

# CHAPTER 4 LECTURE NOTES GENERAL CHEMISTRY

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A SOLUTION IS A HOMOGENEOUS MIXTURE OF TWO OR MORE SUBSTANCES

THE SOLVENT IS THE MAJOR COMPONENT

SOLUTE(S) ARE MINOR COMPONENTS

ELECTROLYTES ARE IONIC COMPOUNDS. SOLUTIONS OF ELECTROLYTES PRODUCE IONS, CONDUCT ELECTRICITY



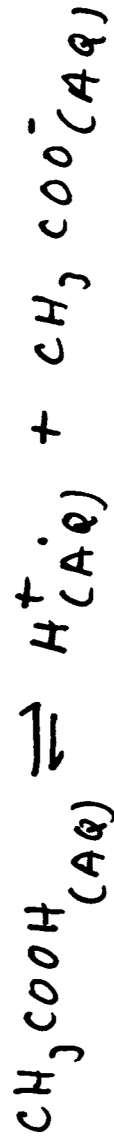
NON-ELECTROLYTES ARE MOLECULAR COMPOUNDS

SOLUTIONS OF NON-ELECTROLYTES  $\rightarrow$  NO IONS, NO CONDUCTION



WEAK ELECTROLYTES ARE MOLECULAR SUBSTANCES

THESE SOLUTIONS PRODUCE A FEW IONS



REVERSIBLE REACTIONS LIKE THESE ARE EQUILIBRIA  
PRECIPITATION REACTIONS

- PRODUCE INSOLUBLE IONIC SOLIDS

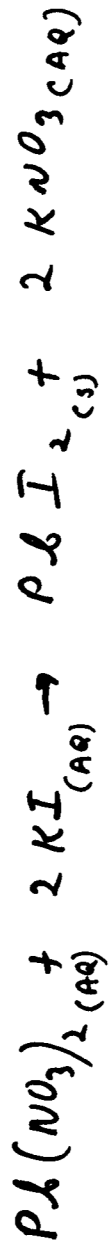
TO DETERMINE IF A COMPOUND IS SOLUBLE, USE

THE SOLUBILITY RULES (TABLE 4.2, PAGE 98)

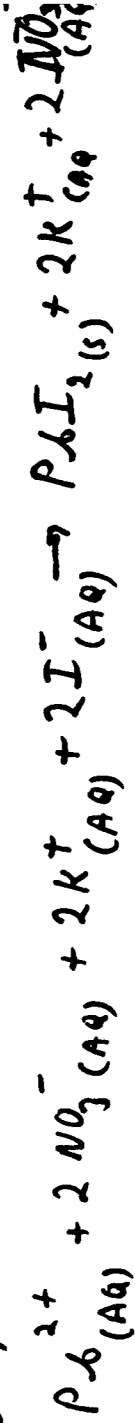
IONIC EQUATIONS, MOLECULAR EQUATIONS AND

NET IONIC EQUATIONS

MOLECULAR  $\rightarrow$  ALL MOLECULES



IONIC  $\rightarrow$  ALL IONS



NET  $\rightarrow$  PARTICIPANTS ONLY



WHEN WRITING IONIC EQUATIONS

1) IS THERE AN INSOLUBLE SUBSTANCE?

- CHECK THE RULES, TABLE 4.2

2) IDENTIFY AND CANCEL SPECTATOR IONS

ACIDS AND BASES

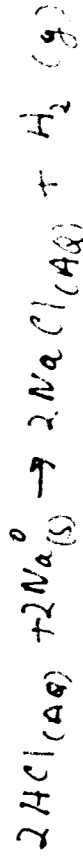
- ACIDS ARE COMPOUNDS THAT PRODUCE

HYDROGEN ION  $H^+(aq)$  (BRONSTED ACIDS)

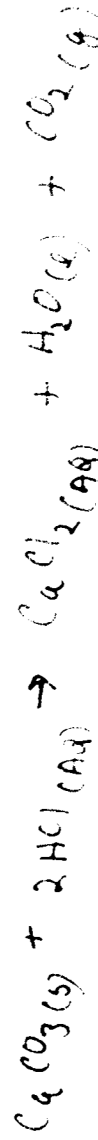
HYDROGEN ION IS "HYDRATED"  $H_3O^+(aq)$  (HYDRONIUM)

