V	+5
VI	+6

Naming Multivalent Ionic Compounds

Example 1 : $TiCl_4$

1. Look at your periodic table and find titanium and chlorine





2. titanium has two ions a 4+ and a 3+

3. Now we look at the anion (chlorine) it has a 1- and in the formula there are 4 chlorine ions combined with one titanium ion

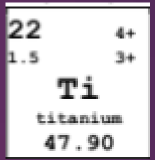
4. This means that the charge on titanium has to be 4+ to balance the chlorine 4-

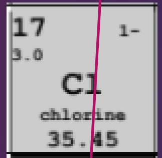
5. This means that it is titanium (IV)

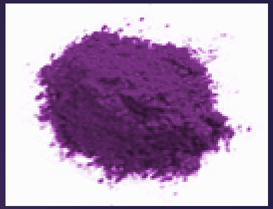
titanium (IV) chloride

Example 2 : $TiCl_3$

1. Look at your periodic table and find titanium and chlorine







2. titanium has two ions a 4+ and a 3+

3. Now we look at the anion (chlorine) it has a 1- and in the formula there are 3 ions combined with one titanium

4. This means that the charge on titanium has to be 3+ to balance the chlorine 3-

5. This means that it is titanium (III)

titanium (III) chloride

Naming Multivalent Ionic Compounds

Example 3 : Fe_2O_3

1. Look at your periodic table and find iron and oxygen

2. iron has two ions a 3+ and a 2+

3. Now we look at the anion (oxygen) it has a 2- and in the formula there are 3 oxygen ions combined with 2 iron

4. This means that the total charge on oxygen is 6-. Since there are two irons its charge has to 3+ to create a 6+ charge.

5. This means that it is iron (III)

iron (III) oxide

Example 4 : FeO

1. Look at your periodic table and find iron and oxygen

2. Iron has two ions a 3+ and a 2+

3. Now we look at the anion (oxygen) it has a 2- and in the formula there is 1 oxygen ion combined with one iron ion

4. This means that the total charge on oxygen is 2- so the iron has to be 2+

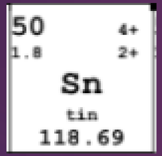
5. This means that it is iron (II)

iron (II) oxide

Naming Multivalent Ionic Compounds

Example 5 : $SnSO_3$

1. Look at your periodic table and find tin and sulfite



polyatomic

2. tin has two ions a 4+ and a 2+

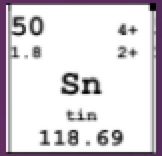
3. Now we look at the anion (sulfite) it has a 2- and the chemical formula is balanced so tin has to be 2+

4. This means that it is tin (II)

tin (II) sulfite

Example 6 : $Sn(SO_3)_2$

1. Look at your periodic table and find tin and sulfite



polyatomic

2. tin has two ions a 4+ and a 2+

3. Now we look at the anion (sulfite) it has a 2- and in the chemical formula we have 2 of them for 4-

4. This means that the charge on tin has to be 4+

5. This means that it is tin (IV)

tin (IV) sulfite

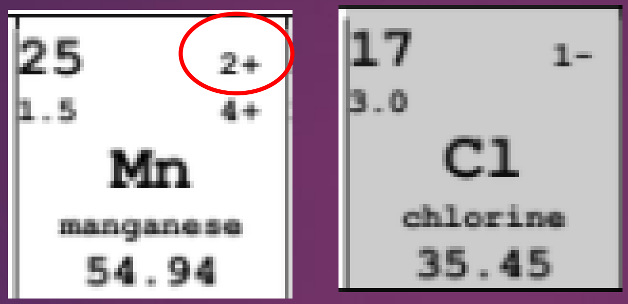
Worksheet #5

- Naming Multivalent Ionic Compounds

Writing Multivalent Ionic Formulas

Example 1: manganese (II) chloride

1. The (II) on manganese tells you the charge **NOT THE NUMBER OF ATOMS!**



2. Write down the correct symbols and charge.

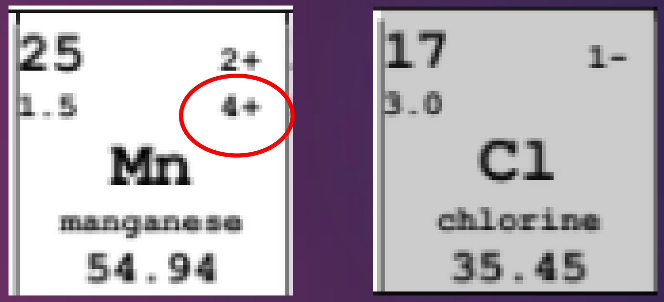
~~Mn^{2+} and Cl^{-}~~

3. The charges are not balanced, we need 2 chlorines with each manganese

$MnCl_2$

Example 2: manganese (IV) chloride

1. The (IV) on manganese tells you the charge **NOT THE NUMBER OF ATOMS!**



2. Write down the correct symbols and charge.

~~Mn^{4+} and Cl^{-}~~

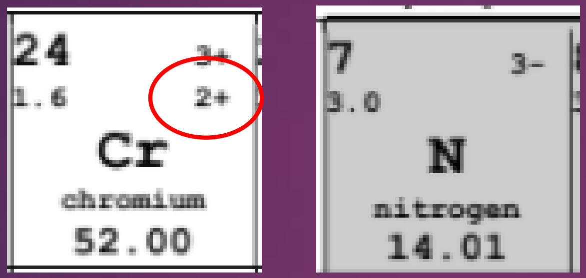
3. The charges are not balanced, we need 4 chlorines with each manganese

$MnCl_4$

Writing Multivalent Ionic Formulas

Example 3: chromium (II) nitride

1. The (II) on chromium tells you the charge **NOT THE NUMBER OF ATOMS!**



2. Write down the correct symbols and charge.

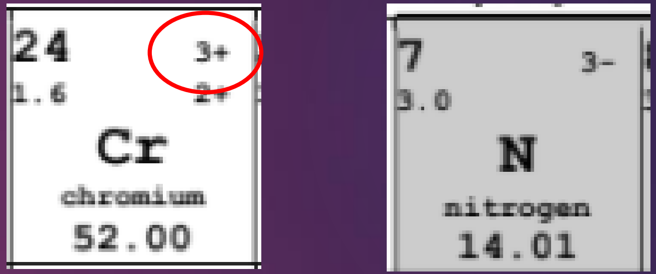
Cr^{2+} and N^{3-}

3. The charges are not balanced, so we can do the criss-cross method here to balance them at +6 and -6.

Cr_3N_2

Example 4: chromium (III) nitride

1. The (III) on chromium tells you the charge **NOT THE NUMBER OF ATOMS!**



2. Write down the correct symbols and charge.

Cr^{3+} and N^{3-}

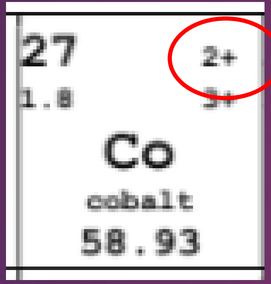
3. The charges are balanced

CrN

Writing Multivalent Ionic Formulas

Example 5: cobalt (II) nitrate

1. The (II) on cobalt tells you the charge **NOT THE NUMBER OF ATOMS!**



NO_3^- nitrate

2. Write down the correct symbols and charge.

Co^{2+} and NO_3^-

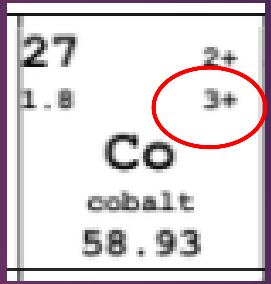
Remember this is a 1- and is not needed

3. The charges are not balanced, so we can do the criss-cross method here to balance them at +2 and -2.

$Co(NO_3)_2$

Example 6: cobalt (III) nitrate

1. The (III) on cobalt tells you the charge **NOT THE NUMBER OF ATOMS!**



NO_3^- nitrate

2. Write down the correct symbols and charge.

Co^{3+} and NO_3^-

Remember this is a 1- and is not needed

3. The charges are not balanced, so we can do the criss-cross method here to balance them at +3 and -3.

$Co(NO_3)_3$

Worksheet #6

- Writing Multivalent Ionic Formulas

Exit Card #2: Ionic Compounds

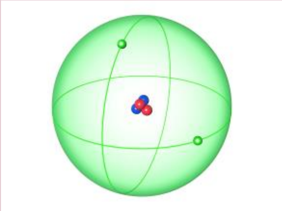
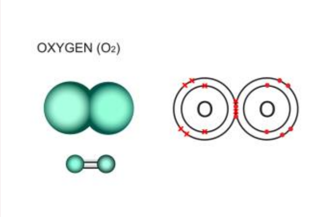
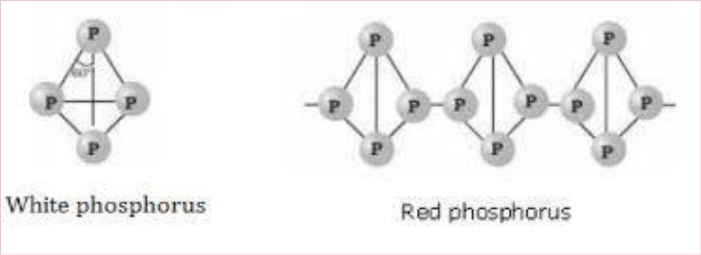
Quiz

- If you miss this quiz, your test mark will be used to replace it.
- Format:
- 12 mc (12 Marks)
- 4 short answer (13 Marks)
- Time to complete
- 45 mins in class
- 1 h 15m extended time **IF** you go to the LRC room 212/214.

Molecular Compounds

You need to memorize these

- Some Molecular Elements contain only one kind of non metal atom

Type	Molecular Elements	
Monatomic = one atom	Non-metals that exist in nature as individual atoms **He, Ne, Ar, Kr, Xe, Rn (the noble gases)**	
Diatomic = two atoms	Non-metals that exist in nature as two atoms bonded together. **O_2, N_2, H_2, and Halogens F_2, Cl_2, Br_2, I_2,**	
Polyatomic = three or more atoms	Non-metals that exist in nature as three or more atoms. **Ozone (O_3), Sulfur (S_8), Phosphorous White (P_4) and Phosphorus Red (P_{12})**	

Trivial Molecular Compounds

Trivial Name	Chemical Formula	IUPAC ID
Ammonia	NH_3	Azane
Hydrogen peroxide	H_2O_2	hydrogen peroxide
Laughing gas	N_2O	nitrous oxide
Ozone	O_3	trioxygen
sugar	$C_6H_{12}O_6$ – Glucose $C_{12}H_{22}O_{11}$ – Sucrose	You don't want to know ☺

Writing Molecular Formulas

- General Rules
  - 1. Write each atom symbol
  - 2. Each prefix indicates the subscript for the non-metal atoms that proceeds it (# of atoms present)
  - 3. if no prefix is present then there is only one atom of that non-metal present

#	Latin prefix	#	Latin prefix
1	Mono	6	Hexa
2	Di	7	Hepta
3	Tri	8	Octa
4	Tetra	9	Nona
5	Penta	10	deca

Writing Molecular Formulas

Example 1: carbon monoxide

There is one carbon and one oxygen

Chemical Formula: CO

Example 2: carbon tetrachloride

There is one carbon and four chlorine

Chemical Formula: CCl_4

Example 3: triboron nitride

There are three boron and one nitrogen

Chemical Formula: B_3N

Example 4: dinitrogen hexafluoride

There are two nitrogen and six fluorine

Chemical Formula: N_2F_6

Worksheet #7

- Writing Molecular Formulas

Rules For Naming Molecular Compounds

- 1. The first element is named in full
- 2. The second element uses the suffix "-ide" at the end
- 3. use prefixes to indicate the number of each kind of atom present
- 4. The prefix mono is only used when there is one atom of oxygen present.

Naming Molecular Formulas

Example 1: NO

nitrogen monoxide

Example 2: P_4O_6

tetra phosphorus hexaoxide

Example 3: SO_2

sulfur dioxide

Example 4: S_2O_3

disulfur trioxide

Example 5: N_7Br_8

heptanitrogen octabromide

Example 6: P_4H_9

tetraphosphorus nonahydride

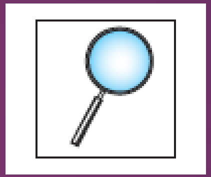
Worksheet #8

- Naming Molecular Compounds

Exit Card #3: Molecular Compounds

Lab 2: 3-3B

- Mass before and after



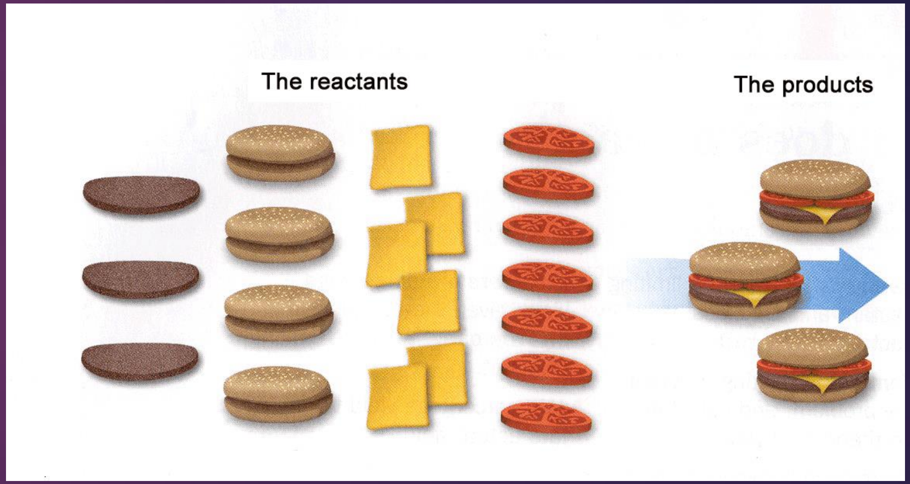
The Law of Conservation of Mass

- In any chemical or physical change, mass (matter) is neither created nor destroyed.
- reactant is a substance that is present at the start of a chemical reaction to the left of the arrow
- The substance(s) to the right of the arrow are called products.

reactant 1 + reactant 2 → product

reactant 1 → product 1 + product 2

reactant 1 + reactant 2 → product 1 + product 2



- The mass of the reactants on the left has to equal the mass of the products on the right.

