ch 2

DIFFUSION

→movement

Delete

ch1

ch 2

# FUNDAMENTAL CONCEPTS

fundamental concepts

**DIMENSIONAL ANALYSIS**

$$\text{quantity } \bar{w} \text{ desired units} = \text{quantity } \bar{w} \text{ given units} \times \boxed{\text{conversion factor}}$$ → MUST BE AN EXACT #

**ex**

$$\frac{1\,min}{60\,s} \times \frac{10^{-12}\,s}{1\,ps} \times \frac{60\,s}{1\,min}$$

molar mass : mass of 1 mole of a substance

avogadro's # : $N_A$

$$^{A}_{Z}X$$

A → mass # Z+N

atomic # (protons) ← Z

To calculate elemental (avg) molar mass, must account for relative proportions of each isotope

elemental MM = weighted avg of number of isotopes

**ex**

$^{12}C$ $12g/mol \times \frac{98.892\%}{100\%} = 11.8670\,g/mol$ ①

$^{13}C$ $13.00335\,g/mol \times \frac{1.108}{100} = 0.194089\,g/mol$ ②

① + ② = elemental mass

(same process to find % abundance

**CONVERSION B/W AMOUNT, MASS, NUMBER**

$$\begin{tikzcd} \text{\# of atoms/molecules} \arrow[r, shift right, "\frac{n}{N_A}"'] & \text{moles} \arrow[l, shift right, "nN_A"'] \arrow[r, shift left, "nM"] & \text{mass of substance} \arrow[l, shift left, "\frac{m}{MM}"] \end{tikzcd}$$

molarity (c)

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

mass % (m/m%)

$\frac{\text{mass of solute (g)}}{100g}$

mole fraction (x)

$\frac{n_A}{n_t} = X_A$

molality (m)

$\frac{m_{solute}}{V_{sol'n}} = \frac{n_{solute}}{1kg\ solvent}$

ch 2

## DIFFUSION

[illegible]

## DILUTIONS

$C_1V_1 = C_2\boxed{V_2}$ includes $H_2O$ as part of volume

→ strong electrolytes dissociate completely in $H_2O$

↳ can use stoic ratios to find [ions] in solution

## EQUATIONS FOR AQUEOUS IONIC RXNS

→ chem eqns can be written as

1) Molecular Equations → ionic species written in non-dissociated form
   → normally written

2) Net Ionic Equation → cancel out same ions on both sides

Law of Mass of Conservation

→ Total mass of rxn before = Total mass after rxn

↳ # of atoms of each element is conserved in a chemical rxn

→ when balancing chem equations, fractions are allowed

→ combustion rxns produce

## HOW TO: Find the Molecular Formula

① # of moles of each element from products of combustion, which are given in the Q

② write out the 'n's from ① w̄ their elements

③ Divide all 'n's by the smallest value

④ multiply by number to make all #s whole ---→ EMPIRICAL FORMULA

⑤ Determine mass of empirical formula, divide given MM (in Q) by calculated empirical MM and multiply the number w̄ the EMPIRICAL FORMULA

## STOICHIOMETRY

$$\begin{tikzcd}
\text{mass}_{\text{rxnt}} \arrow[d, "\text{MM}"] & & \text{mass}_{\text{product}} \\
\text{moles}_{\text{rxnt}} \arrow[rr, "\text{stoic ratio}"'] & & \text{moles}_{\text{product}} \arrow[u, "\text{MM}"']
\end{tikzcd}$$

DIFFUSION
→movement
→diffusion

R

ch 2

ch 1

Delete

ch 2

**HOW TO: reaction yield calculation**

① multiply all yields together (if there are multiple)
② use formula: $\%\text{yield} = \frac{\text{actual amnt of product}}{\text{theor. amnt of product}} \times 100\%$

**HOW TO: Limiting Reagents**

the reactant not limiting is given in excess

1) Write the BCEqn
2) Convert reagent quantities into moles
3) Use rxn stoic to find the amnt of product produced by each reagent
4) Reagent produces smallest amnt of product is limiting

