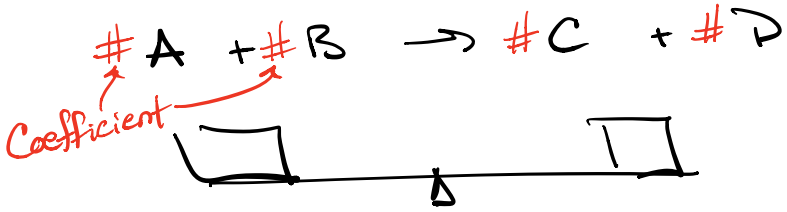
Chapter 7

- Balancing Chemical Eq
- Classifying Chemical Rxn
  - Acid/Base
  - double displacement
  - Redox
  - Combustion
- Stoichiometry w/ Rxns
- Reaction yields

Balancing Chemical Equations



Conservation of matter. Matter cannot be destroyed or created.

Molar Coefficients – Coefficients count as either single molecules or as moles in a larger sense

Rules for balancing

1) you may only change the coefficients
2) Start left to right balancing any element that does not appear more than 3 times in the reaction.
3) Save diatomics for last (O_2, H_2, N_2, Cl_2, S_8)
4) You may use a fractional coefficient to balance an odd number of diatomics ⇒ But must clear the fraction at the end.

Should be able to balance any equation in 4 steps or less.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

C	1	C	1 ✓
H	4	H	~~2~~ 4 ✓
O	~~2~~ 4	O	~~3~~ 4 ✓

$$\boxed{CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O}$$

Stoichiometry (mass to mole conversions) are only valid with a balanced chemical Rxn

$$HC_2H_3O_2 + 2O_2 \rightarrow 2CO_2 + 2H_2O$$

C	2	2 ✗
H	4	2 ✗ 4
O	4 ✗ 6	3 ✗ ✗ 6

$$HC_2H_3O_2 + 2O_2 \rightarrow 2CO_2 + 2H_2O$$

$$2\left[C_3H_8O + \frac{9}{2}O_2 \rightarrow 3CO_2 + 4H_2O\right]$$

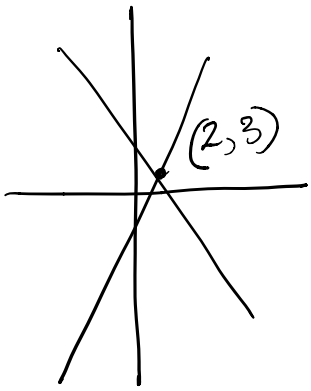
C	3	3 ✗ ✓
H	8	2 ✗ 8 ✓
O	3 ✗ 10	3 ✗ ✗ 10 ✓

$$2C_3H_8O + 9O_2 \rightarrow 6CO_2 + 8H_2O$$

$$3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 4H_2O + 2NO$$

Cu	~~1~~ 3	
H	~~1~~ 8	
N	~~1~~ 8	
O	~~3~~ 24	

Cu	~~1~~ 3	✓
H	~~2~~ 8	✓
N	~~3~~ 8	✓
O	~~8~~ 24	✓



$2x + y = 8$ # N

$6x + y + 4 = 24$ # O

$6x + y = 20$

$-(2x + y = 8)$

$4x = 12$

$x = \frac{12}{4} = 3$

$2(3) + y = 8$

$6 + y = 8$

$y = 2$

$$3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 4H_2O + 2NO$$

Chemical Reactions

"Goes to form"

Reactants → Products

$A + B \rightarrow C + D$

"And"

$aA + bB \xrightarrow[\text{Solvent}\ \text{Temperature}\ \text{Time}\ \text{or other conditions required}]{\text{Catalyst}} cC + dD$

)))) sound

hv light

Types of Reactions

$AB + CD \rightarrow AD + CB$ Double Displacement (precipitation Reaction)

$A + BC \rightarrow B + AC$ Single replacement (type of redox rxn)