Example 1: Dehydration of gypsum by heating it

$CaSO_4 \cdot 2H_2O_{(S)} \rightarrow CaSO_4 + 2H_2O_{(g)}$

172.2 g → 136.2g + 36.0 g

172.2 – 136.2 = 36.0 g

Example 2: Simple composition of mercury oxide

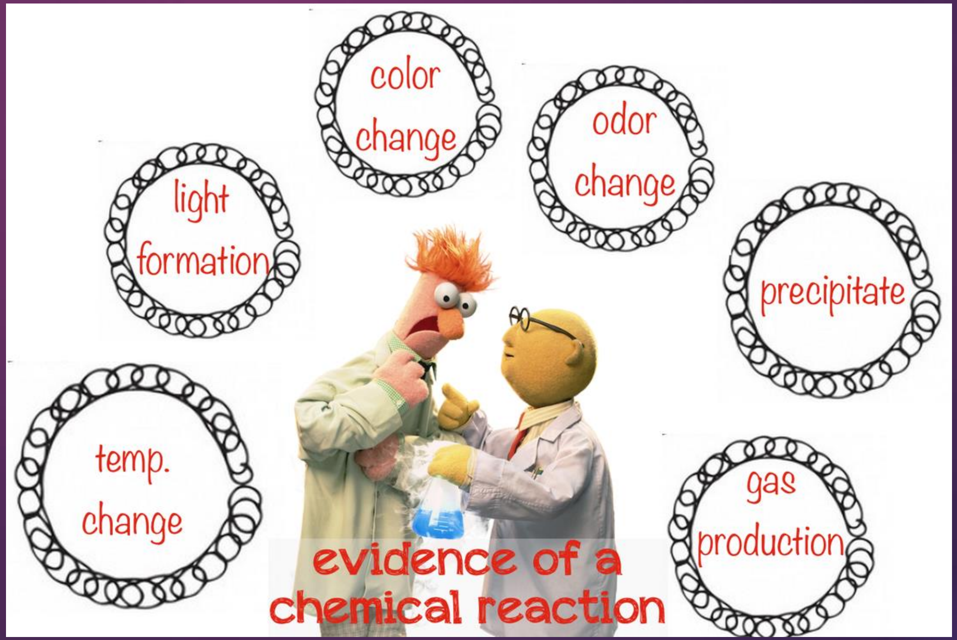
mercury + oxygen → mercury oxide

201 g + 32g → ___233___ g

201 + 32 = 233 g

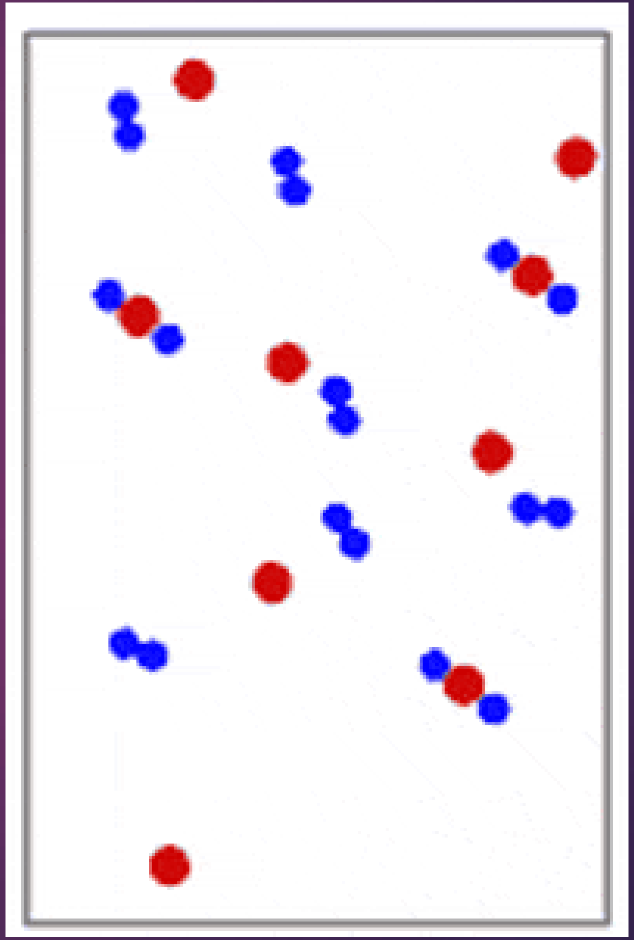
Evidence of Chemical Reactions

- Four ways to tell if a chemical reaction has taken place.
- 1.) Energy change (production of heat of light)
- 2.) Formation of a gas (bubbles)
- 3.) Color change
- 4.) formation of a precipitate (solid)



Types of Chemical Reactions

- 1. **Formation reaction:** a reaction in which two or more elements react to produce a compound.



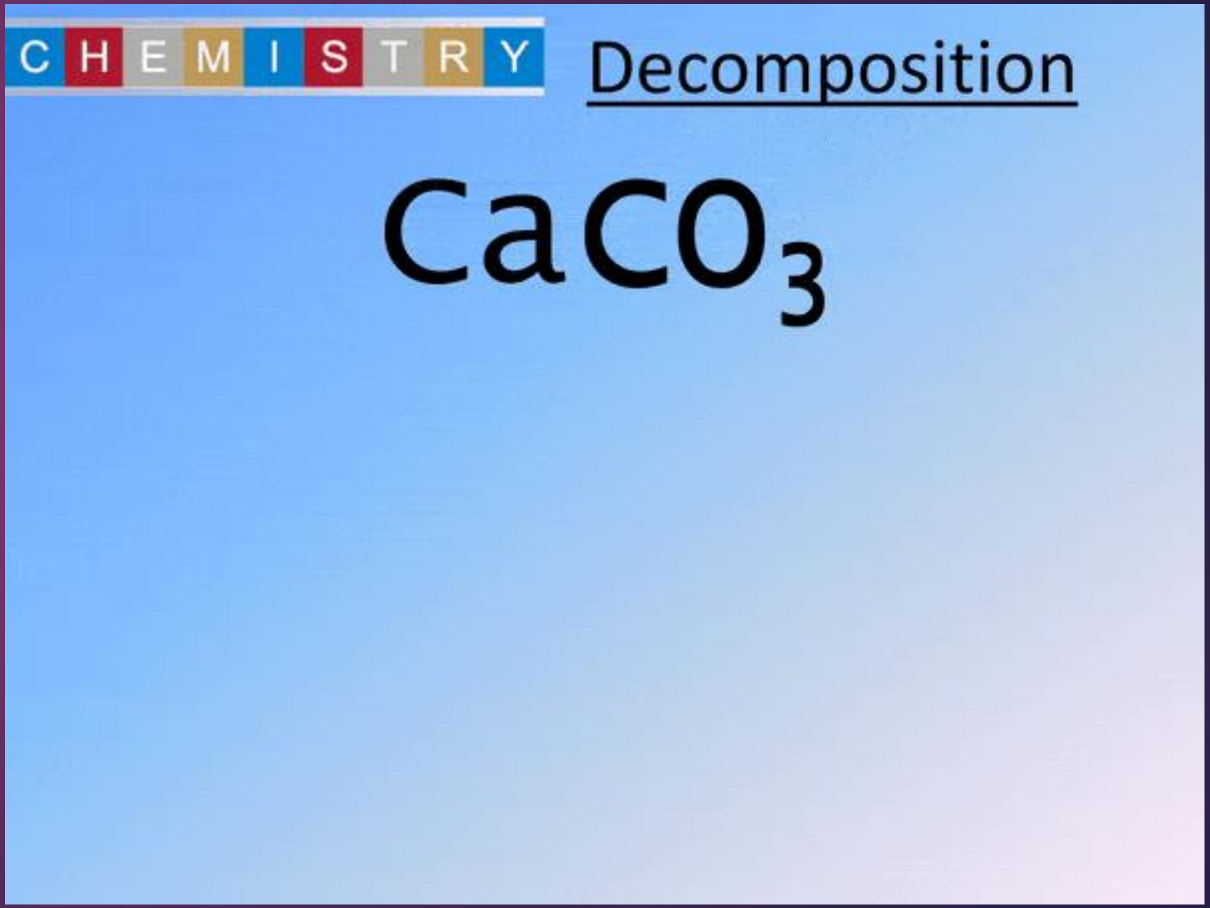
- $A + B \rightarrow AB$
- $Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$

- 2. **Decomposition Reaction**: occurs when a compound is broken down into all of its elements.

- AB → A + B

- $2LiF(s) \rightarrow 2Li(s) + F_2(g)$

- $2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$



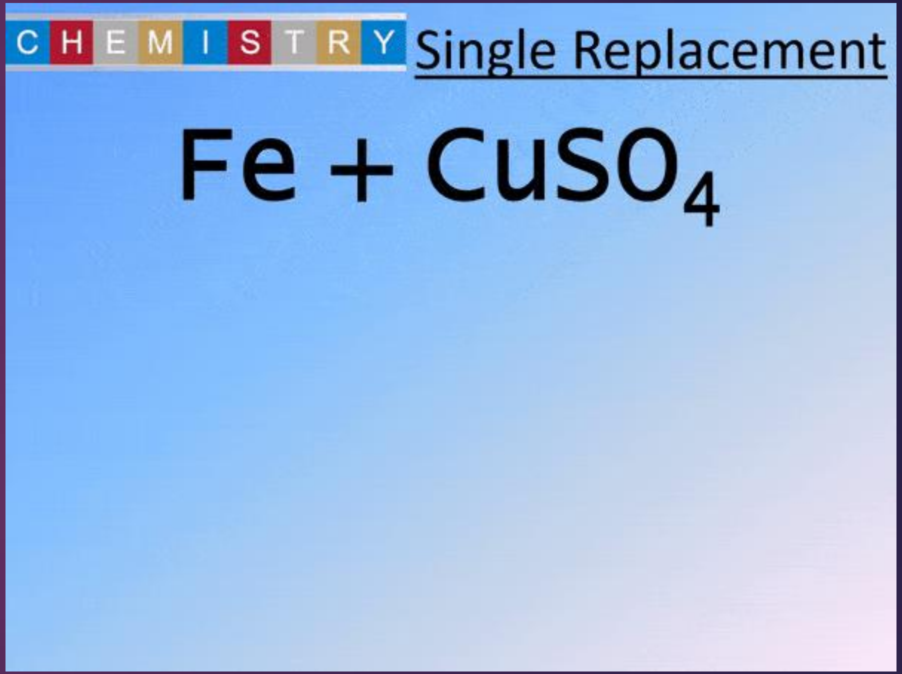
- 3. **Single replacement reaction:** a reaction in which one element
- takes the place of another element in a compound.

- $A + BX \rightarrow AX + B$ or $AX + Y \rightarrow AY + X$

- $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

- $2NaBr(aq) + Cl_2(g) \rightarrow 2NaCl(aq) + Br_2(l)$

- $Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$



- 4. **Double replacement reaction** - a reaction in which the positive ions of two different compounds exchange places, resulting in the formation of two new compounds.

- AY + BX → AX + BY

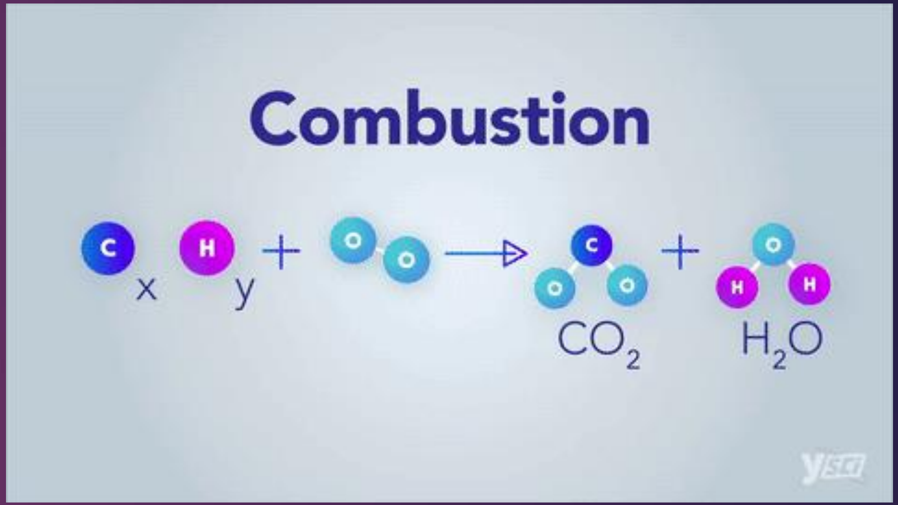
- $AgNO_3(aq) + KCl(aq) \rightarrow KNO_3(aq)\ AgCl(s)$

- **5. Combustion reaction (hydrocarbon combustion):** a reaction in which a compound, containing only the elements carbon and hydrogen, reacts with oxygen to produce carbon dioxide and water.

- $CxHy + O_2 \rightarrow CO_2 + H_2O$

- $C_6H_{12}(aq) + 9O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$

- If the supply of oxygen is too low, then **incomplete combustion** occurs, producing **carbon (soot) and carbon monoxide,** in addition to carbon dioxide and water.



