# Chapter 6 → Dilution

Dilution Formula $C_1V_1 = C_2V_2$

$\underline{M}_1V_1 = \underline{M}_2V_2$

molarity = Concentration

Ex

How many mL of a 1.735 $\underline{M}$ solution of $H_3PO_4$ are required to make 350. mL of 0.625 $\underline{M}$ $H_3PO_4$?

3 out of 4 variables ⟹ $C_1V_1 = C_2V_2$

① Table or List

$C_1 = 1.735\ \underline{M}$ or mols/L

$V_1 = ?\ \text{mL}$

$C_2 = 0.625\ \underline{M}$ or mols/L

$V_2 = 350.\ \text{mL}$

same

same

Solve equation

② $\dfrac{\cancel{C_1}V_1}{\cancel{C_1}} = \dfrac{C_2V_2}{C_1}$

$$V_1 = \frac{C_2V_2}{C_1}$$

③ Plug in values & Solve

$$V_1 = \frac{(0.625\ \cancel{\underline{M}})(350.\ \text{mL})}{(1.735\ \cancel{\underline{M}})} = 126.080691\ \text{mL}$$

3 3 4

$$= \boxed{126\ \text{mL of } 1.735\ \underline{M}\ H_3PO_4\ \text{Req}}$$

Ex A reaction requires 320. mL of a 0.175 M solution of nitric acid ($HNO_3$). In the stockroom you find a bottle of 6.725 M $HNO_3$. How many mL of the 6.725 M $HNO_3$ are required to make the 320. mL of 0.175 M $HNO_3$? } Real question

$C_1 = 6.725$ M $HNO_3$

$V_1 = ?$

$C_2 = 0.175$ M

$V_2 = 320.$ mL

$$\frac{\cancel{C_1} V_1}{\cancel{C_1}} = \frac{C_2 V_2}{C_1}$$

$$V_1 = \frac{C_2 V_2}{C_1}$$

$$V_1 = \frac{(0.175 \cancel{M})(320. \text{ mL})}{(6.725 \cancel{M})}$$

$V_1 = 8.327137$ mL $HNO_3$

$= \boxed{8.33 \text{ mL } HNO_3}$

Ex what is the resulting molarity when 6.72 mL of a stock solution of 10.62 M sulfuric acid is diluted to a final volume of 125 mL ?

$C_1 = 10.62\ \underline{M}$

$V_1 = 6.72\ mL$

$C_2 = ?$

$V_2 = 125\ mL$

$$\frac{C_1V_1}{V_2} = \frac{C_2\cancel{V_2}}{\cancel{V_2}}$$

$$C_2 = \frac{C_1V_1}{V_2}$$

$$C_2 = \frac{\overset{4}{(10.62\ \underline{M})}\overset{3}{(6.72\ \cancel{mL})}}{\underset{3}{(125\ \cancel{mL})}} = 0.570931\ \underline{M}$$

$$\boxed{= 0.571\ \underline{M} \text{ or } mols/L\ H_2SO_4}$$

Conclusion Chapter 6

# Chapter 7

- Balancing Chemical Equations
- Classifying Chemical Reacts
  - Double Displacement
  - Single Replacement
  - Combination
  - Decomposition
  - Combustion

  Covered in Lab

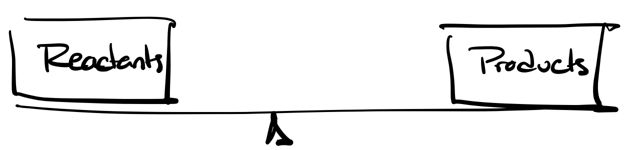
  - Acid / Base
- Stoichiometry with reactions (Stoichiometry RoadMap)
- Reaction Yields

## Balancing Chemical Equations

$$aA + bB \rightarrow cC + dD$$

Lower case are Coefficients

Equations are balanced with Coefficients




Coefficients $\Rightarrow$ Molar Coefficients

$Al_2(CO_3)_3$ atomic & molar Ratios

Subscripts ?

Sigular

1) The subscripts tell us how many atoms of each element are in the compound or molecule.

