Grade 11 Chemistry

Chemical Reactions

Class 4

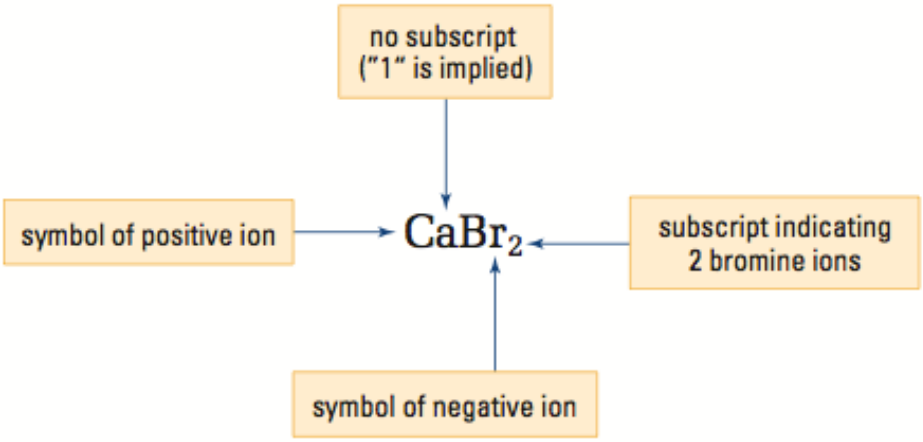
Chemical Reactions

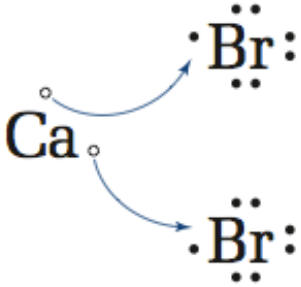
Big Ideas

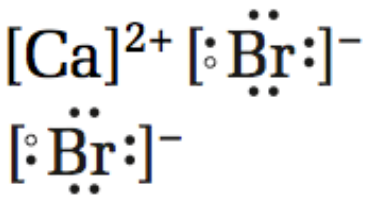
- Analyze chemical reactions used in a variety of applications, and assess their impact on society and the environment
- Investigate different types of chemical reactions
- Demonstrate an understanding of the different types of chemical reactions

Nomenclature

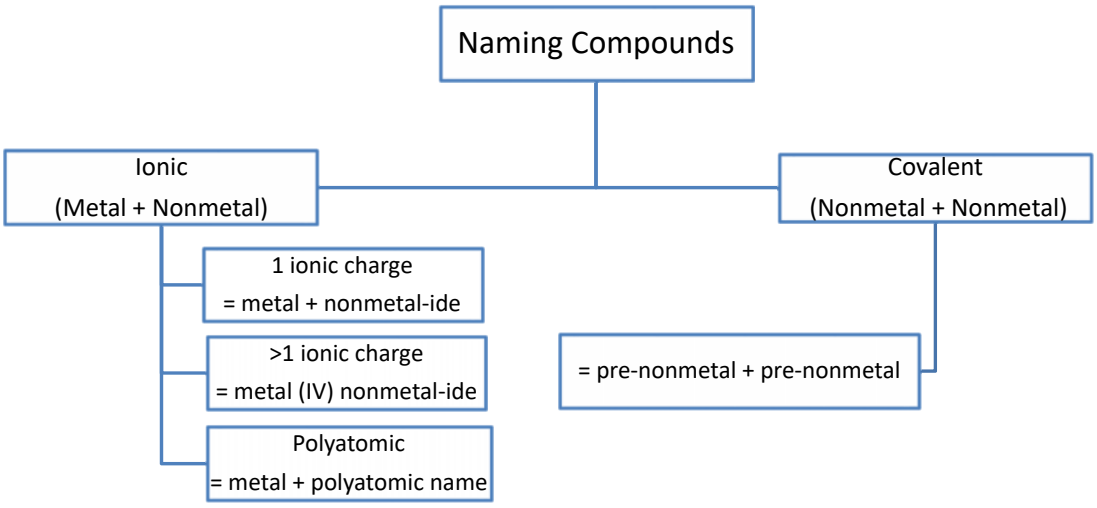
- Chemical Formula tells you:
  - The elements that make up the compound
  - The number of atoms of each element
  - The order tells you which element is more electronegative
    - The first element is less electronegative
    - The second element is more electronegative
- Ex: $CaBr_2$