Complete combustion of methane

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_20$

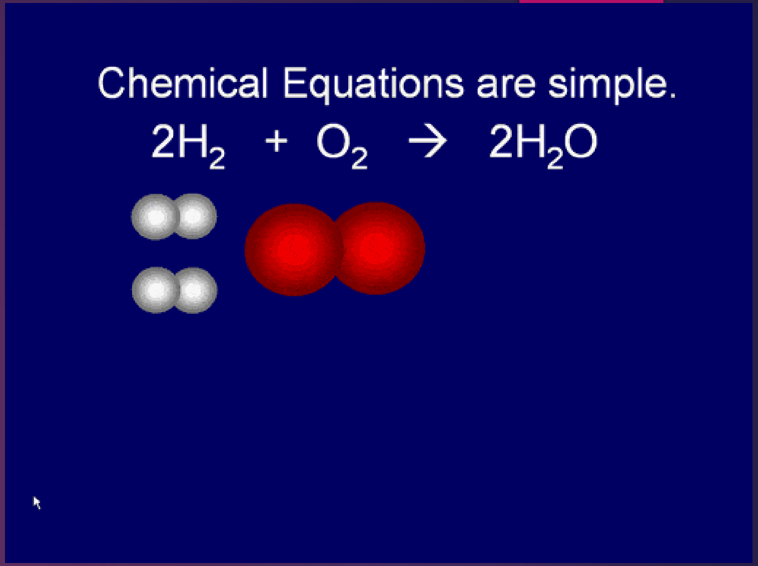
Incomplete combustion of methane

$4CH_4 + 5O_2 \longrightarrow 2CO + 8H_20 + 2C$

Worksheet #9

- Classifying types of reactions

Balancing Chemical Equations



- Experimental evidence indicates that:
  - Atoms are conserved
  - Mass is conserved
  - Energy is conserved
- A chemical equation must:
  - Represent the correct chemical formula and state for each reactant and product
  - Show that atoms or ions are conserved:
  - Total # of each kind of atom in reactants = total # of each kind of atom in products

- Hints for Balancing:
- 1. Balance polyatomic ions first
- 2. If you don't know where to start, start with the element with the largest number of atoms
- 3. Double check every time you put a number in the blank
- 4. For hydrocarbon combustion, balance carbon first, then hydrogen, then oxygen, that is C–H–O

- 1. _2_ Mg + ___ O_2 → _2_ MgO

There are no polyatomic so we will start wit the largest number of atoms first. O_2

Since there are 2 oxygen atoms we need to place a 2 in front of MgO

Now we double check, our oxygen is balanced but our Mg is not. We need to put a 2 in front of Mg

Now our chemical equation is balanced.

- 2. ___Cu + $\underline{2}$ $AgNO_3$ → $\underline{2}$ Ag + ___ $Cu(NO_3)_2$

Start by balancing the polyatomic, NO_3. There is 1 NO_3 on the left but two on the right so we will put a 2 in front of $AgNO_3$

Doing this has created two Ag on the left so now we have to balance it by putting a 2 on the right.

Our chemical equation is now balanced.

- 3. ___ $Pb(NO_3)_2$ + _2_ KI → ___ PbI_2 + _2_ KNO_3

  Start by balancing the polyatomic, NO_3. There are 2 NO_3 on the left but only 1 on the right so we will put a 2 in front of KNO_3

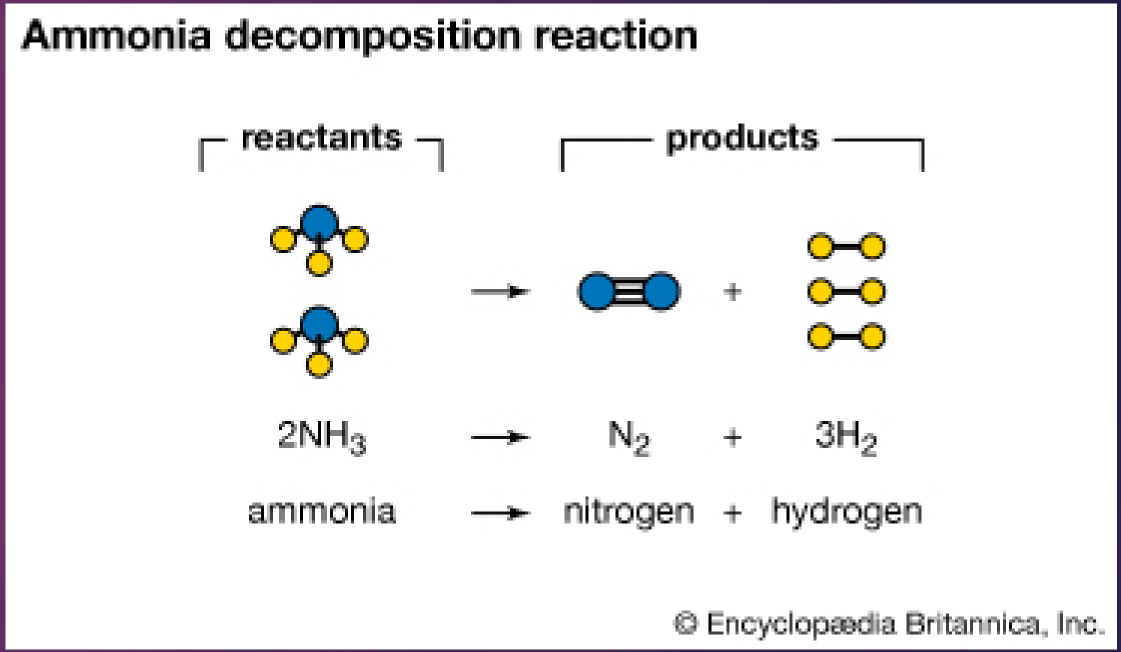
  By doing this we have created 2 K on the right so we have to balanced it on the left with a 2

  Our chemical equation is now balanced.

- 4. __2__ NH_3 → ___ N_2 + __3__ H_2

There are no polyatomic so we will balanced the H first since it is the largest number of atoms. There are 3H on the left and 2H on the right. In order to balanced this we will have place a 2 on the left and a 3 on the right.

Our chemical equation is now balanced.



Don’t forget that CO_2 has oxygen as well.

- 5. ___CH_4 + _2_O_2 → ___ CO_2 + _2_ H_2O

Since this is a hydrocarbon combustion we will use the C-H-O method of balancing.

Our carbons are balanced so we will move on to H, we have 4H on the left and only 2 on the right so we need to place a 2 in front of H_2O

By doing this we now have 4 oxygen on the right and only 2 on the left.

We now have to place a 2 on the left in front of O_2 to balanced the oxygen and we are done.

- 6. _3_ Li + ___ $AlBr_3$ → _3_ LiBr + ___ Al

No polyatomic so we will start with Br_3. We need a 3 in front of LiBr

Now we need a 3 in front of the Li

Our equation is now balanced

- 7. _3_ $Ca(NO_3)_2$ + _2_ Na_3PO_4 → ___ $Ca_3(PO_4)_2$ + 6 ~~2~~ $NaNO_3$

We have two polyatomic ions in this case so we can start with either **BUT** one may will work easily and the other will not.

There are 2 NO_3 on the left so we will place a 2 in front of the $NaNO_3$ on the right.

Now we need to balance the Na, as you can see there are 3Na already on the left and we just made 2 on the right, this will not work.

We will now try balancing PO_4 first. There is 1 on the left and two on the right so we will place a 2 in front of Na_3PO_4

Now we need to balanced the Na, there are 6 on the left so we need to place a 6 in front of $NaNO_3$

Next we will balance the NO_3, there are 6 on the right and two on the left so we need to place a 3 in front of $Ca(NO_3)_2$

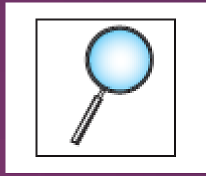
The chemical equation is now balanced

Worksheet #10

- Balancing Chemical Equations

Lab #3

- Chemical Reactions



Writing Equations from Words

- Substitute symbols and formulas for words, then balance each equation. Be sure to include **states of matter solid (s), liquid (l), gas (g), aqueous (aq - dissolved in water, solution, soluble)**, and indicate the type of reaction that is taking place.

1. To do these types of questions start by placing your ions above or below each ionic bond.
2. Next we will create the **skeleton equation**
3. Now it needs to be balanced
4. And finally states of matter need to be placed next to each ionic compound – your questions will have these written in words.

Na^+ Cl^- Pb^{2+} NO_3^- Pb^{2+} Cl^- Na^+ NO_3^-

- 1. sodium chloride + lead (II) nitrate → lead (II) chloride + sodium nitrate

$\underline{\ 2\ }\ NaCl_{(aq)} + \underline{\quad}\ Pb(NO_3)_{2(aq)} \rightarrow \underline{\quad}\ PbCl_{2\,(s)} + \underline{\ 2\ }\ NaNO_{3\,(aq)}$

Ag+ NO_3^{2-} K$^+$ CrO_4^{2-}

- 2. solid silver nitrate reacts with aqueous potassium chromate to yield a silver chromate precipitate and soluble potassium nitrate

Ag+ CrO_4^{2-} K+ NO_3^{2-}

Silver nitrate + potassium chromate → silver chromate + potassium nitrate

$\underline{\;2\;} AgNO_{3\,(s)} + \underline{\quad} K_2CrO_{4\,(aq)} \rightarrow \underline{\quad} Ag_2CrO_{4\,(s)} + \underline{\;2\;} KNO_{3\,(aq)}$

First we create a simple word equation

Next we write down the ionic compounds and create the **skeleton equation**

Now we balance it

Finally we write in the states of matter

Pb^{4+} NO_3^- Na^+ SO_4^{2-}

- 3. aqueous lead (IV) nitrate reacts with aqueous sodium sulfate to yield a lead (IV) sulfate precipitate and soluble sodium nitrate

Pb^{4+} SO_4^{2-} Na+ NO_3^-

lead (IV) nitrate + sodium sulfate → lead (IV) sulfate + sodium nitrate

$\_\_\_\_ Pb(NO_3)_{4\,(aq)} + \underline{\ 2\ } Na_2SO_{4(aq)} \rightarrow \_\_\_\_ Pb(SO_4)_{2\,(s)} + \underline{\ 4\ } NaNO_{3\ (aq)}$

write down the ionic compounds and create the **skeleton equation**

Now we balance it

Finally we write in the states of matter

Fe^{3+} O^{2-} Al^{3+}

- 4. solid iron (III) oxide reacts with solid aluminum metal to yield solid aluminum oxide and solid iron metal

Al^{3+} O^{2-} Fe^{3+}

Iron (III) oxide + Aluminum metal → aluminum oxide + Iron metal

$$\_\_\_\ Fe_2O_3\ _{(s)} + \underline{\ 2\ }\ Al\ _{(s)} \rightarrow \_\_\_\ Al_2O_3\ _{(s)} + \underline{\ 2\ }\ Fe\ _{(s)}$$

write down the ionic compounds and create the skeleton equation

Now we balance it

Finally we write in the states of matter

Mg^{2+} NO_3^- K^+ OH-

5. magnesium nitrate reacts in solution with potassium hydroxide to yield a magnesium hydroxide precipitate and soluble potassium nitrate

Mg^{2+} OH^- K^+ NO_3^-

magnesium nitrate + potassium hydroxide → magnesium hydroxide + potassium nitrate

$$\_\_\_\_ \ Mg(NO_3)_{2(aq)} + \underline{\ 2\ } \ KOH_{(aq)} \rightarrow \_\_\_\_ \ Mg(OH)_{2\ (s)} + \underline{\ 2\ } \ KNO_{3\ (aq)}$$

write down the ionic compounds and create the skeleton equation

Now we balance it

Finally we write in the states of matter

O_2 CO_2

- 6. When butene gas (C_4H_8) is burned in oxygen, carbon dioxide and water vapor are formed.

H_2O

butene + oxygen → carbon dioxide + water

$$\_\_\_\ C_4H_{8\,(g)} + \underline{\ 6\ }\ O_{2\,(g)} \rightarrow \underline{\ 4\ }\ CO_{2\,(g)} + \underline{\ 4\ }\ H_2O_{(g)}$$

Don't forget that oxygen exists as O_2

write down the ionic compounds and create the skeleton equation

Now we balance it using C-H-O

Finally we write in the states of matter

Worksheet #11

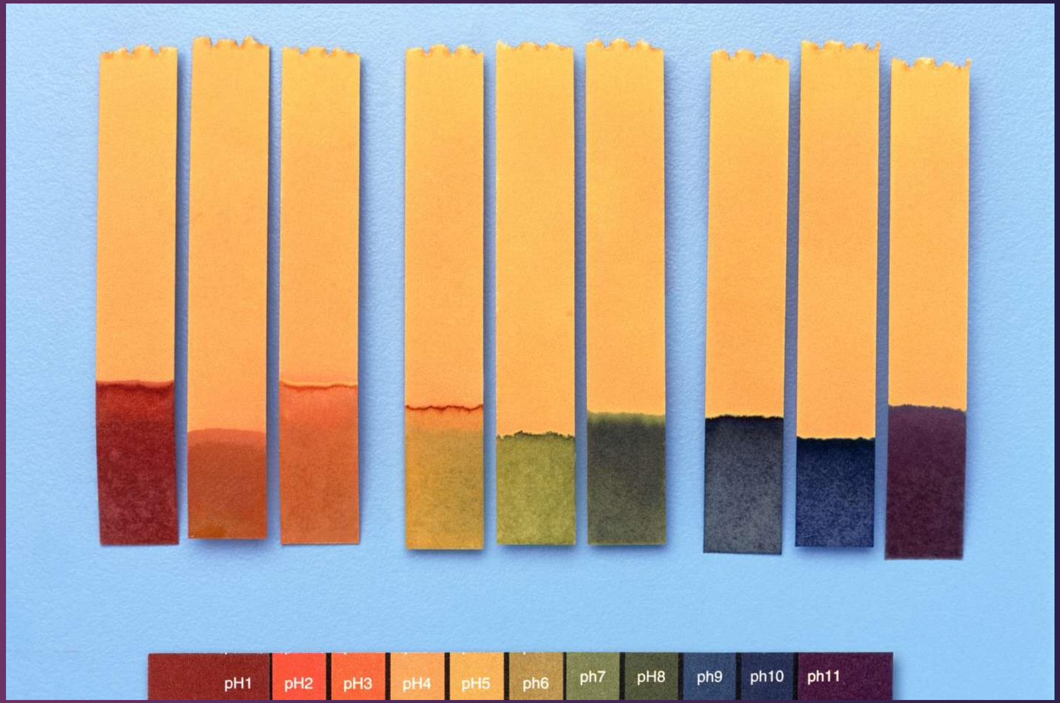
- **Word Equations – writing and balancing**

Exit Card #4: Writing and Balancing Chemical Equations

Ways to measure pH

- pH - potential of hydrogen - It is used to identify a substance as an acid, base or neutral

- Red litmus paper – turns blue in a base and stays red in an acid
- Blue litmus paper – turns red in an acid and stays blue in a base
- pH paper - paper saturated with pH indicators or a mixture of indicators.