$6.022\times10^{23}$

mole

2) The subscripts also tell us how many moles of atoms are in each mole of compound or molecules.

Balanced Chemical Equation

$$3\,Na_2CO_3 + 2\,AlCl_3 \rightarrow 1\,Al_2(CO_3)_3 + 6\,NaCl$$

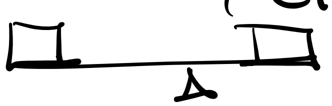
Either Singular (atomic or molecular) ratios or Molar Ratios (moles of molecules)

Reactants

| | |
|---|---|
| Na | $3\times2=6$ |
| C | $3\times1=3$ |
| O | $3\times3=9$ |
| Al | $2\times1=2$ |
| Cl | $2\times3=6$ |

Products

| | |
|---|---|
| Na | $6\times1=6$ |
| C | $1\times3\times1=3$ |
| O | $1\times3\times3=9$ |
| Al | $1\times2=2$ |
| Cl | $6\times1=6$ |



# Rules for Balancing Eq

1) You may only change Coefficients ⇒ never Subscripts

2) Start left to right balancing any element that does not appear more than 3 times in the reaction.

3) Save diatomic & monatomic elements for **last**

<u>diatomic</u> Hofbrincl ($H_2$, $O_2$, $F_2$, $Br_2$, $I_2$, $N_2$, $Cl_2$)
or
Brinclhof HOFBrINCl

monatomic (Na, K, Fe, Cu)

4) You may use a fractional Coefficient to gain an odd number of a diatomic

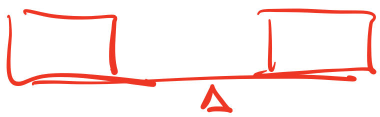
$\frac{3}{2}O_2 = 3\,O$ ⇒ You must clear the fraction at the end

By following the rules you should be able to balance any equation in this Class in 4 steps or less. More than 4 steps ⇒ Likely made an error.

Save for last

$$HC_2H_3O_{2(l)} + 2\,O_{2(g)} \rightarrow 2\,CO_{2(g)} + 2\,H_2O_{(g)}$$

| | |
|---|---|
| H 4 ✓ | H $\cancel{2\times 2} = 4$ ✓ |
| C 2 ✓ | C $1\times 2 = 2$ ✓ |
| Last ⟹ O $\cancel{4}$ 6 ✓ | O $\cancel{3}$ |
| $2 + 2\times 2$ | $2\times 2 + 2\times 1 = 6$ ✓ |
| $2 + 4 = 6$ | $4 + 2$ |



tool to balance

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

9

| | |
|---|---|
| C 3 | C $\cancel{1}$ 3 ✓ |
| H 8 | H $\cancel{2}$ 8 ✓ |
| O $\cancel{3}$ 10 | O $\cancel{3}$ $\cancel{7}$ 10 ✓ |

$$\frac{9}{\cancel{2}} \times \cancel{2} = 9$$

No fractional Coefficients

$$\boxed{2\,C_3H_8O + 9\,O_2 \rightarrow 6\,CO_2 + 8\,H_2O}$$

# Types of Chemical Reactions

$\overset{+}{A}\overset{-}{B} + \overset{+}{C}\overset{-}{D} \longrightarrow \overset{+}{A}\overset{-}{D} + \overset{+}{C}\overset{-}{B}$ Double Displacement

$3\ NaOH_{(aq)} + FeCl_{3(aq)} \rightarrow 3NaCl_{(aq)} + Fe(OH)_{3(s)}$

$A + BC \longrightarrow B + AC$ Single Repacement

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

$A \longrightarrow B + C + D$ Decomposition

$H_2CO_{3(aq)} \rightarrow H_2O_{(l)} + CO_{2(g)}$

$A + B + C \longrightarrow D$ Combination

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

# Combustion Reaction

$$\underbrace{C_xH_yO_zS_cN_m}_{\text{possible combinations}} + \underset{\substack{\uparrow \\ \text{oxygen gas}}}{O_2} \longrightarrow \underbrace{CO_2 + H_2O + SO_2 + NO_2}_{\text{oxides}}$$

