

# Grade 11 Chemistry

Chemical Reactions

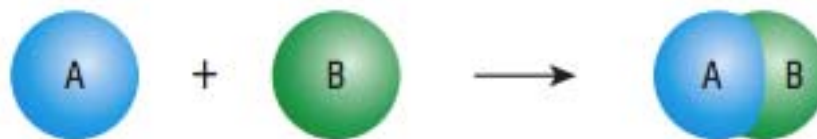
Class 5

## Types of Reactions

- Synthesis
- Decomposition
- Combustion
- Single Displacement
- Double Displacement
  - Precipitation
  - Neutralization

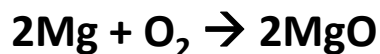
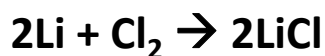


# Synthesis Reactions



## 1) Synthesis of Ionic Compounds

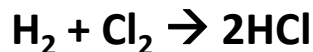
- Use ionic charges of the reactants to predict the product



## 2) Synthesis of Molecular Compounds

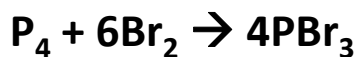
### a) Reactions involving Hydrogen

- Treat Hydrogen as +1 and still use ionic charges for nonmetals



### b) Reactions not involving Hydrogen

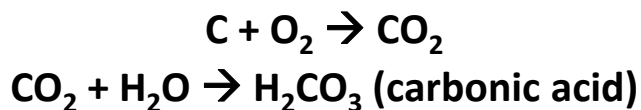
- Combine the two non-metals to form the compound
- Difficult to predict; requires experiments



### 3) Synthesis Involving Oxides

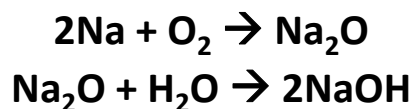
#### a) Acidic Oxides

- Non-metals + Oxygen  $\rightarrow$  Non-metallic oxides
- Non-metallic oxides + Water  $\rightarrow$  Acidic oxides



#### b) Basic Oxides

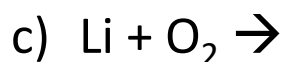
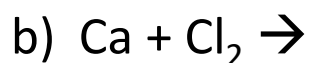
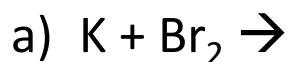
- Metals + Oxygen  $\rightarrow$  Metallic oxides
- Metallic oxides + Water  $\rightarrow$  Basic oxides



## Checkpoint



Predict the products of each reaction and balance the chemical equations.



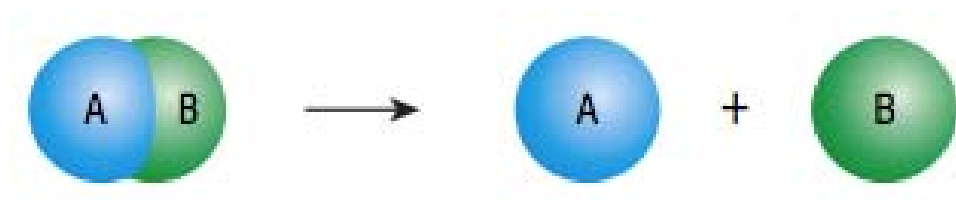


## Checkpoint



Show the synthesis of calcium oxide and show the reaction of calcium oxide with water.

## Decomposition Reactions



### 1) Simple Ionic or Molecular Compounds

- Compound breaks down into its elements



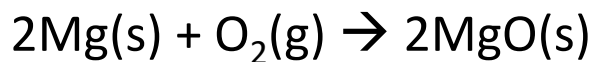
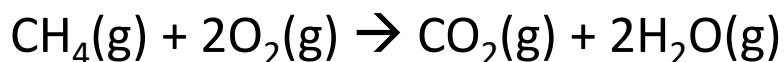
## 2) Decomposition of Complex Compounds

- Breaks down into simpler compounds
- Difficult to predict
- Carbonates  $\rightarrow$  Metal oxide +  $\text{CO}_2$

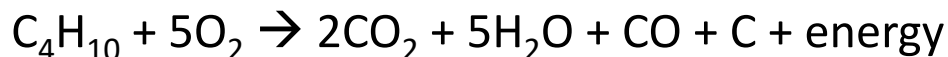


## Combustion Reactions

- **Complete Combustion:** The reaction of a compound or element with sufficient  $\text{O}_2$  to form an oxide



- **Incomplete Combustion:** a combustion reaction without sufficient oxygen



**BRAMPTON** March 17, 2014 5:30 pm

### Suspected carbon monoxide poisoning kills 3 in Brampton

By David Shum Global News

Facebook 718 Twitter 71 Email Print ...