Ways to measure pH

- pH meter - electric device used to measure hydrogen-ion activity (acidity or alkalinity) in solution.

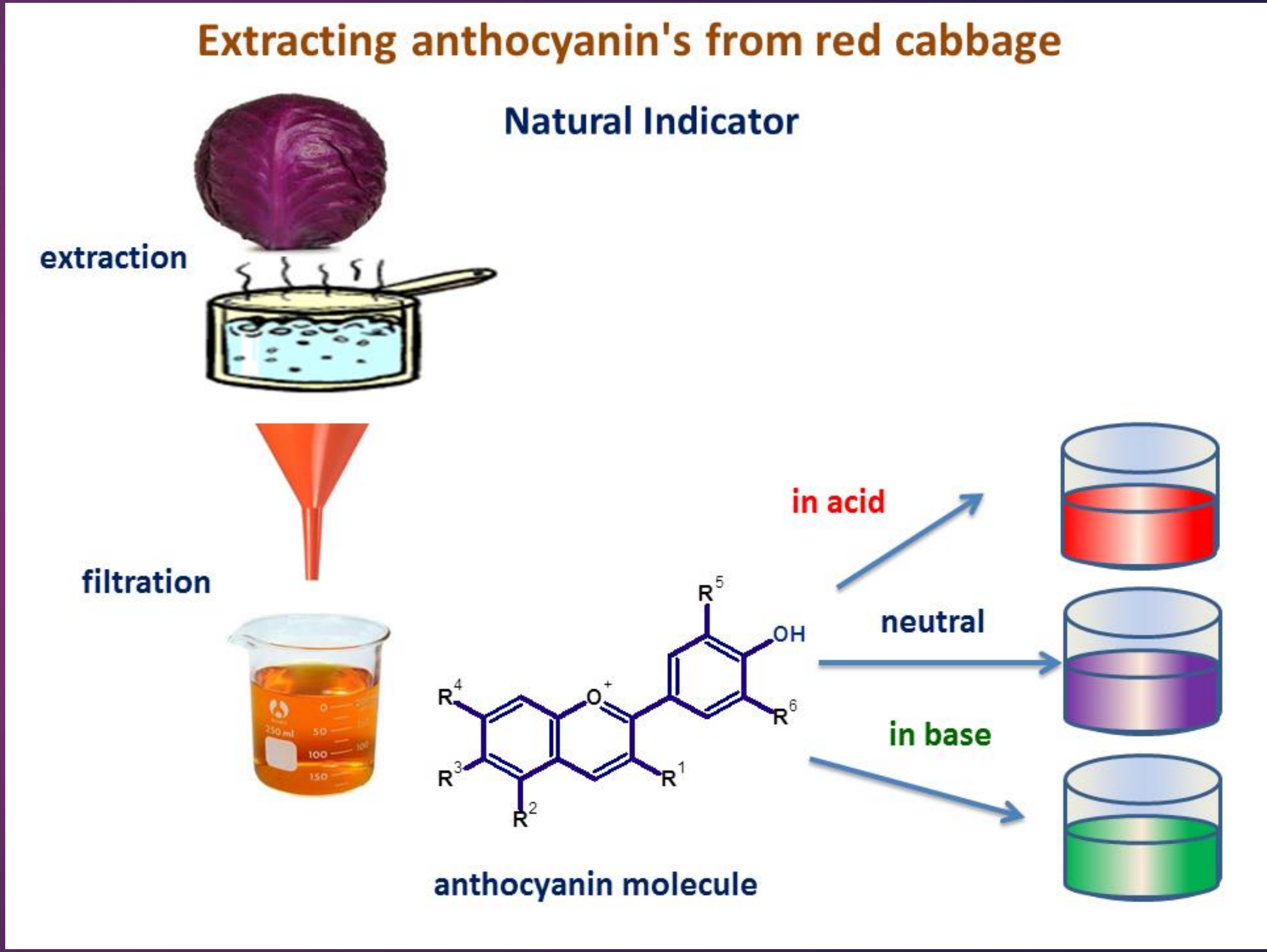
- Indicator solutions - are substances whose solutions change color due to changes in pH.
  - Methyl orange
  - Thymol blue
  - Methyl red
  - Thymolphthalein
  - Phenolphthalein - As an indicator of a solution's pH, phenolphthalein is colourless below pH 8.5 and attains a pink to deep red hue above pH 9.0.

Ways to measure pH

- **Universal indicator - is a pH indicator made of a solution of several compounds that exhibits several smooth colour changes over a wide range pH values to indicate the acidity or alkalinity of solutions.**

Ways to measure pH

- Natural indicator - a type of indicator that can be found naturally and can determine whether the substance is an acidic substance or a basic substance
- Red Cabbage Juice
- Herbal Teas - turmeric, grape juice, turnip skin, curry powder, cherries, beetroots, onion, tomato

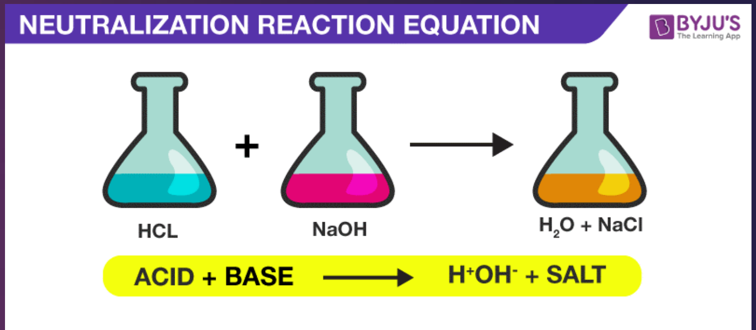


Acids and Bases

Property	Acid	Base
Taste	Sour taste (lemon juice, vinegar)	Bitter taste (coffee, baking soda)
Touch	Many will burn skin	Feels slippery and many will burn skin
Litmus Test Indicator Test	Turns blue litmus red	Turns red litmus blue
Reaction with metals	Yes (most)	No (most)
Electrical Conductivity	Conducts electricity	Conducts electricity
Solubility in Water	Yes (most)	varies
PH	< 7.0	> 7.0
Production of Ions	Hydrogen ions H^+ (aq)	Hydroxide ions OH^- (aq)

Neutralization Reactions

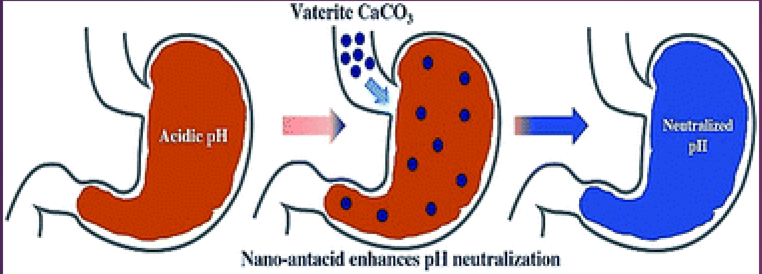
- Neutralization: the reaction of an acid with a base to form salt and water.
- Acid + Base → Water + Salt
- $2HCl_{(aq)} + Ba(OH)_{2(aq)} \rightarrow BaCl_{2(aq)} + 2H_2O_{(l)}$

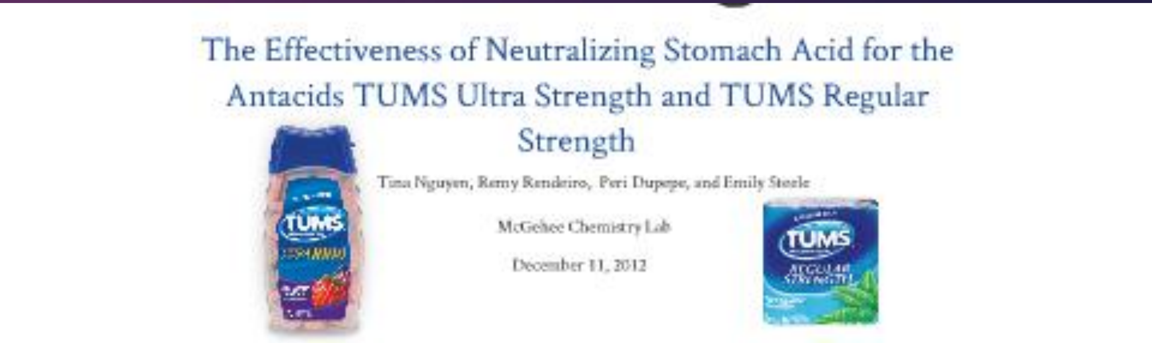


- Chemical reactions between an acid and a base (i.e., neutralization reaction) are also double replacement reactions; the ions switch places to form two new compounds, water and a salt.
- when an acid is added to a base or a base is added to an acid, the hydrogen (H+) and hydroxide ions (OH-) are removed from the solution, forming water molecules.
- Pure water has a pH of 7.
- As a result, the pH of the mixture approaches 7; becoming less acidic or less basic.

Common Neutralization Reactions

- **antacid use to treat heartburn;**





The Effectiveness of Neutralizing Stomach Acid for the Antacids TUMS Ultra Strength and TUMS Regular Strength

Tina Nguyen, Remy Rendeiro, Peri Dupepe, and Emily Steele

McGehee Chemistry Lab

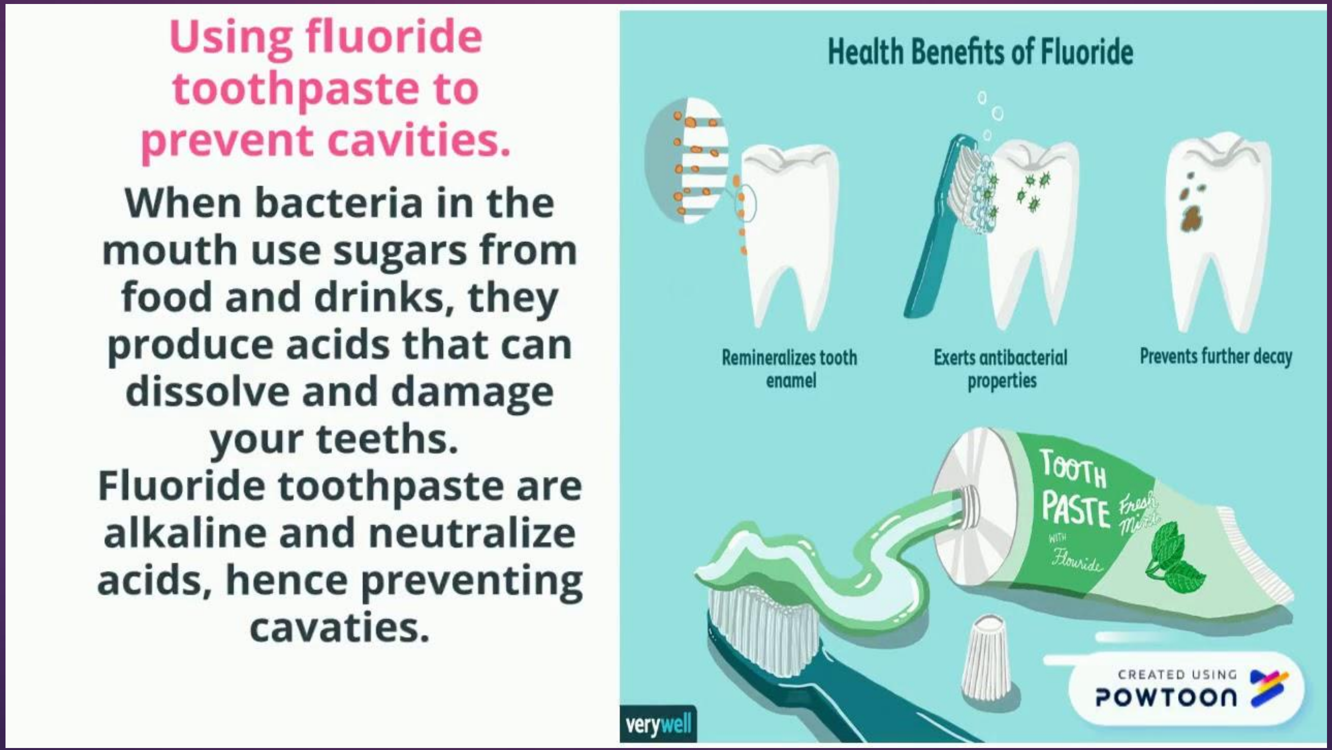
December 11, 2012

- **neutralizing fish odours with lemon juice;**

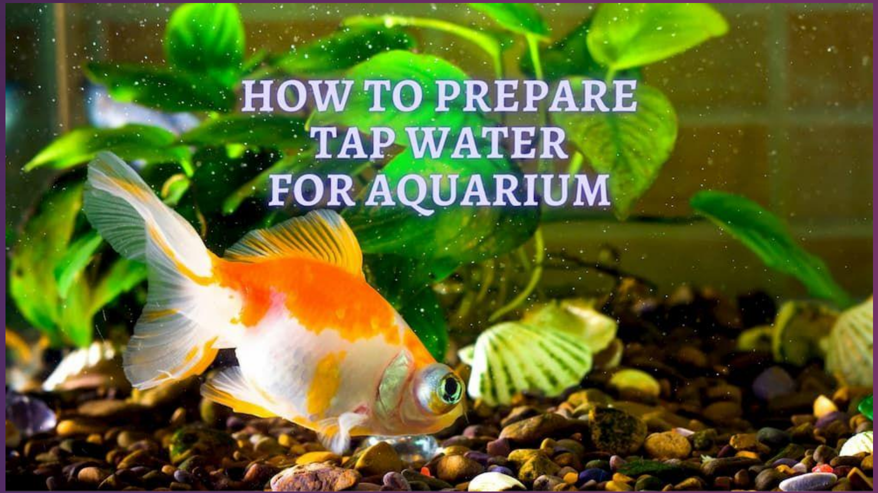
$$CH_3COOH + NH_2CH_2CH_2CH_2CH_2NH_2 \longrightarrow CH_3COO^- + NH_3^+CH_2CH_2CH_2CH_2NH_2$$