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

$$CS_2 + 3O_2 \longrightarrow CO_2 + 2SO_2$$

most frequently

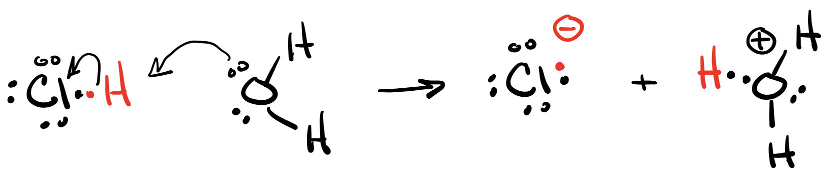
$$\underset{\text{Hydrocarbon}}{C_xH_yO_z} + O_2 \longrightarrow \underbrace{CO_2 + H_2O}_{\text{Carbondioxide \& water}}$$

# Acid-Base Reaction

$$\underset{\substack{\uparrow \\ \text{acidic}}}{\underline{H}}Cl + H_2O \longrightarrow Cl^- + H_3O^+$$

Acid = proton (or hydrogen ion) donor $H^+$

Base = proton (or hydrogen ion) acceptor



donor $H^+$
Acid

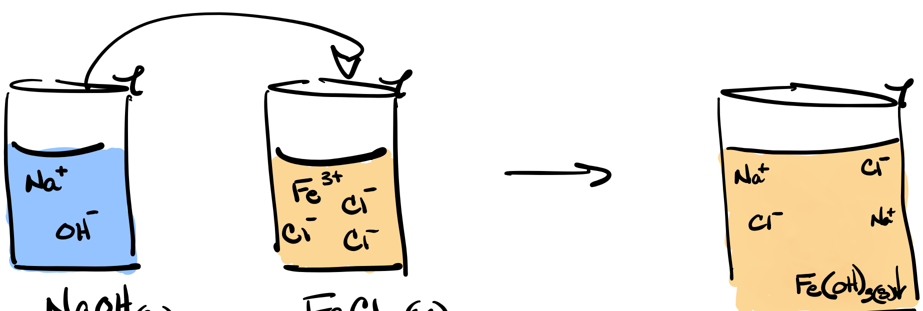
$$HCl + \underset{\substack{\text{Base} \\ \text{Acceptor } H^+}}{H_2O} \rightarrow Cl^- + H_3O^+$$

Acid/Base
$H^+$ is traded

<u>7.2</u> after classification focuses on double displacement

predicting the products of double displacement

Double Displacement
or
Double Replacement
or
Precipitation Reaction ⇐




$NaOH_{(aq)}$ — Clear & Colorless

$FeCl_{3(aq)}$ — Clear & yellow

yellow solution with a white cloudy precipitate

Clear ⇒ no visible solids
you can see through it

Colorless ⇒ no color

$$NaOH_{(aq)} + FeCl_{3(aq)} \rightarrow NaCl_{(aq)} + Fe(OH)_{3(s)}$$

| $Na^{+}$ | $OH^{-}$ |
|---|---|
| | |

| $Fe^{3+}$ | $Cl^{-}$ |
|---|---|
| | $Cl^{-}$ |
| | $Cl^{-}$ |

| $Na^{+}$ | $Cl^{-}$ |
|---|---|
| – | – |

| $Fe^{3+}$ | $OH^{-}$ |
|---|---|
| | $OH^{-}$ |
| | $OH^{-}$ |
| 3+ | 3- |

① Must properly balance products

⇒ Subscripts

② must balance Equation

⇒ Coefficients

$$\underline{3}\,NaOH_{(aq)} + FeCl_{3(aq)} \rightarrow \underline{3}\,NaCl_{(aq)} + Fe(OH)_{3(s)}$$

| | | |
|---|---|---|
| $Na^{+}$ | $\cancel{1}$ 3 | $\cancel{1}$ 3 ✓ |
| $OH^{-}$ | $\cancel{1}$ 3 | 3 ✓ |
| $Fe^{3+}$ | 1 | 1 ✓ |
| $Cl^{-}$ | 3 | $\cancel{1}$ 3 ✓ |

Can be predicted