Police believe carbon monoxide caused the deaths of three members of the same Brampton, Ont., family early Monday when propane heaters were brought into the home after the furnace stopped working in frigid conditions.

ABOVE: A tragic mistake claims the lives of three family members, and leaves a community devastated. Global's Laura Zilke reports.

TORONTO - A mother, her husband and son are dead following a suspected carbon monoxide poisoning incident at a home in Brampton early Monday morning.

Police say they received a 9-1-1 call at a residence on Linden Crescent near Dixie Road and Howden Boulevard around 2 a.m.



## Checkpoint



Write the balanced chemical equation for each of the following questions:

- Complete combustion of  $\text{CH}_3\text{OH}$
- Complete combustion of octane ( $\text{C}_8\text{H}_{18}$ )

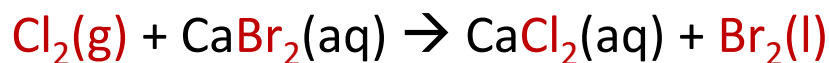
# Single Displacement



- Metal replaces a metal cation

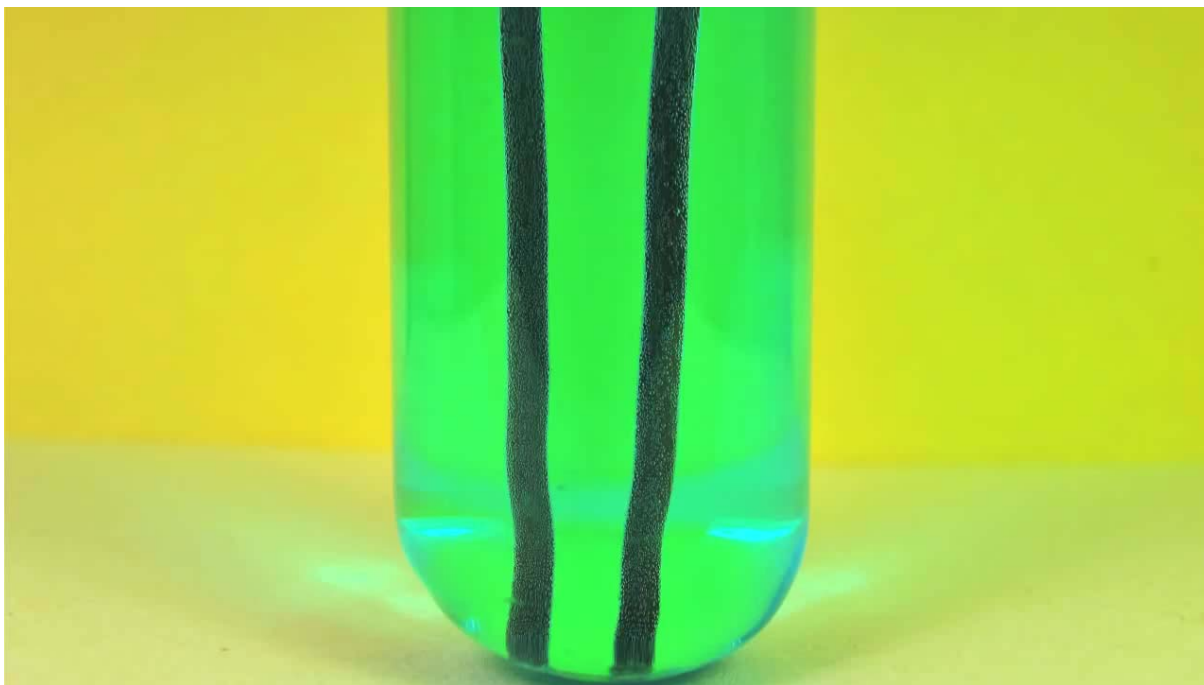


- Non-metal replaces an anion



## General Guidelines:

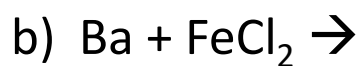
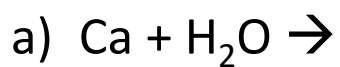
- Treat hydrogen as a metal with a +1 charge
- Treat acids such as HCl as ionic compounds of the form  $\text{H}^+\text{Cl}^-$ 
  - Ex:  $\text{Mg(s)} + 2\text{HCl(aq)} \rightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{(g)}$
- Treat water as ionic with the formula  $\text{H}^+(\text{OH})$ 
  - Ex:  $2\text{Na(s)} + 2\text{HOH(l)} \rightarrow 2\text{NaOH(aq)} + \text{H}_2\text{(g)}$



## Checkpoint






Write the products of the following single displacement reactions and balance the equation