Acetic acid + Putrescine ⟶ Acetate ion + Putrescinium ion

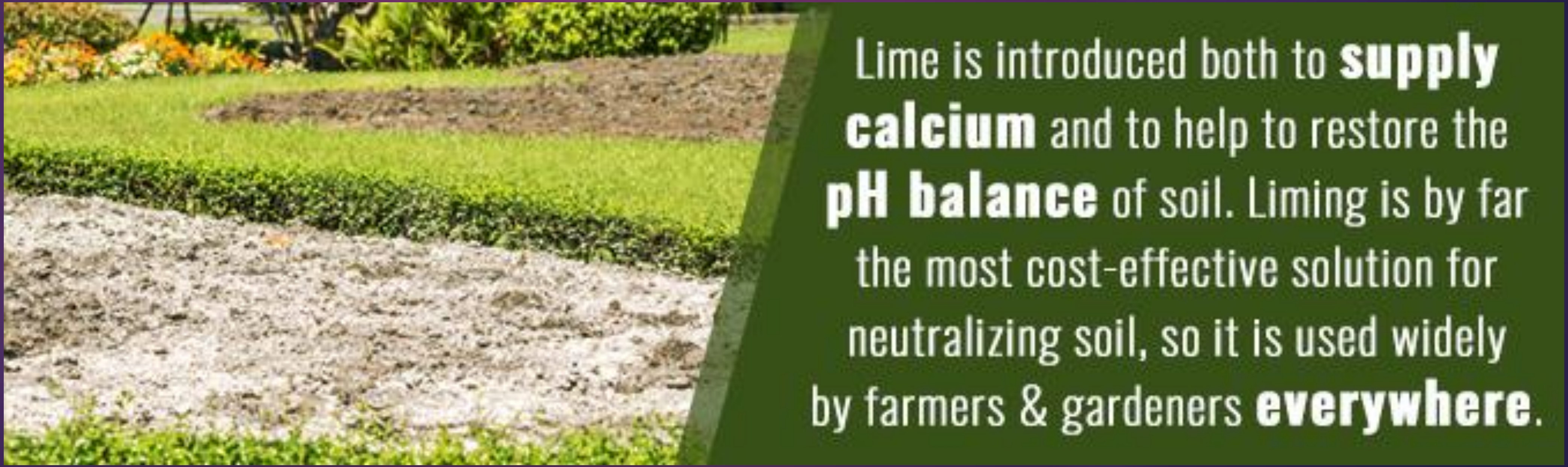
- using baking soda in the refrigerator to neutralize odours and in baking to react with acidic ingredients;
- using toothpaste to neutralize dietary acids that erode teeth;



- setting correct pH of water in aquariums, swimming pools, and hydroponic systems;



- **liming lawns**



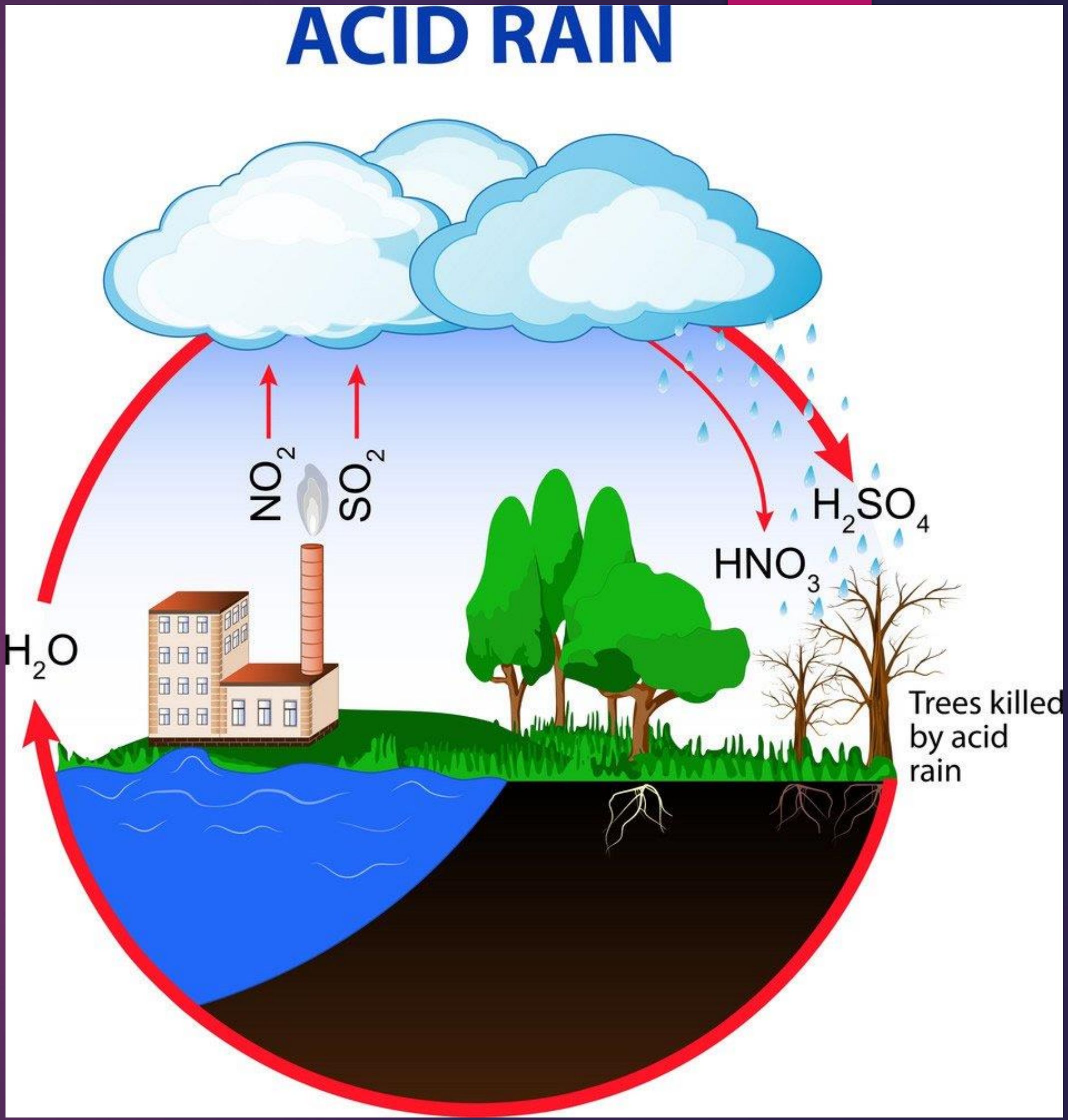
- Neutralization reactions also have industrial applications

- To neutralize acidic gases such as carbon dioxide and sulfur dioxide released from power stations to minimize pollution.
- In the rubber industry, ammonia solution, NH_4OH, is used to prevent the coagulation of latex because ammonia solution, NH_4OH, can neutralize the acid (lactic acid) produced by bacteria in the latex.

Natural Rubber – Coagulation of Latex

Acid Precipitation

- **Acid rain**, or acid deposition, is a broad term that includes any form of precipitation with acidic components, such as sulfuric or nitric acid that fall to the ground from the atmosphere in wet or dry forms. This can include rain, snow, fog, hail or even dust that is acidic.
- **calcium carbonate, $CaCO_3$, used in liming, reacts with and neutralizes environmental acids.**



Neutralization of Acids in the Environment

- **liming agricultural soils**

- **liming acidic bodies of water.**

Worksheet #12

- Acid or Base and balancing neutralization reactions

Exit Card #5: Acids and Bases

- Acid or Base

Lab #4

- Acid or Base

Chemistry Related Technologies

- **Carbon monoxide detectors:** sound an alarm when they sense a certain amount of carbon monoxide over time.
  - **Biomimetic sensor:** a gel changes color when it absorbs carbon monoxide, and this color change triggers the alarm.
  - **Metal oxide semiconductor:** when the silica chip's circuitry detects carbon monoxide, it lowers the electrical resistance, and this change triggers the alarm.
  - **Electrochemical sensor:** electrodes in a chemical solution sense changes in electrical currents when they come into contact with carbon monoxide, and this change triggers the alarm.

- Catalytic converters use reactions to reduce harmful emissions.
- reduce nitrogen oxides (NOx) by removing nitrogen atoms from nitrogen oxide molecules (NO and NO_2). This lets the free oxygen form oxygen gas (O_2). Then, the nitrogen atoms attached to the catalyst react with each other. This reaction creates nitrogen gas (N_2).
- helps reduce hydrocarbons (HC) and carbon monoxide (CO). To start with, carbon monoxide and oxygen combine to form carbon dioxide (CO_2). Then, unburnt hydrocarbons and oxygen combine to form carbon dioxide and water.

Nitric acid	$2NO \rightarrow N_2 + O_2$
Nitrogen dioxide	$2NO_2 \rightarrow N_2 + 2O_2$

Reaction #1	$2CO + O_2 \rightarrow 2CO_2$
Reaction #2	$HC + O_2 \rightarrow CO_2 + H_2O$

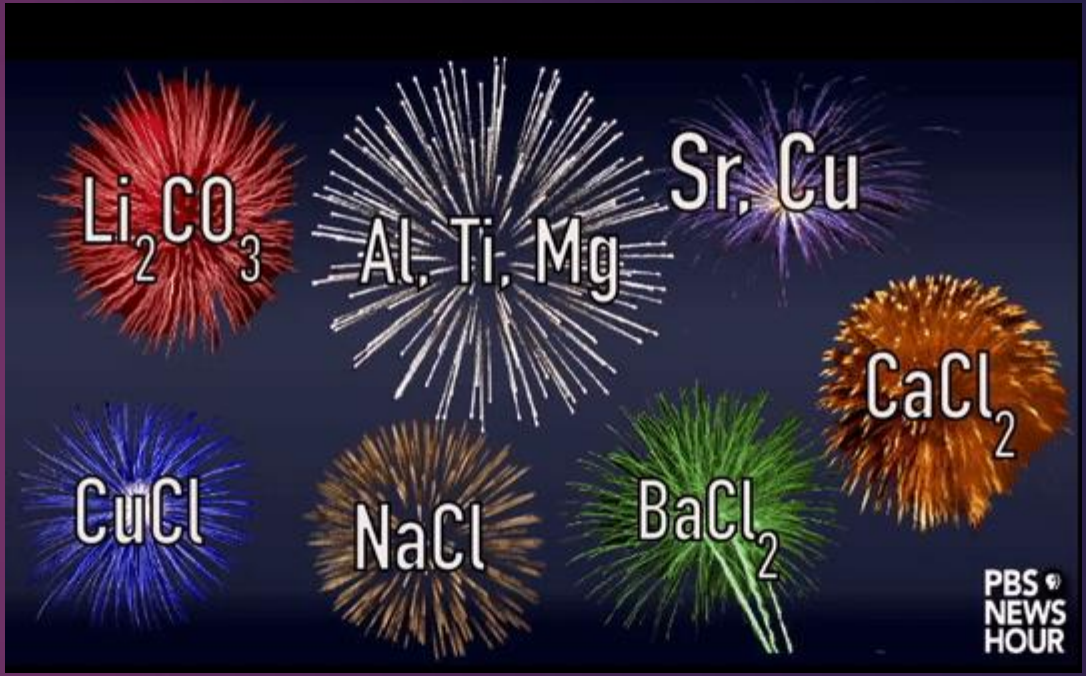
- Chemical Heating Pads
- Disposable chemical pads employ a one-time exothermic chemical reaction. One type, frequently used for hand warmers, is triggered by unwrapping an air-tight packet containing slightly moist iron powder and salt or catalysts which rusts over a period of hours after being exposed to oxygen in the air.