$A \rightarrow B + C + D$ Decomposition

$A + B + C \rightarrow D$ Combination

$C_xH_yO_z + O_2 \rightarrow CO_2 + H_2O$ Combustion Reaction

Ex

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

$A \rightarrow B + C$

$Ca(OH)_{2(aq)} + 2HBr_{(aq)} \rightarrow CaBr_{2(aq)} + 2\,H\text{-}OH_{(l)}$

$AB + CD \rightarrow AD + CB$

Double displacement

States

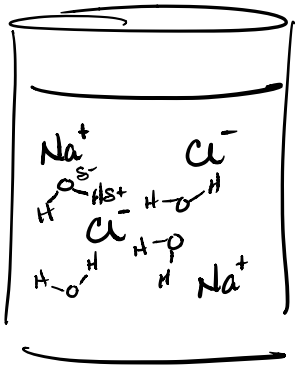
(l) Liquid

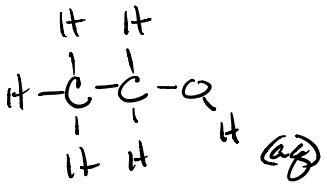
(s) Solid

(g) gas

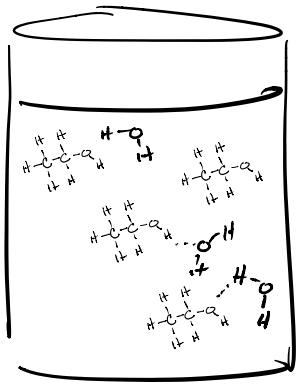
(aq) aqueous → dissolved in H_2O

$NaCl_{(aq)} \rightarrow Na^+_{(aq)} + Cl^-_{(aq)}$





$C_2H_6O_{(aq)}$



Dissolves as a molecule and it does not dissociate

$$Zn_{(s)} + 2HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}$$

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

Single Replacement

7.2

Double Displacement (Precipitation Reactions)

- Solubility Rules to predict outcome of these reactions ⇒ predict products

⇒ Lab experiment

Table 7.1 Solubility Rules

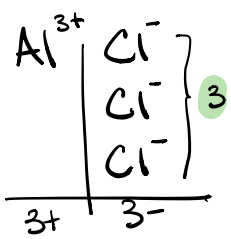
Ions	Rule	Exception
Group 1A cations (Na^+, K^+, Li^+) & ammonium NH_4^+	Always Soluble	None
$C_2H_3O_2^-$ & NO_3^-	Always Soluble	None
Cl^-, Br^-, I^-	Usually Soluble	Pb^{2+}, Hg_2^{2+}, Ag^+
F^-, SO_4^{2-}	Usually Soluble	Pb^{2+}, Ba^{2+}, Ca^{2+}
CO_3^{2-}, PO_4^{3-}, OH^-	Usually Insoluble	Group 1A cation & NH_4^+

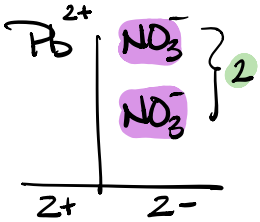
	Soluble/Insoluble	Reason
$LiCl$	Soluble	- Li^+ is group IA ⇒ always soluble. - Cl^- usually soluble & Li^+ not one of it's exceptions
$Fe(OH)_3$	Insoluble	- OH^- usually insoluble Fe^{3+} not an exception
$(NH_4^+)_3PO_4$	Soluble	NH_4^+ always Soluble Cation
$MgCO_3$	Insoluble	CO_3^{2-} is usually insoluble Mg^{2+} not an exception

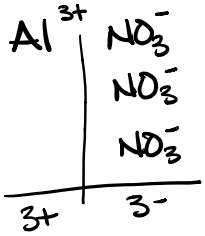
Double Displacement Reaction

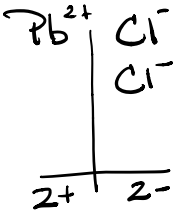
Give the products of the following reaction with their State of matter (s, l, g, or aq)

$$AlCl_{3(aq)} + Pb(NO_3)_{2(aq)} \rightarrow Al(NO_3)_{3(aq)} + Pb(Cl)_{2(s)}$$

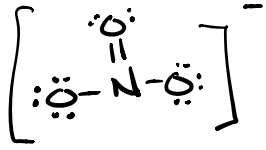








~~Cl-Cl-Cl-~~



- Broken the reactants into ions ✓
- Swapped ion pairs & balance ✓ the formulas for charge
- Decide on State ✓