Summary



Checkpoint

- Write the chemical formula for each of the following:
  a) Aluminum oxide
  b) Silicon dioxide
  c) Manganese (II) iodide
- Write the chemical name for each of the following:
  a) Mg_3N_2
  b) Cu_2S
  c) N_2O

Polyatomic Ions

- Polyatomic – "more than one atom"
  - Charged particles
  - Remains unchanged in simple chemical reactions
  - Treat as a single unit
- Ex: $CaCO_3$
  - CO_3^{2-} is carbonate
- NH_4Cl
  - NH_4^{1+} is ammonium, a polyatomic cation

Valence = –1			
Ion	Name	Ion	Name
CN^-	cyanide	$H_2PO_3^-$	dihydrogen phosphite
CH_3COO^-	acetate	$H_2PO_4^-$	dihydrogen phosphate
ClO^-	hypochlorite	MnO_4^-	permanganate
ClO_2^-	chlorite	NO_2^-	nitrite
ClO_3^-	chlorate	NO_3^-	nitrate
ClO_4^-	perchlorate	OCN^-	cyanate
HCO_3^-	hydrogen carbonate	HS^-	hydrogen sulfide
HSO_3^-	hydrogen sulfite	OH^-	hydroxide
HSO_4^-	hydrogen sulfate	SCN^-	thiocyanate

Valence = –2			
Ion	Name	Ion	Name
CO_3^{2-}	carbonate	O_2^{2-}	peroxide
$C_2O_4^{2-}$	oxalate	SiO_3^{2-}	silicate
CrO_4^{2-}	chromate	SO_3^{2-}	sulfite
$Cr_2O_7^{2-}$	dichromate	SO_4^{2-}	sulfate
HPO_3^{2-}	hydrogen phosphite	$S_2O_3^{2-}$	thiosulfate
HPO_4^{2-}	hydrogen phosphate		

Valence = –3			
Ion	Name	Ion	Name
AsO_3^{3-}	arsenite	PO_3^{3-}	phosphite
AsO_4^{3-}	arsenate	PO_4^{3-}	phosphate

Checkpoint

- Write the chemical formula for each of the following:
  a) Sodium acetate
  b) Potassium permanganate
  c) Ammonium phosphate
- Write the chemical name for each of the following:
  a) $Al(NO_2)_3$
  b) Li_2CO_3
  c) $Cu(CH_3COO)_2$

Additional Naming Systems

- Before the Stock system (Roman Numerals), *-ic* and *–ous* endings were used
  - ic = larger valence number
  - ous = smaller valence number
- Ex: Tin (Sn)
  - Sn^{2+} = stannous Sn^{4+} = stannic
  - Cu^{+} = cuprous Cu^{2+} = cupric
  - Pb^{2+} = plumbous Pb^{4+} = plumbic

Naming Compounds with Hydrogen

- Usually hydrogen is the less electronegative element
  - HCl = hydrogen chloride
  - H_2S = hydrogen sulfide
- If hydrogen is the more electronegative anion, its ending also changes to *–ide*
  - NaH = sodium hydride
  - LiH = lithium hydride

Naming for Oxoanions

- Base polyatomic ion ends with ***–ate***

  ex: ClO_3^- chlor**ate**
- Remove an oxygen and ending changes to ***–ite***

  ex: ClO_2^- chlor**ite**
- Remove two oxygens and add a prefix of ***–hypo***

  ex: ClO^- **hypo**chlorite
- Add an oxygen (to base ion) and add a prefix of ***–per***

  ex: ClO_4^- **per**chlorate

Checkpoint

- Write the chemical name for the following:

SO_4^{2-} sulfate

SO_3^{2-} ?