- Deicing Salts

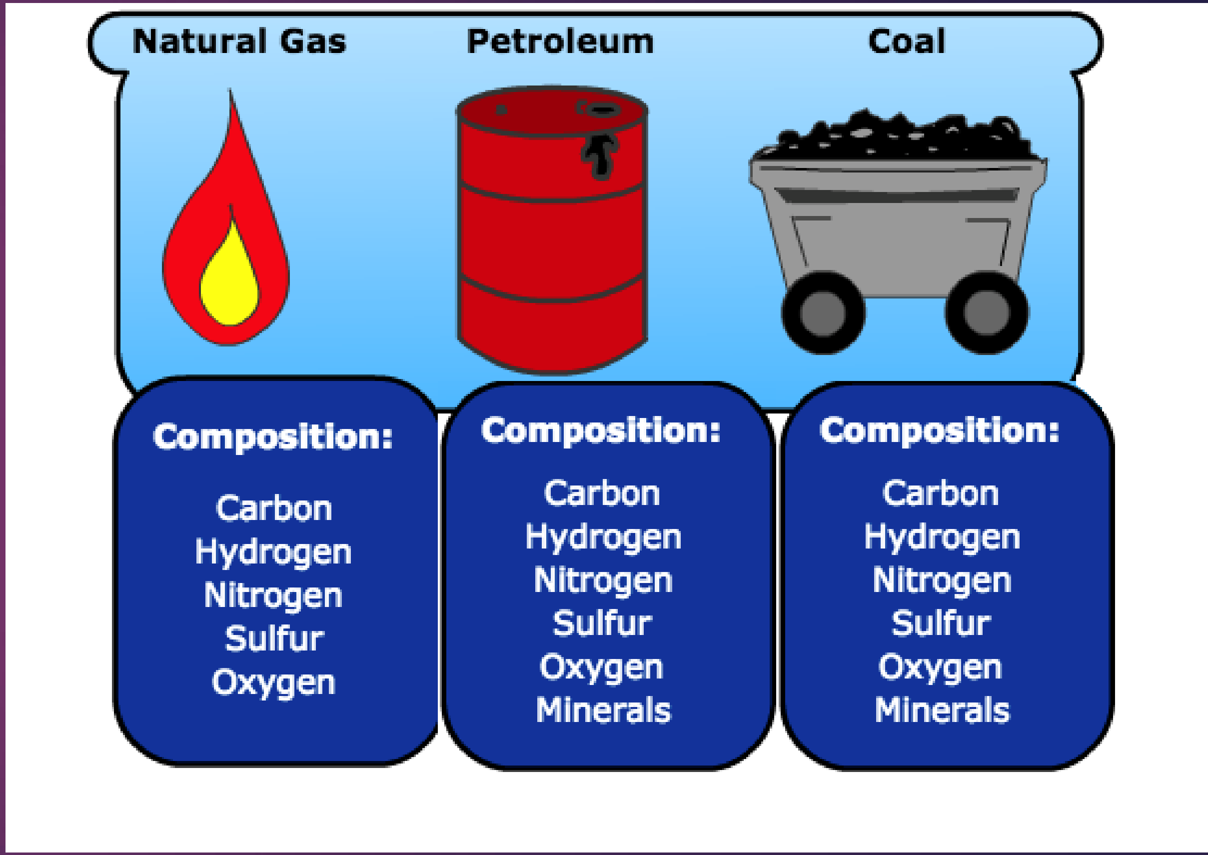
- A deicer is a substance that melts or prevents the formation of ice, and does so by lowering the freezing point of water and preventing a bond between ice and paved surfaces.

- the freezing point of water; plain water freezes at 0°C, but when there's salt in it, it stays liquid at colder temperatures.
- For example, a water solution that contains 10 per cent salt will stay liquid until its temperature reaches –6°C.

- Fireworks
- three reagents, potassium nitrate, carbon, and sulfur, make gunpowder. You're doing a combustion reaction out of those types of materials that creates this detonation explosion. Those three reagents react to make solid potassium carbonate, solid potassium sulfate, nitrogen gas, and carbon dioxide gas, so you have solid reagents reacting to make gases.

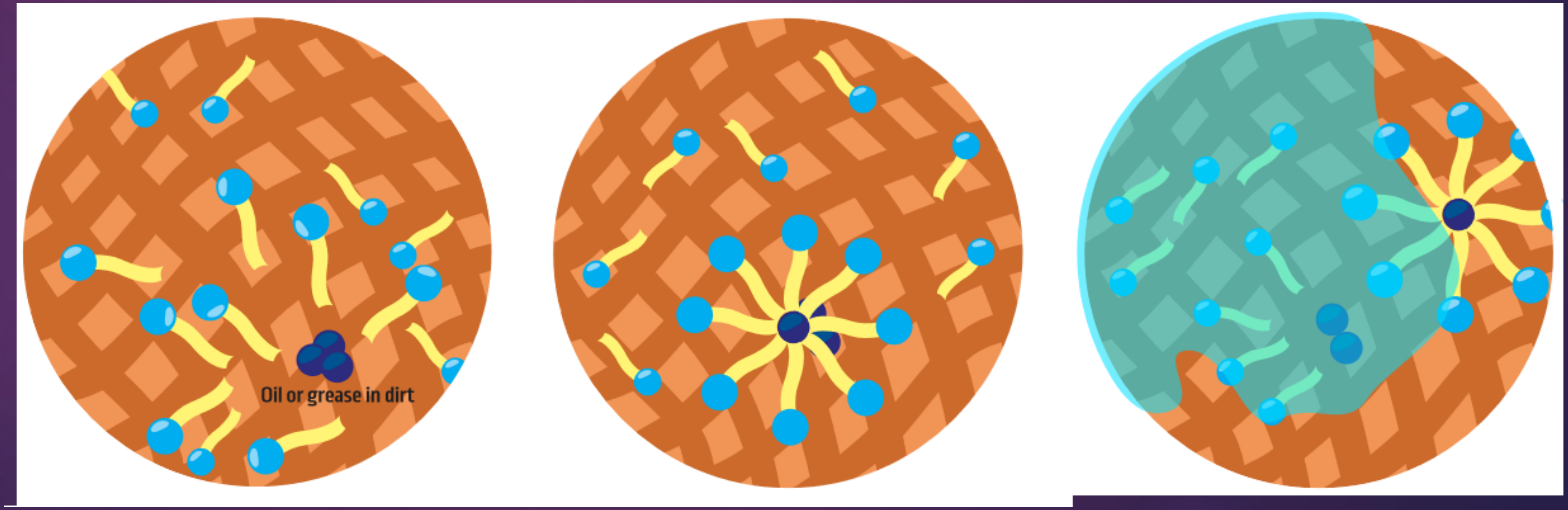


- **Fuels**
- Hydrocarbon combustion is a chemical process in which a substance reacts rapidly with oxygen and gives off heat. The original substance is called the fuel, and the source of oxygen is called the oxidizer. The fuel can be a solid, liquid, or gas.

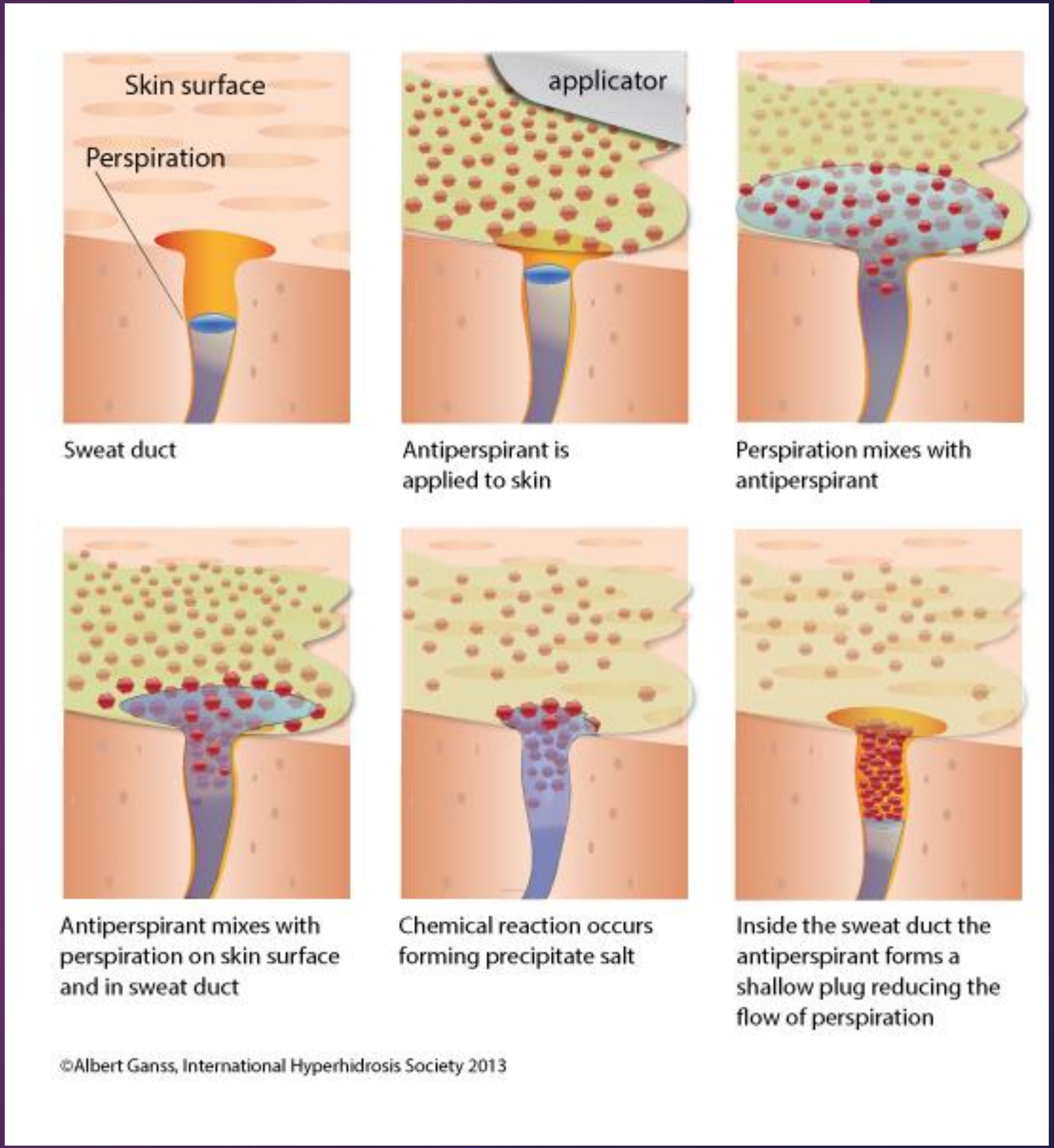


- **Household Cleaners (surfactants)**

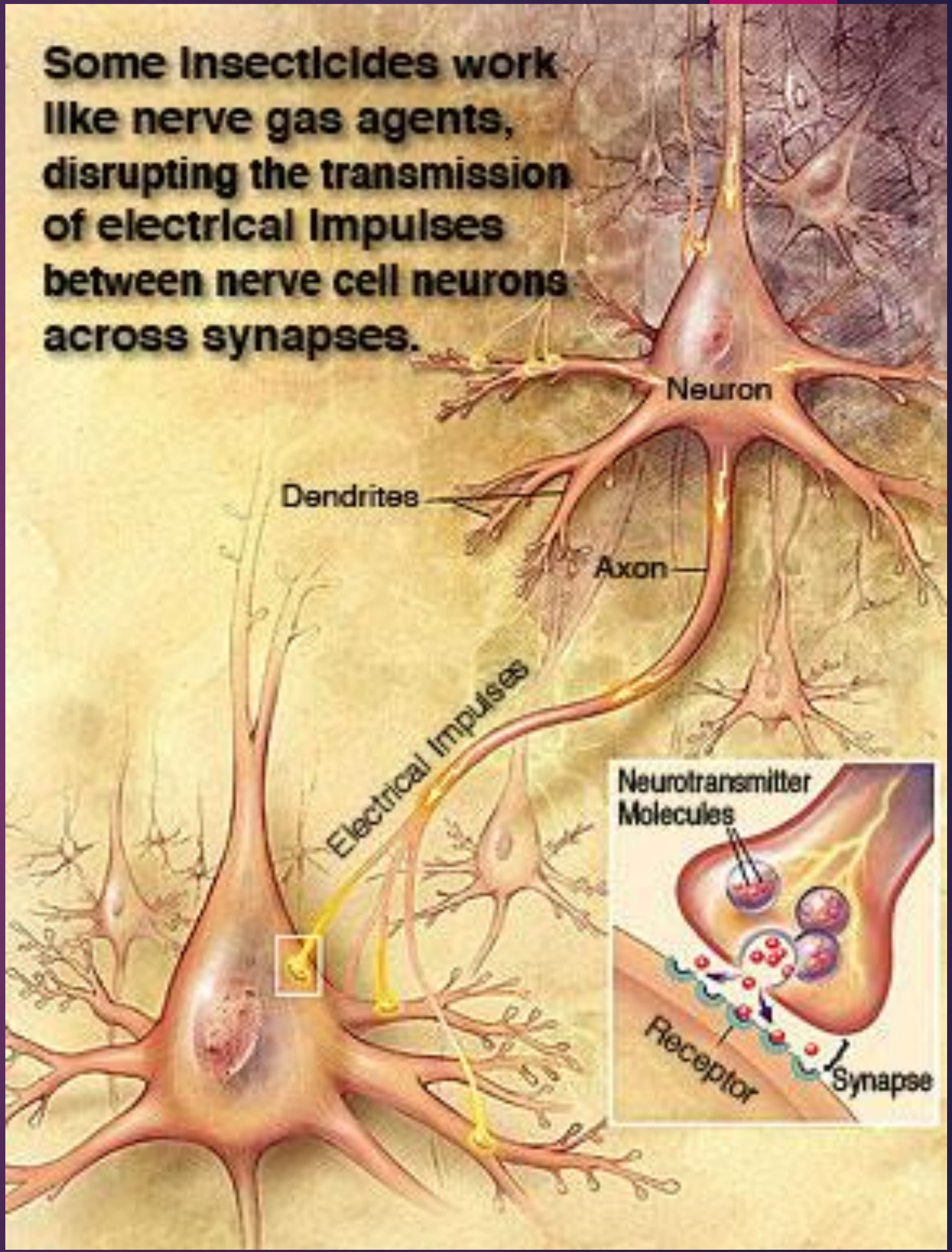
- Adding relatively tiny amounts of a chemical compound called a surfactant radically changes the properties of water. The surfactant is able to interfere and prevent the hydrogen bonding allowing a cleaning solution to penetrate and lift dirt from surfaces.