# Metal Activity Series

- Not all single displacement reactions occur
- Depends on the reactivity of the metals
- **Metals above will displace metals below it**

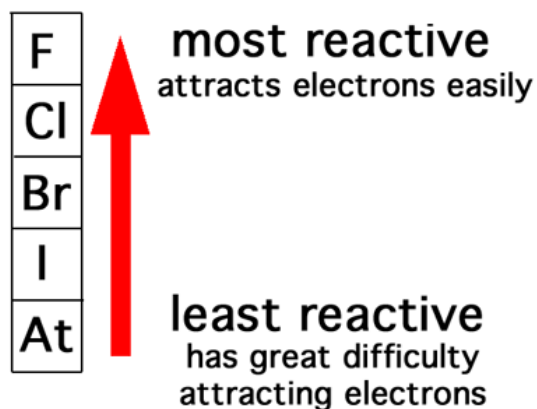
Metal	Displaces hydrogen from acids	Displaces hydrogen from cold water	
lithium			<div>Most Reactive</div>  <div>Least Reactive</div>
potassium			
barium			
calcium			
sodium			
magnesium			
aluminum			
zinc			
chromium			
iron			
cadmium			
cobalt			
nickel			
tin			
lead			
hydrogen			
copper			
mercury			
silver			
platinum			
gold			

Metal
lithium
potassium
barium
calcium
sodium
magnesium
aluminum
zinc
chromium
iron
cadmium
cobalt
nickel
tin
lead
hydrogen
copper
mercury
silver
platinum
gold

- Ex:  $\text{Fe(s)} + \text{CuSO}_4\text{(aq)} \rightarrow$ 
  - Since iron is above copper, the iron is more reactive and reaction will proceed
- Ex:  $\text{Ag(s)} + \text{CaCl}_2\text{(aq)} \rightarrow$ 
  - Since silver is lower in the reactivity series than calcium, there would be no reaction between these two substances

# Non-Metal Activity Series

- Non-Metals above will displace non-metals below it



- Ex:  $\text{F}_2(\text{g}) + 2\text{NaCl}(\text{aq}) \rightarrow 2\text{NaF}(\text{aq}) + \text{Cl}_2(\text{aq})$
- Ex:  $\text{I}_2(\text{aq}) + \text{CaBr}_2(\text{aq}) \rightarrow \text{NR}$



## Checkpoint



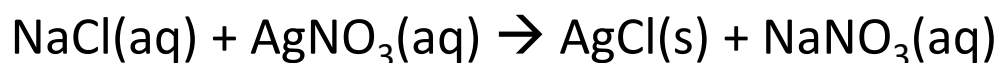
Write the products of the following single displacement reactions and balance the equation. Write "NR" if you predict that no reaction will occur.