- EITHER  $H^+(aq)$  OR  $H_3O^+(aq)$  MAY BE USED

ACIDS REACT WITH METALS TO PRODUCE  $H_2(g)$

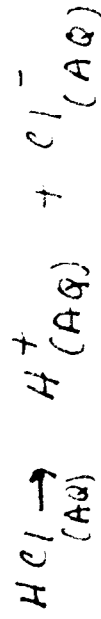


ACIDS REACT WITH CARBONATES TO PRODUCE  $CO_2(g)$

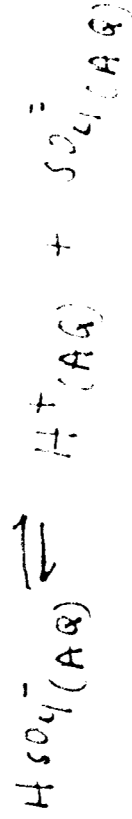
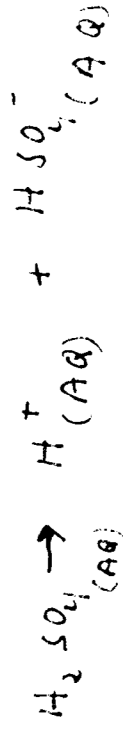


ONLY SIX ACIDS ARE STRONG ELECTROLYTES

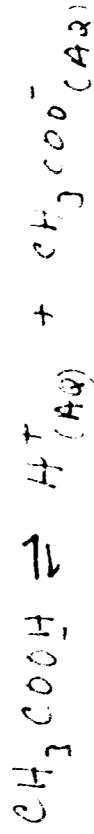
HCl, HNO<sub>3</sub>, H<sub>2</sub>SO<sub>4</sub>, HBr, HI, HClO<sub>3</sub>



H<sub>2</sub>SO<sub>4</sub> IS DI-PROTIC

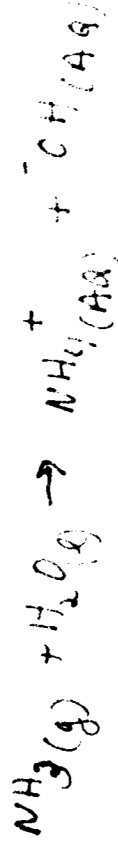


MOST ACIDS ARE WEAK ELECTROLYTES



BASES

- PRODUCE HYDROXIDE ION  $\text{OH}^-_{(\text{AQ})}$

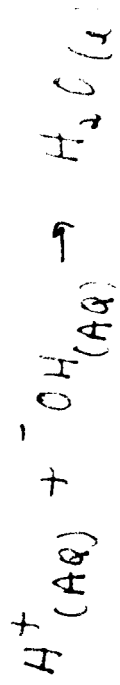


NEUTRALIZATION

ACID + BASE  $\rightarrow$  WATER + SALT



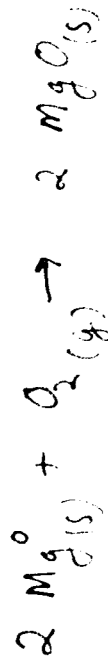
NET IONIC EQUATION (Na<sup>+</sup> AND Cl<sup>-</sup> ARE SPECTATORS)



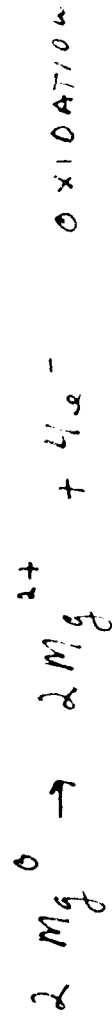
# OXIDATION-REDUCTION REACTIONS (REDOX)