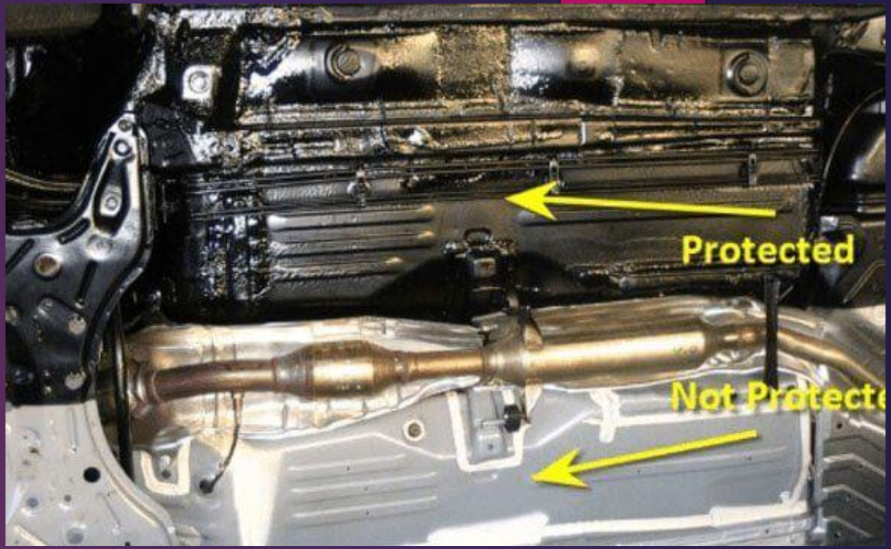
- **Hygiene Products**
  - **Antiperspirants** - Aluminium-based antiperspirants work by **blocking the sweat ducts,** thereby reducing the amount of sweat that reaches the skin's surface. Aluminium salts are soluble as long as the formulation is acidic (low pH). When they are applied to the skin and come in contact with sweat, the pH rises causing the **aluminium salts to precipitate out and form a plug over the sweat glands.** Sweat continues to be produced by the sweat gland but it just isn't able to reach the surface of the skin.



- **Pesticides**
- Most pesticides work by **affecting the nervous system** of the insect. The pesticide interrupts the information being sent by neurotransmitters in the synapses. The chemical produced by the body used to send information through the synapses is called acetycholine.



- **Rust Proofing (two ways)**
- The industry standard for vehicle rust-proofing is an **oil-spray treatment.** Through a combination of oil's well-known inability to mix with water and the rust-inhibiting compounds mixed in with that oil.



- **Electronic rust proof protection system** this little device can be easily installed by a mechanic, and works by issuing a weak electric current throughout the metal of the vehicle. This current interferes with the charge between the metal and oxygen, thus stopping rust from forming.

Science Watch

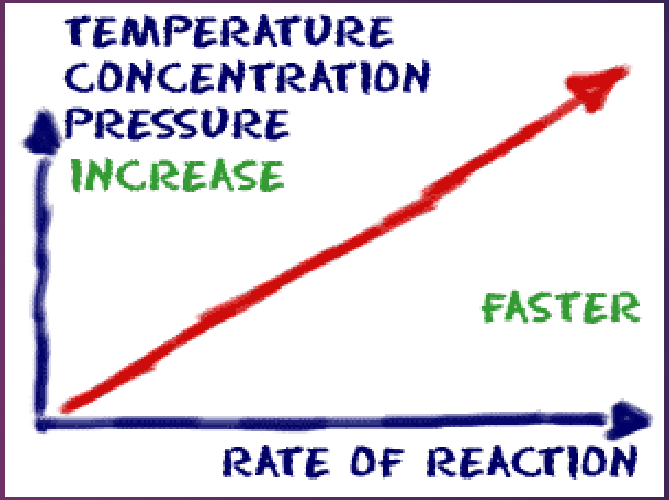
- **Green Chemistry   Green Medicine**

Lab #5

- Reaction Rates

Reaction Rates

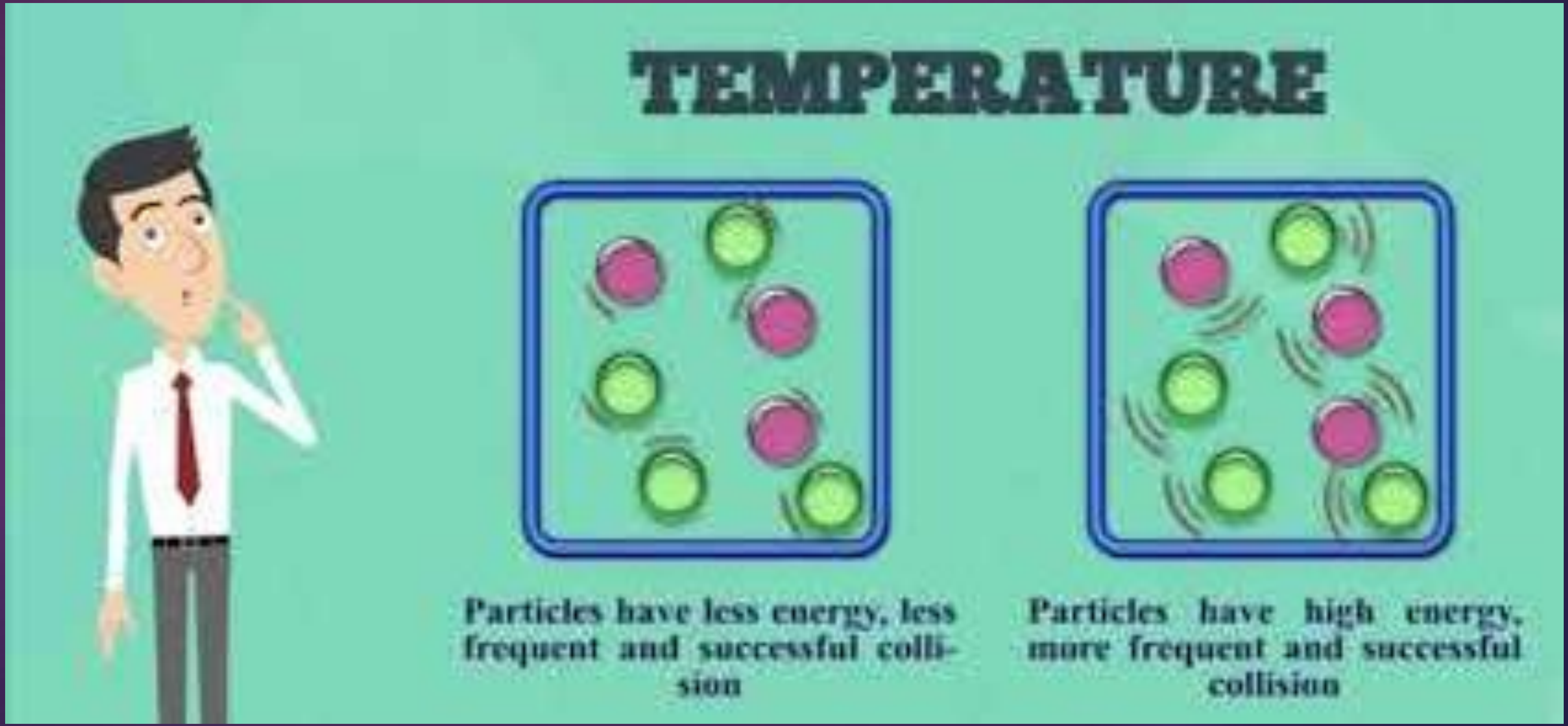
- Changing those conditions causes the reaction rate to speed up or slow down. Increasing the following will cause the rate of reaction to increase
  - temperature
  - concentration/pressure
  - light
  - surface area
  - catalyst



- **Collision theory** explains why different reactions occur at different rates, and suggests ways to change the rate of a reaction.
- **Collision theory states that for a reaction to occur reactants must collide with one another with correct orientation and sufficient energy to break their bonds.**
- **The rate of the reaction depends on the frequency of collisions.**

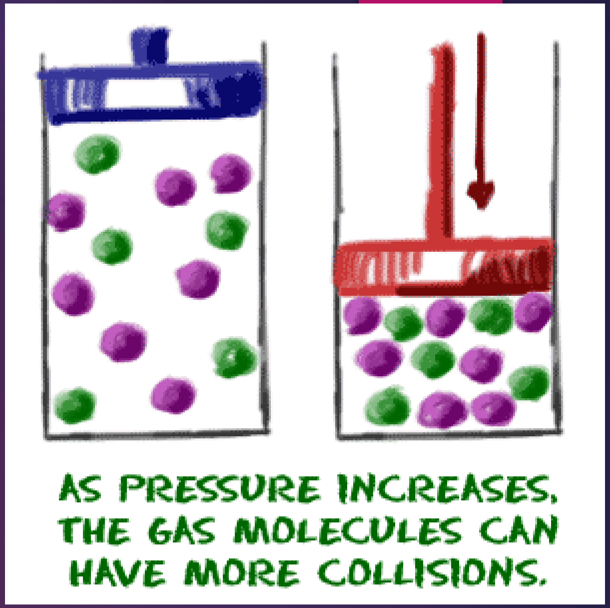
Heat

- An increase in temperature typically increases the rate of reaction. An increase in temperature will raise the average kinetic energy of the reactant molecules. Therefore, a greater proportion of molecules will have the minimum energy necessary for an effective collision



Concentration/Pressure

- **If you increase the concentration of a reactant, there will be more of the chemical present. More reactant particles moving together allow more collisions to happen and so the reaction rate is increased. The higher the concentration of reactants, the faster the rate of a reaction will be.**

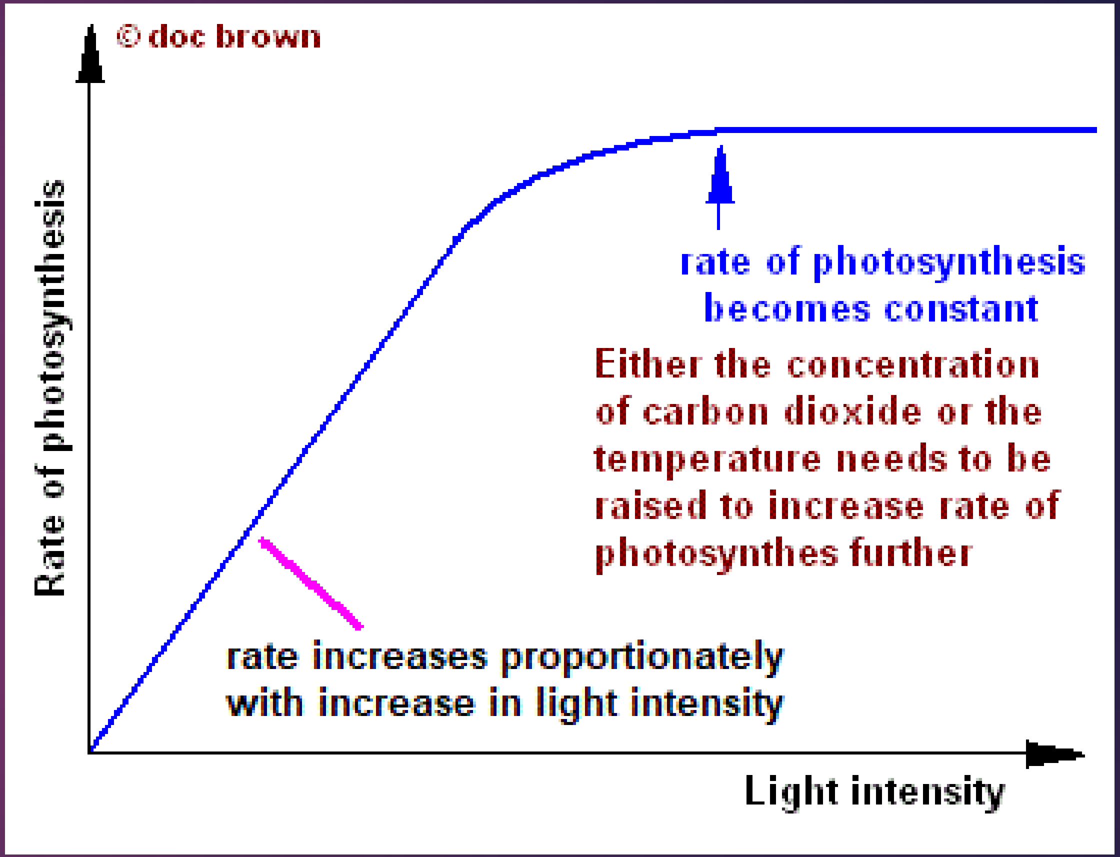


Low Concentration, Less chance of Collisions.

High Concentration, more chance of Collisions.