  soluble = (aq) aqueous

  insoluble = (s) solid

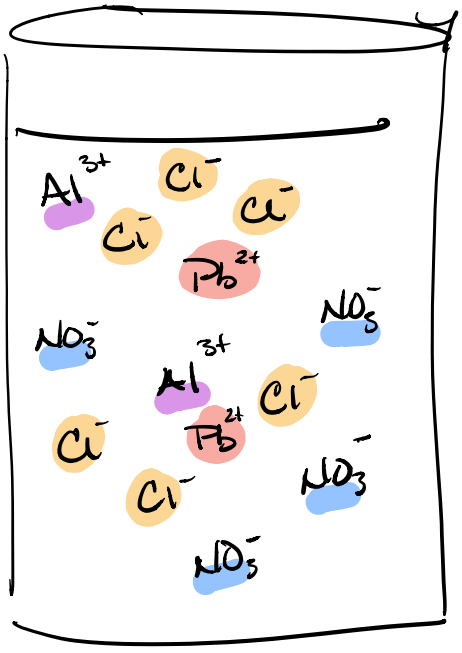
- Balance the Coefficients

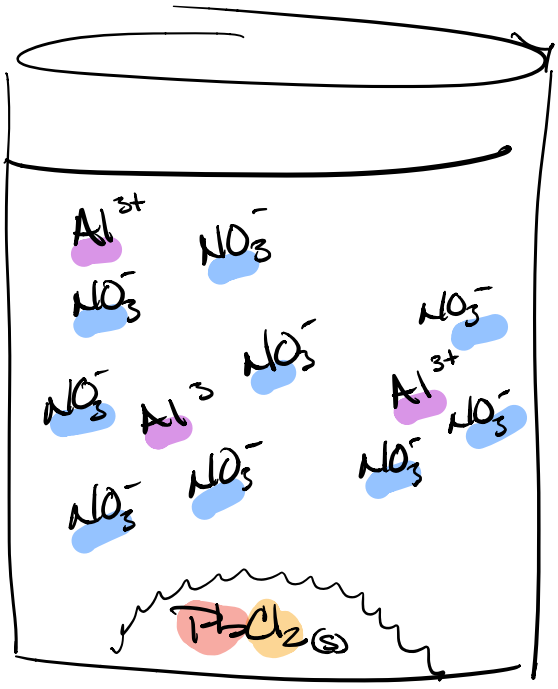
$2\,AlCl_{3(aq)} + 3\,Pb(NO_3)_{2(aq)} \rightarrow 2\,Al(NO_3)_{3(aq)} + 3\,PbCl_{2(s)}$

Al^{3+}	✗2		Al^{3+}	✗2	✓
Cl^-	~~3~~ 6		Cl^-	~~2~~ 6	✓
Pb^{2+}	✗3		Pb^{2+}	✗3	✓
NO_3^-	~~2~~ 6		NO_3^-	~~3~~ 6	✓

Complete Balanced Equation

$$2\,AlCl_{3(aq)} + 3\,Pb(NO_3)_{2(aq)} \rightarrow 2\,Al(NO_3)_{3(aq)} + 3\,PbCl_{2(s)}$$





Chemical Formula

Reactants & products shown as "associated" written together as cation - Anion pairs

Ionic Formula

Reactants & Products in aqueous state written as dissociated ions w/ charge & state.

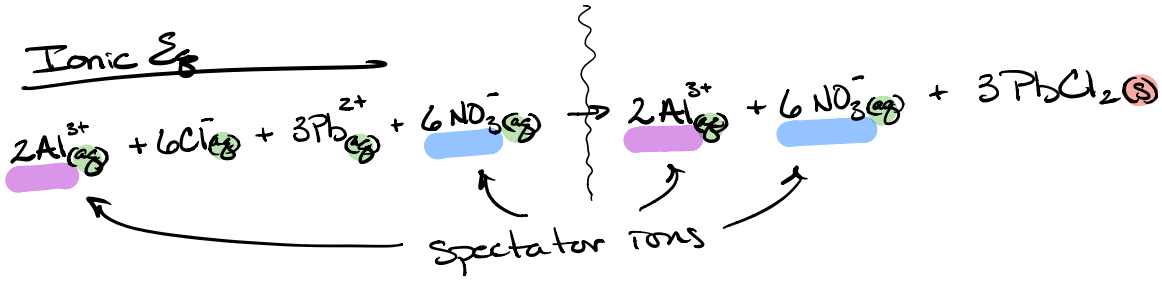
Net Ionic Formula

Reactants & products without spectator ions ⟹ Those things that remain in solution after the reaction.