ELECTRONS ARE TRANSFERRED FROM ONE SPECIES TO ANOTHER

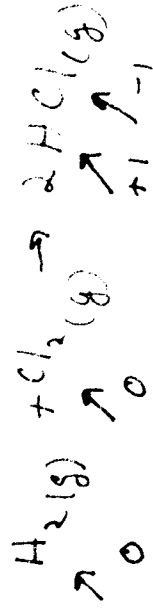
OXIDATION IS LOSS OF  $e^-$  OIL  
REDUCTION IS GAIN OF  $e^-$  RIG



HALF REACTIONS  $\rightarrow$  1 OXIDATION, 1 REDUCTION



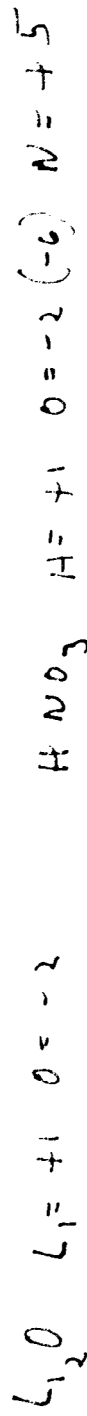
FOR MOLECULAR COMPOUNDS, USE OXIDATION NUMBERS



AN INCREASE IN OXIDATION NUMBER = OXIDATION

A DECREASE IN OXIDATION NUMBER = REDUCTION

- 1) ELEMENTS = 0  $\text{H}_2 = 0$
- 2) MONATOMIC IONS = CHARGE  $\text{Cu}^{2+} = 2$
- 3) OXYGEN = -2
- 4) HYDROGEN = +1 (EXCEPT METAL HYDRIDES)
- 5) THE SUM OF OXIDATION NUMBERS = 0

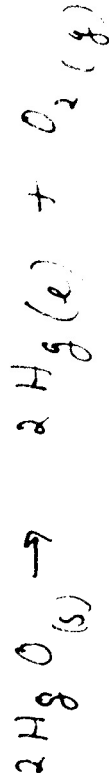


## COMMON REDOX REACTIONS

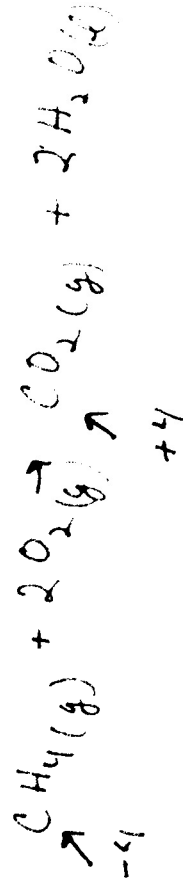
### COMBINATIONS



### DECOMPOSITIONS



### COMBUSTIONS

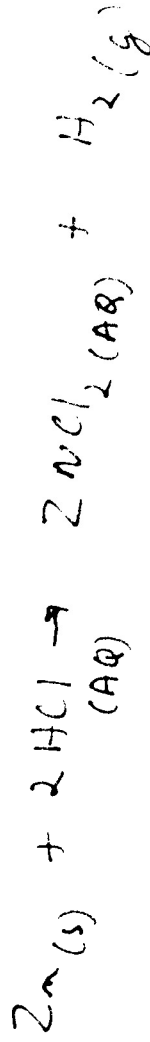


### DISPLACEMENTS

- HYDROGEN DISPLACEMENT  
FROM WATER



FROM ACID



- METAL DISPLACEMENT



NET



THIS LEADS TO THE ACTIVITY

SERIES OF THE METALS

CONCENTRATION OF SOLUTION

- EXPRESSED AS  $\text{MOL/L}$  (M) MOLAR

A SOLUTION PREPARED BY ADDING 0.400 MOL  $\text{NaOH}$

TO 0.500 L  $\text{H}_2\text{O}$  HAS A MOLARITY OF

$$\frac{0.400 \text{ mol NaOH}}{0.500 \text{ L H}_2\text{O}} = 0.800 \text{ M NaOH}$$