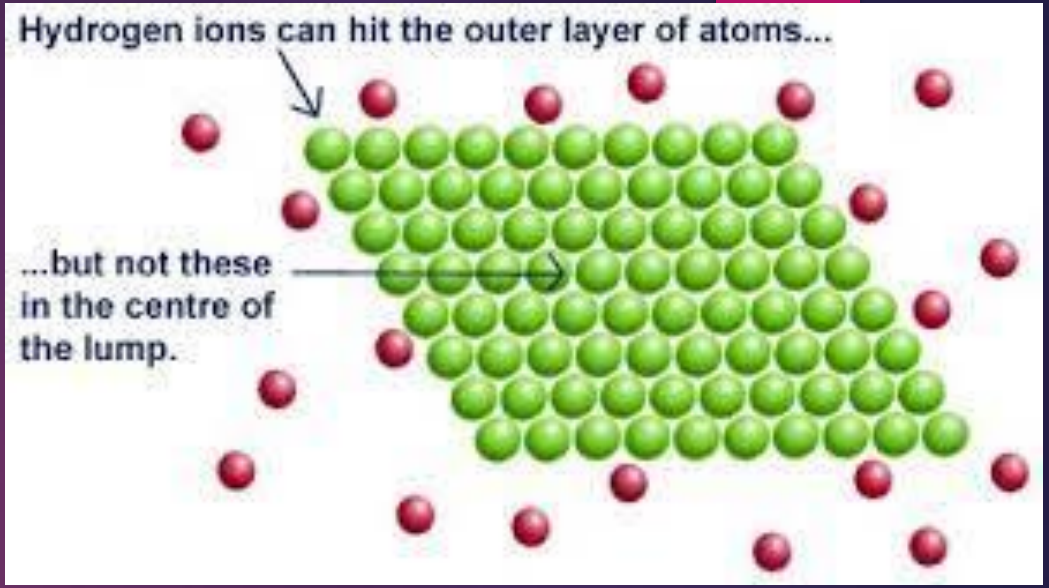
Light

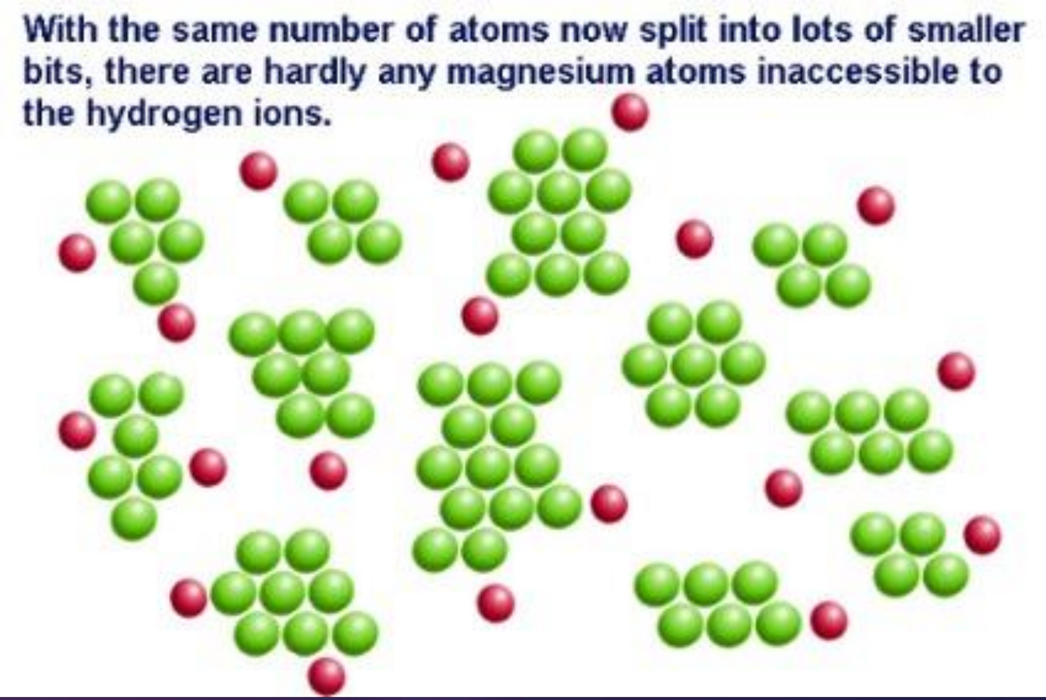
- The greater the intensity of light (visible or ultra-violet) the more reactant molecules are likely to gain the required energy (activation energy) and react, so the reaction speed increases - greater frequency of initiation.
- the chemical reaction for photosynthesis.
-
- $6CO_2 + 6H_2O \rightarrow C_6H_{12}O6 + 6O_2$



Surface Area

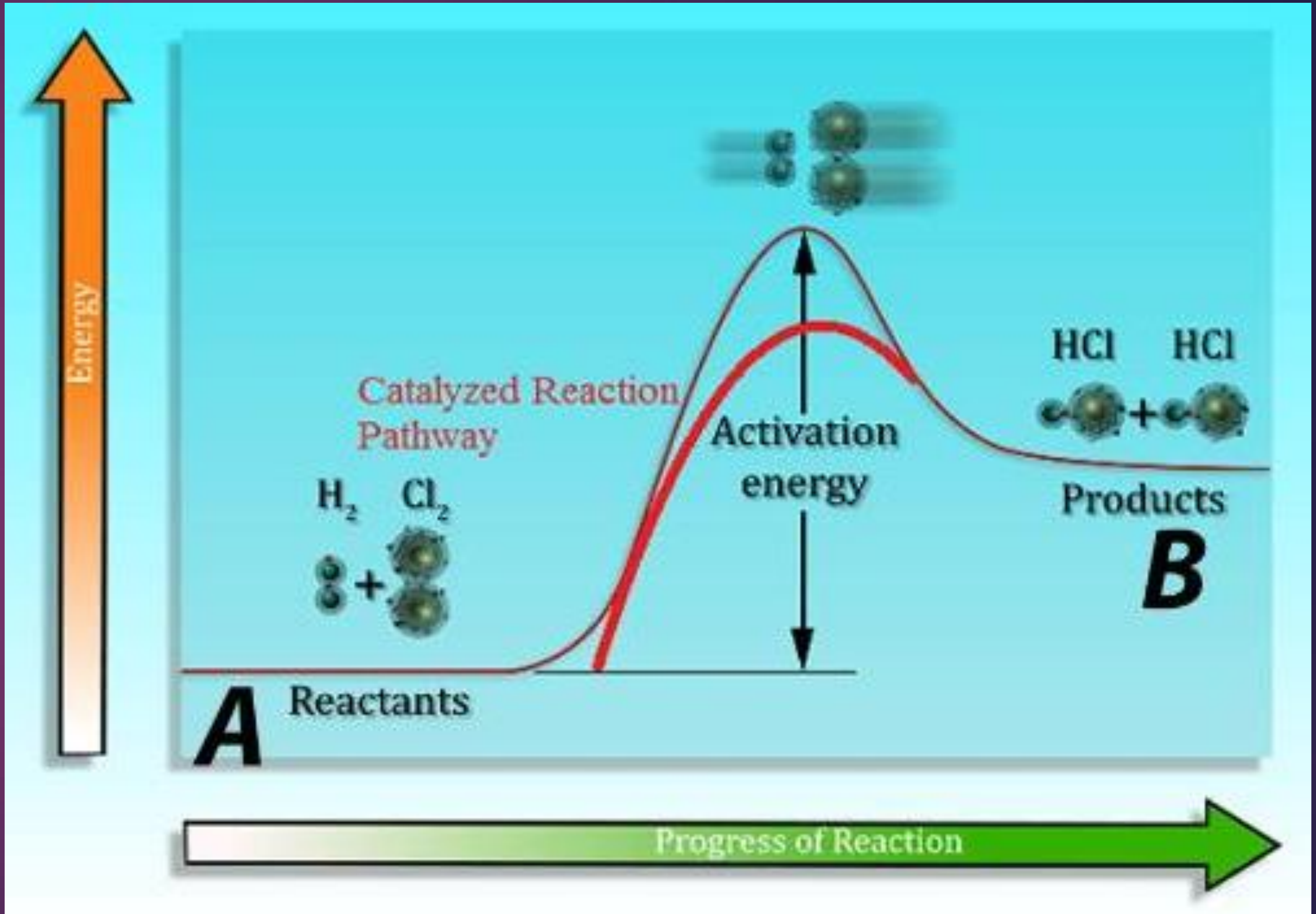
- **The rate of a chemical reaction can be raised by increasing the surface area of a solid reactant. This is done by cutting the substance into small pieces, or by grinding it into a powder. If the surface area of a reactant is increased: the rate of reaction increases.**





Catalyst

- **Catalysts can lower the activation energy and increase the reaction rate without being consumed in the reaction. Differences in the inherent structures of reactants can lead to differences in reaction rates.**



Chemistry Related Careers

- If you have a particular interest in or aptitude for chemistry, or if you hold or are currently working towards a chemistry degree, you may wish to find out about potential careers in the industry. Chemistry jobs vary in nature, salary, and required qualifications; the information and list below is intended to help you to judge the right chemistry career for you.

- Analytical Chemist
- Chemical Engineer
- Chemistry Teacher
- Forensic Scientist
- Geochemist
- Hazardous Waste Chemist
- Materials Scientist
- Pharmacologist
- Toxicologist
- Water Chemist

Analytical Chemist

- **Analytical chemists use their skills and expertise to analyze substances, identify what components are present and in what quantities, as well how these components may behave and react with one another. This can include the analysis of drugs, food and other products to determine effectiveness, quality and to ensure they are safe for human consumption or use.**

Chemical Engineer

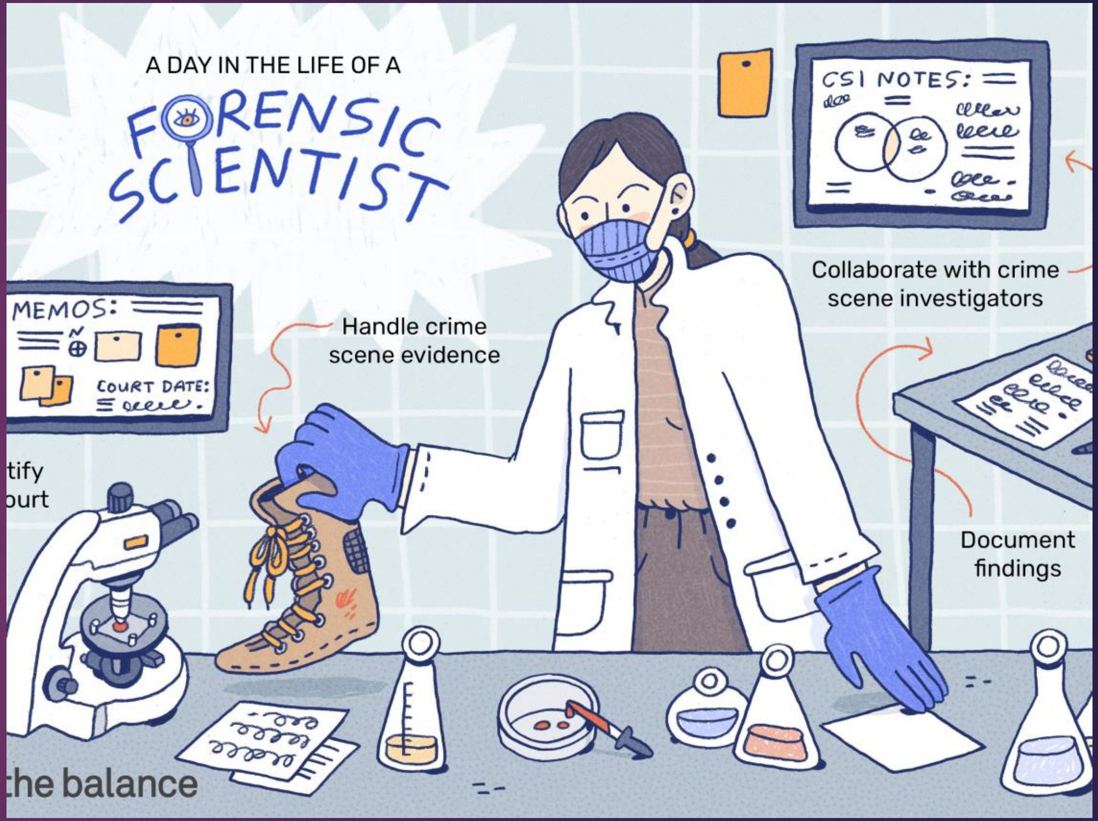
- Chemical engineers are involved the design and development of new products from raw materials. They use their knowledge of chemical properties and reactions to transform materials from one state to another, for example making plastic from oil.
- Chemical engineers may work in almost any industry, assisting in the production of innovative, high-end products such as ultra-strong fabrics or biocompatible implants.

Chemistry Teacher

- Chemistry teachers **work in schools passing on their knowledge of chemistry** to the next generation, following a set curriculum and helping their students to pass and excel in their school examinations. As well as a degree or equivalent qualification in chemistry, also require a teaching qualification in order to become a chemistry teacher.

Forensic Scientist

- **Forensic scientists search for and analyse forensic materials found at crime scenes, for example blood and other bodily fluids, hair, or non-biological substances such as paint. They are then able to present this evidence for use in legal investigations and courts of law. Forensic scientists may sometimes be called in to speak in court as experts in their field, to explain the evidence to the jury.**



Geochemist

- Geochemists **study the physical and chemical properties of the Earth, particularly rocks and minerals.** They use their knowledge to determine the make-up and distribution of rock and mineral components, and how these may affect the soil and water systems in which they are found. Geochemists may help to identify oil drill sites, improve water quality or determine how best to remove hazardous waste.

Hazardous Waste Chemist

- **Hazardous waste chemists deal with the management and safe relocation of hazardous materials (hence the common abbreviation ‘hazmat’). They use their expertise to identify harmful chemical components in the air, water or soil, evaluate the danger they present and coordinate their removal and containment.**

Materials Scientist

- Materials scientists study man-made and natural substances to determine their properties, composition and how they could be transformed or combined to increase effectiveness or create new materials. By analyzing and experimenting with existing materials, materials scientists are able to enhance the way they are used and create new materials to better serve humanity's needs.

Pharmacologist

- **Pharmacologists undertake the development and testing of drugs, analyzing how they interact with biological systems. This is essential for ensuring that drugs are effective and safe for human use, and may involve the testing of drugs on animals or on human volunteers. Pharmacology roles are often lab-based and may involve non-standard hours in order to monitor ongoing experiments.**

Toxicologist

- Toxicologists, like pharmacologists, may study the effects of drugs on biological systems but also look at the effects of other substances, both natural and man-made. They work with and develop methodologies for determining harmful effects of substances, as well as how to judge correct dosages and therefore avoid them. As with pharmacology, toxicology roles are often lab-based and involve the monitoring of experiments and interpretation of results.

Water Chemist

- Water chemists, as the name suggests, are concerned with **analyzing and maintaining the quality and condition of water, essential for human life on Earth.** This is a highly interdisciplinary field, so as well as chemistry you may also need knowledge of linked fields such as microbiology and geology. You may find similar roles under a variety of names, for example hydrologist or hydrogeologist.

Science Watch

- **Testing, testing, …with Tox21**

Test

- Format:
- 15 mc (15 Marks)
- 5 short answer (10 Marks)

- Time to complete
- 45 mins in class
- 1 h 15m extended time IF you go to the LRC room 212/214.