Chemical Eq

$$2AlCl_{3(aq)} + 3Pb(NO_3)_{2(aq)} \rightarrow 2Al(NO_3)_{3(aq)} + 3PbCl_{2(s)}$$

Ionic Eq



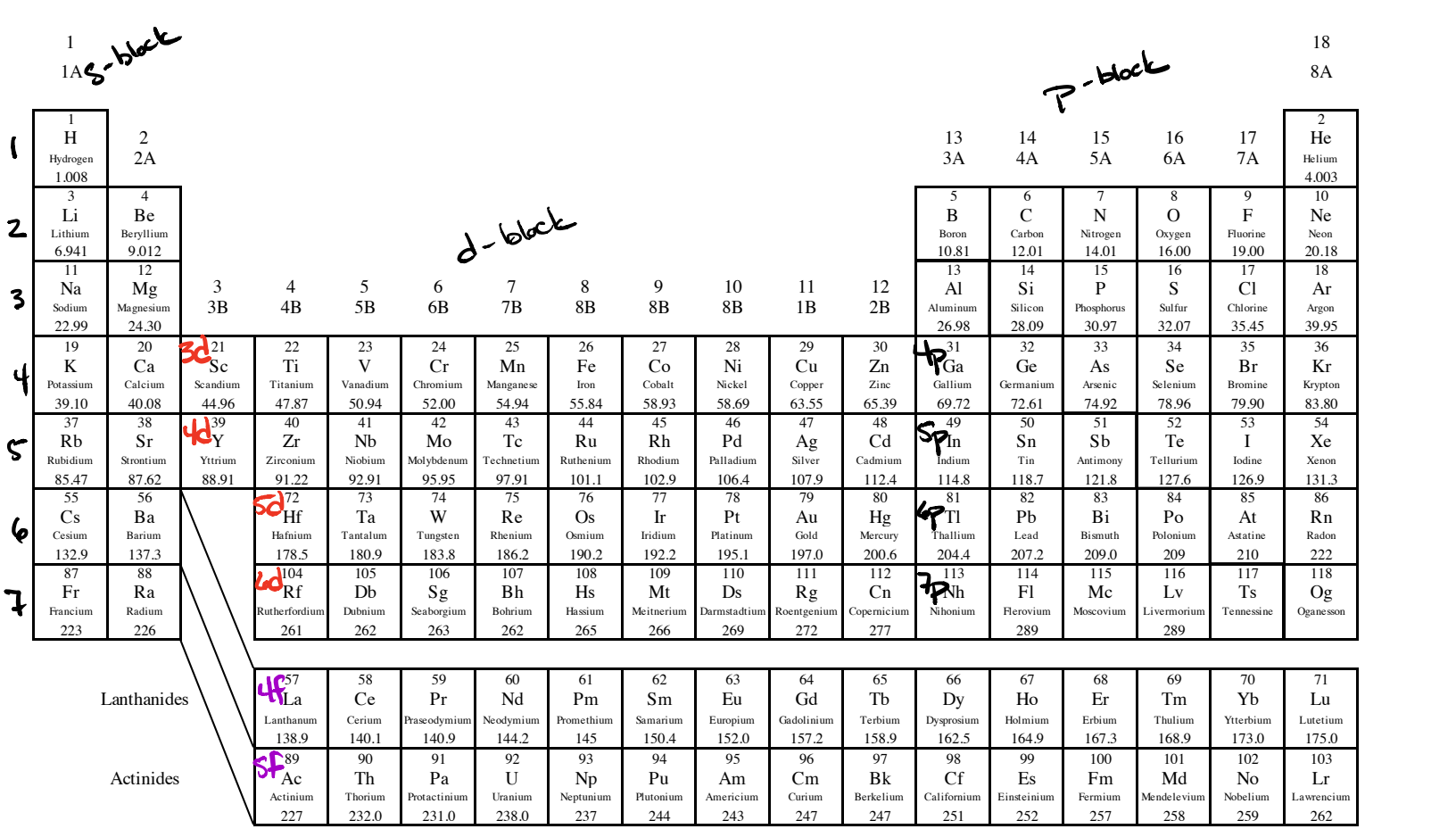
Net Ionic Eq

$$3Pb^{2+}_{(aq)} + 6Cl^-_{(aq)} \rightarrow 3PbCl_{2(s)}$$

or

$$Pb^{2+}_{(aq)} + 2Cl^-_{(aq)} \rightarrow PbCl_{2(s)}$$

Lowest Whole # Ratios



$Ca = [Ar]\,4s^2$ $\qquad$ $Se = [Ar]\,4s^2 3d^{10} 4p^4$

$Ca = \underbrace{1s^2 2s^2 2p^6 3s^2 3p^6}_{[Ar]}\ 4s^2$