- $\text{MgSO}_4 + \text{Zn} \rightarrow$
- $\text{Ni (2+ charge)} + \text{H}_2\text{SO}_4 \rightarrow$
- $\text{F}_2 + \text{KBr} \rightarrow$

# Double Displacement Reactions



- A double displacement reactions has occurred if:
  - A solid precipitate forms
  - A gas is produced
  - Water is also produced but this is hard to observe



- $\text{AgCl(s)}$  is a white precipitate



- How do you predict if a precipitate forms?  
Use the Solubility Guidelines to help you

# Solubility Guidelines

- A higher guideline number always takes precedence over a lower guideline number

**Table 9.1** General Solubility Guidelines

Guideline	Cations	Anions	Result	Exceptions
1	Li <sup>+</sup> , Na <sup>+</sup> , K <sup>+</sup> , Rb <sup>+</sup> , Cs <sup>+</sup> , NH <sub>4</sub> <sup>+</sup>	NO <sub>3</sub> <sup>-</sup> , CH <sub>3</sub> COO <sup>-</sup> , ClO <sub>3</sub> <sup>-</sup>	soluble	Ca(ClO <sub>3</sub> ) <sub>2</sub> is insoluble
2	Ag <sup>+</sup> , Pb <sup>2+</sup> , Hg <sup>+</sup>	CO <sub>3</sub> <sup>2-</sup> , PO <sub>4</sub> <sup>3-</sup> , O <sup>2-</sup> , S <sup>2-</sup> , OH <sup>-</sup>	insoluble	BaO and Ba(OH) <sub>2</sub> are soluble. Group 2 sulfides tend to decompose.
3		Cl <sup>-</sup> , Br <sup>-</sup> , I <sup>-</sup>	soluble	
4	Ba <sup>2+</sup> , Ca <sup>2+</sup> , Sr <sup>2+</sup>		insoluble	
5	Mg <sup>2+</sup> , Cu <sup>2+</sup> , Zn <sup>2+</sup> , Fe <sup>2+</sup> , Fe <sup>3+</sup> , Al <sup>3+</sup>	SO <sub>4</sub> <sup>2-</sup>	soluble	



## Checkpoint

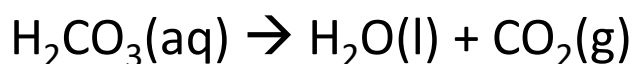


- Which of the following are soluble in water?
  - CaS
  - FeSO<sub>4</sub>
  - MgCl<sub>2</sub>
- Which of the following pairs of aqueous solutions produce a precipitate when mixed together?
  - Potassium carbonate and copper (II) sulfate
  - Ammonium chloride and zinc sulfate

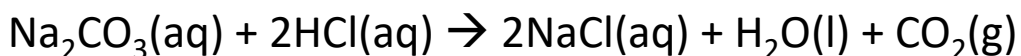
- Another way to know a double displacement reaction has occurred is the production of a gas



The carbonic acid  $\text{H}_2\text{CO}_3(\text{aq})$  is unstable and continues to decompose



Net equation:



The  $\text{NH}_4\text{OH}(\text{aq})$  immediately decomposes to produce:



Net Reaction:



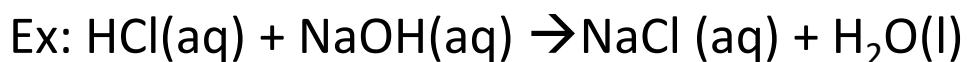
**TABLE 5.1** Some Substances Found as Gases at 1 atm and 25°C

Elements	Compounds
H <sub>2</sub> (molecular hydrogen)	HF (hydrogen fluoride)
N <sub>2</sub> (molecular nitrogen)	HCl (hydrogen chloride)
O <sub>2</sub> (molecular oxygen)	HBr (hydrogen bromide)
O <sub>3</sub> (ozone)	HI (hydrogen iodide)
F <sub>2</sub> (molecular fluorine)	CO (carbon monoxide)
Cl <sub>2</sub> (molecular chlorine)	CO <sub>2</sub> (carbon dioxide)
He (helium)	NH <sub>3</sub> (ammonia)
Ne (neon)	NO (nitric oxide)
Ar (argon)	NO <sub>2</sub> (nitrogen dioxide)
Kr (krypton)	N <sub>2</sub> O (nitrous oxide)
Xe (xenon)	SO <sub>2</sub> (sulfur dioxide)
Rn (radon)	H <sub>2</sub> S (hydrogen sulfide)
	HCN (hydrogen cyanide)*

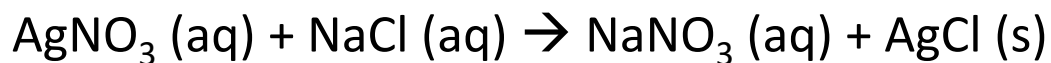
\*The boiling point of HCN is 26°C, but it is close enough to qualify as a gas at ordinary atmospheric conditions.

