Acid-Base Reactions

Arrhenius definition

Acid- Produces $H^+(aq)$ ions in solution

Base- Produces $OH^-(aq)$ ions in solution

Acid + Base = Water + Salt

TABLE 5.2 ■ Some Common Acids and Bases

	Name of Acid	Formula	Name of Base	Formula	
Strong acids Ionize completely	Hydrochloric acid	HCl	Sodium hydroxide	$NaOH$	Strong bases Ionize completely
	Hydrobromic acid	HBr	Lithium hydroxide	$LiOH$	
	Hydroiodic acid	HI	Potassium hydroxide	KOH	
	Nitric acid	HNO_3	Calcium hydroxide	$Ca(OH)_2$	
	Sulfuric acid	H_2SO_4	Barium hydroxide	$Ba(OH)_2$	
	Perchloric acid	$HClO_4$	Ammonia*	NH_3 (weak base)	
Don't ionize completely	Formic acid	$HCHO_2$ (weak acid)			
	Acetic acid	$HC_2H_3O_2$ (weak acid)			
	Hydrofluoric acid	HF (weak acid)			

*Ammonia does not contain OH^-, but it produces OH^- in a reaction with water that occurs only to a small extent: $NH_3(aq) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$.

Weak Acid-Strong Base Reaction

Weak acid Strong base

$HC_2H_3O_2$ (aq) + KOH (aq) →

Molecular Equation

$HC_2H_3O_2(aq) + KOH(aq) \rightarrow H_2O(l) + KC_2H_3O_2(aq)$

Complete (or Total) Ionic Equation

$HC_2H_3O_2(aq) + K^+(aq) + OH^-(aq) \rightarrow H_2O(l) + K^+(aq) + C_2H_3O_2^-(aq)$

Net Ionic Equation

$HC_2H_3O_2(aq) + OH^-(aq) \rightarrow H_2O(l) + C_2H_3O_2^-(aq)$

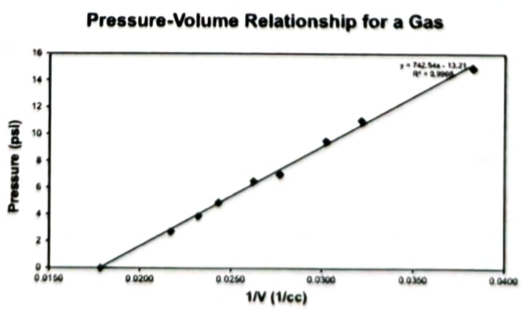
Simple Gas Laws

Volume and Pressure- Boyle's Law

PV = constant at T and number of moles

$V \propto \frac{1}{P}$

$P_1V_1 = P_2V_2$



Simple Gas Laws

Volume and Temperature- Charles' Law

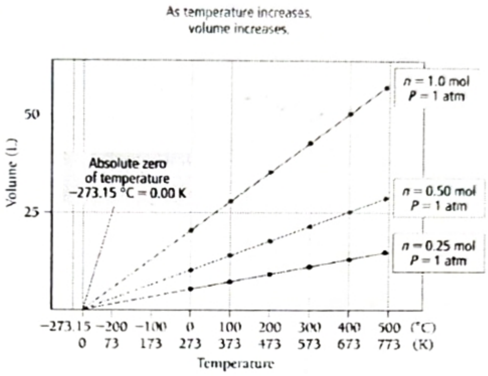
$V \alpha T$ at constant P and number of moles

$\frac{V}{T}$ = constant

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$V = 0 \rightarrow$ Absolute zero temperature K

No molecular motion



K = C + 273.15

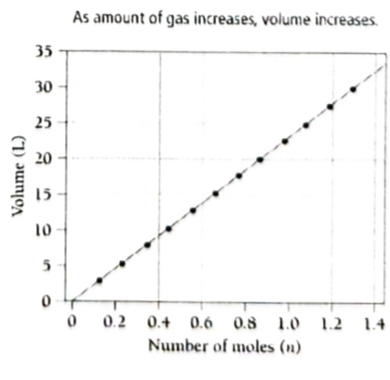
Simple Gas Laws

Volume and Quantity (moles)- Avagadro's Law

$V \alpha n$ at constant T and P

$\frac{V}{n}$ = constant

$\frac{V_1}{n_1} = \frac{V_2}{n_2}$



Ideal Gas Law

$$\left.\begin{array}{l} V \propto \frac{1}{P} \\ V \propto T \\ V \propto n \end{array}\right\} V \propto \frac{nT}{P} \rightarrow V = \frac{RnT}{P}$$

Ideal gas constant $0.08206 \frac{L\,atm}{K\,mol}$

$$PV = nRT$$

at constant n: $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

*Always use T in K

Applications of the Ideal Gas Law

Molar Volume of a Gas at STP

STP = Standard temperature and pressure

$T = 0°C = 273.15\ K$

$P = 1\ atm$

$$V(1\,mol\ @\ STP) = \frac{nRT}{P} = \frac{1\,mol \cdot 0.08206\,Latm/Kmol \cdot 273.15\,K}{1\,atm}$$

$$= 22.4L$$

Applications of the Ideal Gas Law

Calculate the density of NO_2 gas at 1.00 atm pressure and 35°C. $mm = 46\ g/mol$

$D = \frac{mass}{V}$ $P = 1\ atm$

$T = 308.15\ K$

$V = \frac{nRT}{P}$

$V = \frac{1\ mol \cdot 0.08206\ Latm/Kmol \cdot 308.15\ K}{1\ atm} = 25.29\ L$

$D = \frac{46\ g}{25.29\ L} = 1.82\ g/L$

$D = \frac{P \cdot mm}{RT}$

Applications of the Ideal Gas Law

A 1.00g sample of cyanogen (C_2N_2) (a highly toxic gas) occupies 0.500 L at 25°C and 750 torr. Determine the molar mass of cyanogen.

$V = 0.5\ L$ $T = 298.15\ K$ $P = 750 \cdot \frac{1\ atm}{760\ torr} = 0.987\ atm$

$mm = \frac{mass}{n} = \frac{1g}{n}$

$n = \frac{1}{mm}$

$V = \frac{\frac{1}{mm}RT}{P}$ $VP = \frac{1}{mm}RT$

$mm = \frac{RT}{VP} = \frac{0.08206\ Latm/Kmol \cdot 298.15\ K}{0.5\ L \cdot 0.987\ atm} = 49.58\ g/mol$