A SOLUTION PREPARED BY ADDING 60.0g HF (MW=20.0)  
TO 0.750L  $\text{H}_2\text{O}$  IS:

$$60.0 \text{ g HF} \times \frac{1 \text{ mol HF}}{20.0 \text{ g HF}} = \frac{3.00 \text{ mol HF}}{0.750 \text{ L}} = 4.00 \text{ M HF}$$

HOW MANY GRAMS OF GLUCOSE (MW=180.2g) ARE PRESENT  
IN 0.450L OF 1.20M GLUCOSE?

$$0.450 \text{ L soln} \times \frac{1.20 \text{ mol glucose}}{1 \text{ L soln}} \times \frac{180.2 \text{ g glucose}}{1 \text{ mol glucose}} = 97.3 \text{ g glucose}$$

NOTE: VOLUME  $\times$  MOLARITY = MOL

$$\text{L} \times \frac{\text{MOL}}{\text{L}} = \text{MOL}$$

DILUTION

- SINCE NUMBER OF MOLES DOES NOT CHANGE,

$$V_1 M_1 = V_2 M_2$$

PREPARE:

0.521 L OF 0.150 M  $\text{H}_2\text{SO}_4$  FROM 0.350 M  $\text{H}_2\text{SO}_4$

$$V_2 = \frac{V_1 M_1}{M_2} =$$

$$\frac{0.521 \text{ L} \times 0.150 \text{ mol}}{0.350 \frac{\text{mol}}{\text{L}}} = 0.223 \text{ L}$$

SO, DILUTE 0.223L OF 0.350M  $\text{H}_2\text{SO}_4 \rightarrow$  0.521L

## ACID / BASE NEUTRALIZATIONS

AN EXAMPLE OF SOLUTION STOICHIOMETRY

WHAT VOLUME OF 0.22 M NaOH WILL NEUTRALIZE  
100.0 mL OF 0.57 M HCl



NOTE: WHEN THE MOLAR RATIO IS 1:1

$$V_1 M_1 = V_2 M_2$$

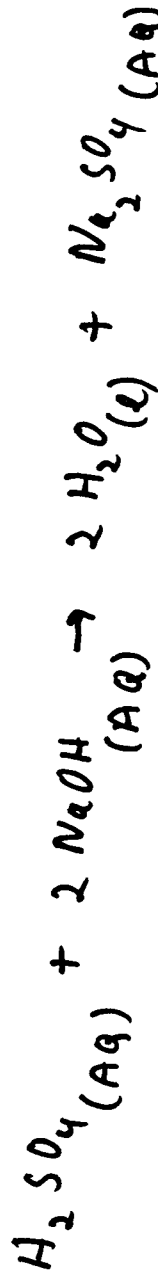
$$\text{SO } 100.0 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times 0.57 \frac{\text{mol HCl}}{\text{L}} = V_2 \times 0.22 \frac{\text{mol}}{\text{L}}$$

$$V_2 = \frac{0.57 \text{ mol}}{0.22 \frac{\text{mol}}{\text{L}}} = 0.259 \text{ L NaOH}$$

IF MOLAR RATIOS ARE NOT  
1:1  
THEN YOU MUST USE MOL RATIO IN CALC

WHAT VOLUME OF 0.091 M NaOH NEUTRALIZES

0.25 L OF 0.33 M H<sub>2</sub>SO<sub>4</sub>



$$0.25 \text{ L} \times \frac{0.33 \text{ mol H}_2\text{SO}_4}{1 \text{ L}} \times \frac{2 \text{ mol NaOH}}{1 \text{ mol H}_2\text{SO}_4} \times \frac{1 \text{ L}}{0.091 \text{ mol NaOH}} = 0.181 \text{ L NaOH}$$

CHECK

$$0.181 \text{ L NaOH} \times \frac{0.091 \text{ mol NaOH}}{1 \text{ L NaOH}} = 0.0165 \text{ mol NaOH}$$

$$0.25 \text{ L H}_2\text{SO}_4 \times \frac{0.33 \text{ mol H}_2\text{SO}_4}{1 \text{ L H}_2\text{SO}_4} = 0.0825 \text{ mol NaOH}$$

THIS IS THE 2:1 MOL RATIO