Reaction Tables
→records quantities in a LR Question

Initial
Change
Final

**SIG FIG RULES**

1) Non zero digits are significant
2) Any zero b/w 2 sig digs is significant
3) A final zero or trailing zero in the decimal portion ONLY is significant

ex. 0.00500
0.03040

**ADD/SUBTRACT**

Rues:
1) count # of sig figs in decimal portion to the right side
2) Add/Sub normally
3) Round answer to least # of places

**MULTIPLY/DIVIDE**

Rules:
1) Least # of sig digs decides # of sig figs in answer

# BEHAVIOUR OF GASES

behaviour of gases

## PROPERTIES

- amount
- temperature
- volume
- pressure

## PRESSURE

→ Pressure = $\frac{\text{force}}{\text{area}}$ ⟶ $P_{atm}$ comes from $F_g$ exerted on air

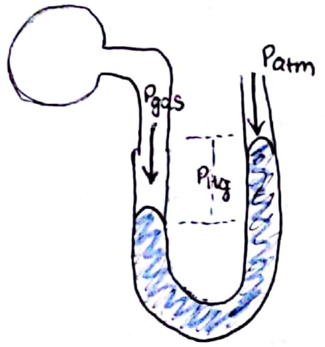
→ as altitude ↑, atmosphere's pressure ↓ [force ↓ as we go up]

→ Pressure exerted by liquid depends on:

- height of column of liquid
- density of column of liquid

Pressure = $ghd$, where $g = 9.8$, $h$ = height & $d$ = density

Manometers



$P_{gas} = P_{atm} + P_{Hg}$

## IDEAL GAS LAW

$$pV = nRT$$

$R = 8.3145\ \frac{J}{K \cdot mol}$ is SI

## MIXTURE OF GASES

Partial Pressure: pressure exerted by one gas in a mixture of gases

$$P_A = X_A \cdot P_t \rightarrow \boxed{\frac{n_A}{n_t}}$$

## VAPOUR PRESSURE OF $H_2O$ !

→ some water enters gas phase when used to trigger gas rxns
→ have to subtract this by looking it up

$$P_{gas} = P_t - P_{H_2O}$$

## GAS STOICHIOMETRY !

$$\begin{tikzcd} \text{mass}_{rxnt} \arrow[d, "MM"] & \text{mass}_{product} \\ \text{moles}_{rxnt} \arrow[r, "\text{Stoic factor}"'] & \text{moles}_{product} \arrow[u, "PV=nRT"'] \end{tikzcd}$$

## GAS DENSITY !

→ dp to MM
→ ip to temperature

→ as molecular density ↓, avg distance b/w molecular collisions ↑

## MOLECULAR SPEEDS OF GASES !

→ as temp. gets higher, gas molecules move faster
→ as temp. increases, the range of molecular speeds increase and distribution of speeds increase
→ as MW increases, speed decreases and distribution of speeds decrease

**aka** lighter gases move faster

Gas Molecule Speed & NRG

$$E = \frac{1}{2}mv^2$$

Avg $E_K$ of ONE gas molecule

$$E = \frac{3RT}{2N_A}$$

Avg $E_K$ of one mole of gas

$$E = \frac{3RT}{2}$$

## LAW OF EFFUSION !

EFFUSION: process by which a gas escapes through a small hole in the container

→ rate is ip to $\sqrt{MM}$

→ lighter gases move more quickly & have ↑ rate of effusion

ch.3
ch 2

## DIFFUSION

→ movement of one gas through another
→ diffusion rates are much slower than effusion rates
→ lighter gases travel more than heavier gases

## MOLECULAR MODEL OF GAS

| | ideal | real |
|---|---|---|
| Gas particle size | $V_{molec} = 0$ | $V_{molec} \neq 0$ |
| intermolec. interactions | NONE | ATTRACTIVE/ REPULSIVE |

→ the ideal gas eqn doesn't work under
- high pressure
- low temperature

## VAN DER WAALS EQUATION

$$\left[P + \underset{\substack{\uparrow\\\text{reduce pressure}\\\text{from ideal values}}}{\frac{n^2a}{V^2}}\right]\left[V - \underset{\substack{\uparrow\\\text{volume of}\\\text{molecule}}}{nb}\right] = RT$$

experimentally found for each gas

## CHARLES' LAW: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

→ volume of a fixed gas is d.p. to its temp

## BOYLE'S LAW: $P_1V_1 = P_2V_2$

→ volume of an ideal gas is i.p. to its absolute pressure @ constant tem

NOTES:

- mmHg is mm (millimeters of Hg)
- Temperature of any standard rxn is 298.15 K
- if $\Delta V < 0$, then $w > 0$
- gases w/ larger attractive forces b/w molecules leads to ↓ pressure

ch 3

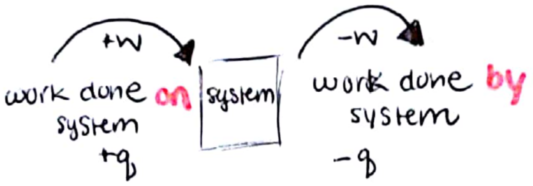
# ENERGY AND ITS CONSERVATION

energy and its conservation

**ENERGY** is the capacity to do work & produce heat

TWO FORMS → thermal & chemical

**THERMODYNAMICS** is the study of NRG transfers & transformations b/w system & surroundings as **heat** or **work**



**FIRST LAW:** NRG may be transferred but no NRG can be lost nor can heat/work be created from nothing $\Delta E = w + q$

**STATE FXN:** property of system determined by state of it, independent of how the system got there [ex. ENERGY]

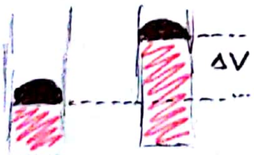
**BOND NRG** is NRG required to break a chemical bond

$$\Delta E = \sum BE_{\substack{\text{reactant} \\ \text{bonds broken}}} - \sum BE_{\substack{\text{product} \\ \text{bonds made}}}$$

**ENTHALPY** is the heat of a constant pressure process $\boxed{\Delta H}$

↳ production of heat is enthalpy

**PRESSURE-VOLUME WORK** is mechanical work done when volume changes in the presence of an ext pressure $w = -p\Delta V$



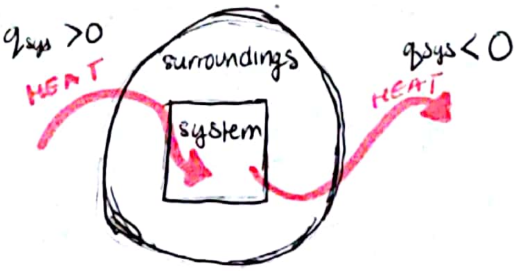
→ Work & Heat aren't state fxns because they are dependant on ext pressure and/or volume

**ENTHALPY & INTERNAL NRG**

$$\Delta H_{rxn} = \Delta E_{rxn} + RT\Delta n_{gas}$$

## HEAT OF CHEMICAL RXNS

→ rxn that releases / consumes NRG will have heat transfer



**ENDOTHERMIC:** heat/NRG is absorbed & ΔH is **positive**

**EXOTHERMIC:** heat/NRG is released & ΔH is **negative**

**HEAT CAPACITY:** amount of heat needed to raise temp of substance by 1°C

**SPECIFIC HEAT CAPACITY:** amount of heat needed to change temp of 1g of substance by 1 K   $Q = mc\Delta T$

→(+) must be positive

## STANDARD ENTHALPY VALUES

→ amnt of heat transferred depends on the pressure

$\Delta H^\circ$ → standard enthalpy symbol

BOMB CALORIMETER

$\Delta V = 0$

$W = -p\Delta V = 0$

$q_v = \Delta E$

$$q_v = C_{calorimeter}\Delta T$$

heat of calorimeter (NOT rxn)

**HESS' LAW:** change in enthalpy is sum of changes in enthalpy of individual steps

**STD ENTHALPY OF FORMATION:** forming of 1 mole of a compound from its elements in std state

$\Delta H_f^\circ = 0$ for pure elements

1) Decompose reactants into std elements

2) Formation of products from std elements

$$\sum \Delta H^\circ_{rxn} = \sum v_p \Delta H^\circ_{f.p.} - \sum v_r \Delta H^\circ_{f.r.}$$

$\Delta H^\circ_{fp}$ = formation enthalpy for products (or reactants - r)

$v$ = stoic ~~ratio~~ coefficient in rxn