## Neutralization Reactions

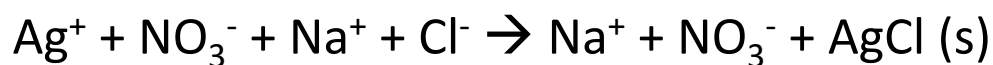
- A special type of double displacement reaction



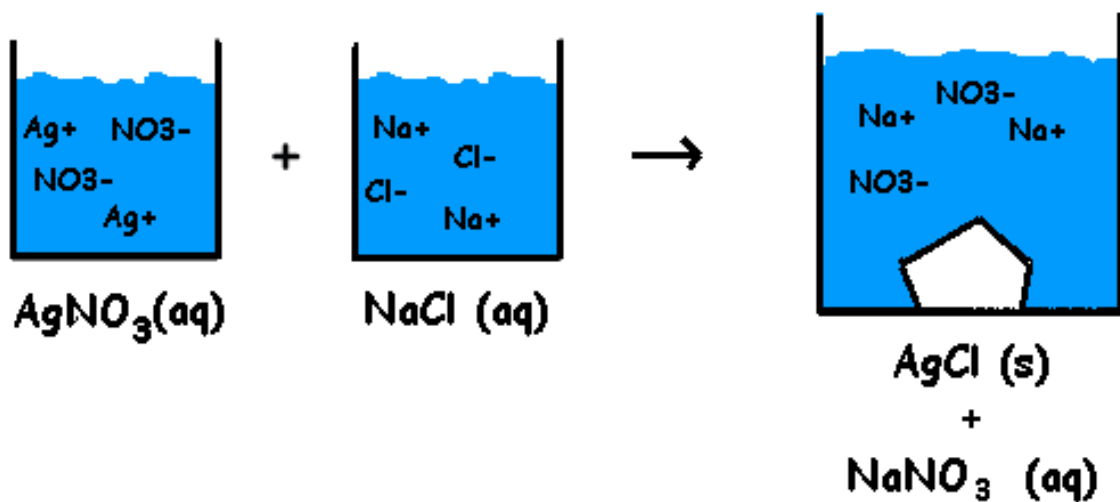
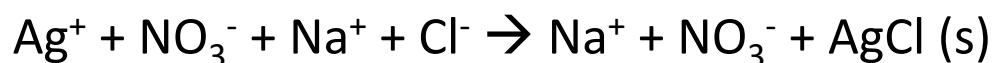
# Net Ionic Equations

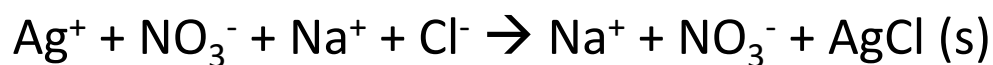


- In reality, soluble ionic compounds dissociate into their respective ions in solution

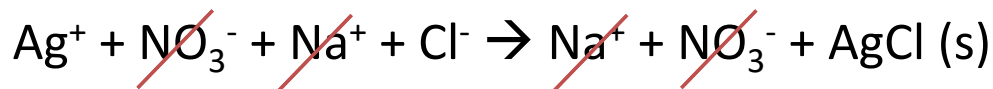


AgCl is still written as an ionic formula because precipitates are insoluble





Cross-out terms that appear on both sides



Terms that are crossed out are called spectator ions – ions that are not important to the net result



## Checkpoint



Identify the spectator ions then write the balanced net ionic equation for the reaction of sodium sulfide and iron(II) sulfate.