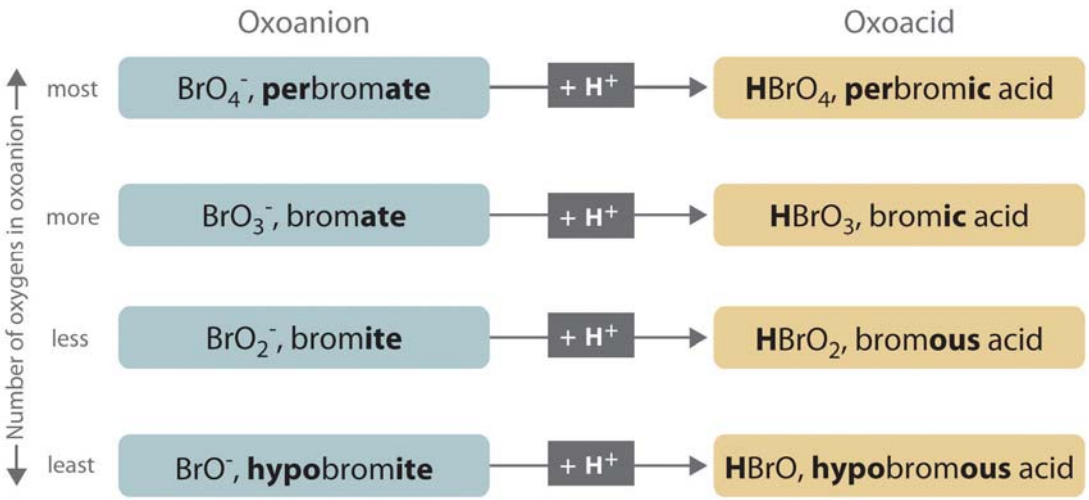
SO_2^{2-} ?

SO_5^{2-}

Naming Acids

Naming Binary and Oxoacids

- Binary acids – change the ending to ic acid
  - Hydrochloric acid, hydrofluoric acid
- Oxoacids – acid formed from a polyatomic ion
  - For anions that end in –ate, the suffix of the acid is –ic. Ex: chlorate ion ClO_3^- is chloric acid $HClO_3$
  - For anions that end in –ite, the suffix of the acid is –ous. Ex: chlorite ion ClO_2^- is chlorous acid $HClO_2$
  - Prefixes –hypo and –per remain a part of the acid name



Checkpoint

Write the chemical formulas for the following acids:

a) Nitric acid

b) Periodic acid

c) Phosphoric acid

d) Phosphorous acid

Thio- Compounds

- When an oxygen atom in an ion is replaced by a sulfur atom, the prefix ***thio-*** is added to the name

- Ex: OCN^- cyanate SCN^- thiocyanate
- Ex: SO_4^{2-} sulfate $S_2O_3^{2-}$ thiosulfate

Hydrates

- Hydrates have water molecules chemically bound to another compound
- Ex: Calcium chloride dihydrate = $CaCl_2 \bullet 2H_2O$

Table 2.6 Numerical Prefixes for Hydrates and Binary Covalent Compounds

Number	Prefix
1	mono-
2	di-
3	tri-
4	tetra-
5	penta-
6	hexa-
7	hepta-
8	octa-
9	nona-
10	deca-

Chemical Equations

Reactant → Product

- Forms:
  - Word Equation

    Sodium + Chlorine → Sodium chloride
  - Skeleton Equation

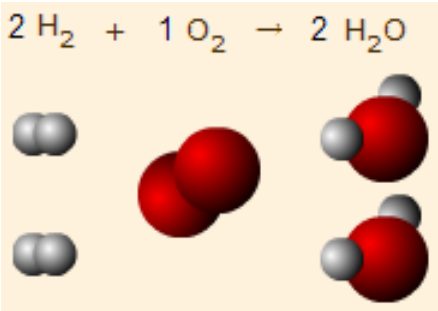
    $Na(s) + Cl_2(g) \rightarrow NaCl(s)$
  - Balanced Equation

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

Symbol	Meaning
+	reacts with (reactant side)
+	and (product side)
→	to form
(s)	solid or precipitate
(ℓ)	liquid
(g)	gas
(aq)	in aqueous (water) solution

Law of Conservation of Mass

- In any given reaction, the total mass of the reactants equals the total mass of the products
- Atoms cannot be created or destroyed in ordinary chemical reactions



Balancing Equations

Skeleton Question: $H_2 + Cl_2 \rightarrow HCl$

Number of Atoms: 2H + 2Cl 1H + 1Cl

Add Coefficients: $H_2 + Cl_2 \rightarrow 2HCl$

*Coefficients vs. Subscripts

- Coefficients give the ratio of reactants and products in a **reaction**
- Subscripts give the ratio of elements in a **chemical formula** and cannot change in a reaction

Checkpoint

- Balance the following reactions:

a) $P_4(s) + O_2(g) \rightarrow P_4O_{10}(s)$

b) $HCl(aq) + Na_2SO_3(aq) \rightarrow NaCl(aq) + H_2O(l) + SO_2(g)$

c) Aqueous lead (II) nitrate and solid magnesium react to form aqueous magnesium nitrate and solid lead

d) Solid barium reacts with solid sulfur to produce solid barium sulfide