CHM 1025
Final Exam Review

Academic Resources

Welcome!

- Lead: Erin Kaufman
- Support: Angelica Caraballo-Santiago
- Please have your periodic table and a calculator!

Limiting Reagent

What is limiting reagent?

- Two reagents react, you need to find out how much of each reacted
- There will be less of one reagent available to react, this will be your limiting reagent
- Use dimensional analysis to:
  - Determine how much of each reagent reacts
    - Determine limiting reagent
  - Use limiting reagent to determine how much product is formed

Consider the following reaction: $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$. If 3.25 g NH_3 are allowed to react with 3.50 g O_2, how many grams of NO are formed?

$$3.25\,g\,NH_3 \cdot \frac{1\,mol\,NH_3}{17\,g\,NH_3} \cdot \frac{4\,mol\,NO}{4\,mol\,NH_3} \cdot \frac{30\,g\,NO}{1\,mol\,NO} = 5.74\,g\,NO$$

$$3.50\,g\,O_2 \cdot \frac{1\,mol\,O_2}{32\,g\,O_2} \cdot \frac{4\,mol\,NO}{5\,mol\,O_2} \cdot \frac{30\,g\,NO}{1\,mol\,NO} = \boxed{2.63\,g\,NO}$$

Consider the following reaction: $N_2 + 3H_2 \rightarrow 2NH_3$. If you use 30g of N_2 and 10 g of H_2, what is the mass of the excess reagent?

$$30g\ N_2 \cdot \frac{1mol\ N_2}{28g\ N_2} \cdot \frac{3\ mol\ H_2}{1\ mol\ N_2} \cdot \frac{2g\ H_2}{1mol\ H_2} = 6.43g\ H_2$$

$$10g\ H_2 - 6.43g\ H_2$$

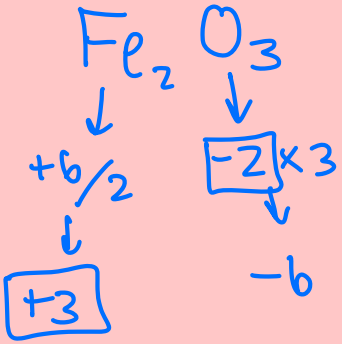
$$= \boxed{3.57g\ H_2}$$

Redox Reactions

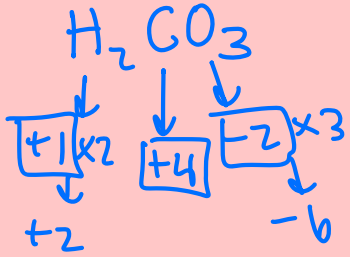
Finding Oxidation Numbers

- Oxidation number
  - The hypothetical charge of an atom if all of its bonds to different atoms were fully ionic
- Group 1 metals: always +1
- Group 2 metals: always +2
- Oxygen: usually -2
- Hydrogen: usually +1
- Halogens: usually -1
- Elements by themselves= 0!

What is the oxidation number of each atom in Fe_2O_3?



What is the oxidation number of each atom in H_2CO_3?



How Oxidation Numbers Relate to Redox

- Loss of electrons: oxidation
  - Charge gets more positive
- Gain of electrons: reduction
  - Charge gets more negative
- Remember: LEO the lion goes GER!
  - (Loss of Electrons=Oxidation, Gain of Electrons=Reduction)

In the reaction, $2HCl + Zn \rightarrow H_2 + ZnCl_2$, which reactant is oxidized and which reactant is reduced?

$$\underset{+1\ \ -1}{2HCl} + \underset{0}{Zn} \longrightarrow \underset{0}{H_2} + \underset{+2\ \ -1}{ZnCl_2}$$

Zn: $0 \rightarrow +2$ Zn is oxidized

H: $+1 \rightarrow 0$ H is reduced

In the reaction, $Au + 4H^+ + NO_3^- + 4Cl^- \rightarrow AuCl_4 + 2H_2O + NO$, which reactant is the oxidizing agent?

$$\underset{0}{Au} + \underset{+1}{4H^+} + \underset{+5\ \ -2}{NO_3^-} + \underset{-1}{4Cl^-} \rightarrow \underset{+4\ \ -1}{AuCl_4} + \underset{+1\ \ -2}{2H_2O} + \underset{+2\ \ -2}{NO}$$

Au: $0 \rightarrow +4$ Au got oxidized; Au is the reducing agent

N: $+5 \rightarrow +2$ N got reduced; NO_3^- is the oxidizing agent

Balancing Redox Reactions

- Half reaction method
  - Balance each species individually
  - Electrons are included
  - Ensure that electrons lost= electrons gained
  - Combine half reactions

Balance $MnO_4^- + SO_3^{2-} \rightarrow MnO_2 + SO_4^{2-}$ using the half reaction method

$$2\left(3e^- + 4H^+ + MnO_4^- \rightarrow MnO_2 + 2H_2O\right)$$

$$3\left(H_2O + SO_3^{2-} \rightarrow SO_4^{2-} + 2H^+ + 2e^-\right)$$

$$\cancel{6e^-} + 8H^+ + 2MnO_4^- \rightarrow 2\,MnO_2 + \cancel{4}H_2O$$

$$\cancel{3H_2O} + 3SO_3^{2-} \rightarrow 3SO_4^{2-} + \cancel{6H^+} + \cancel{6e^-}$$

$$2H^+ + 2MnO_4^- + 3SO_3^{2-} \rightarrow 2MnO_2 + 3SO_4^{2-} + H_2O$$

Titration

Titration

- You will have an acidic/basic solution
- You want it to become neutral, so you add base (acidic solution) or acid (basic solution)
- Titration stops when the solution is neutral

It takes 83 mL of a 0.45 M NaOH solution to neutralize 235 mL of an HCl solution. What was the initial concentration of the HCl solution?

$$NaOH + HCl \rightarrow NaCl + H_2O$$

$$(0.083\ L)(0.45 M) = 0.03735\ mol\ NaOH$$

$$mol\ NaOH = mol\ HCl$$

$$\frac{0.03735\ mol}{0.235\ L} = \boxed{0.16 M}$$

It takes 38 mL of 0.75 M NaOH solution to completely neutralize a 0.092 M solution of sulfuric acid (H_2SO_4). What was the initial volume of the sulfuric acid solution, in mL?

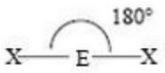
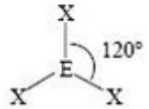
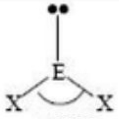
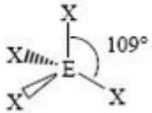
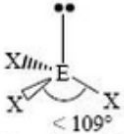
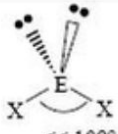
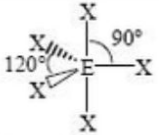
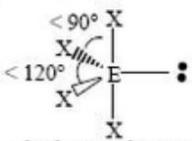
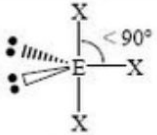
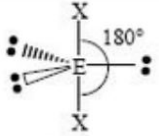
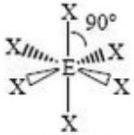
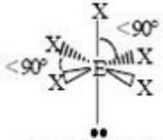
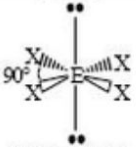
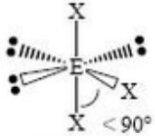
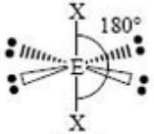
$$2NaOH + H_2SO_4 \rightarrow 2H_2O + Na_2SO_4$$

$$(0.038\,L)(0.75\,M) = 0.0285\ mol\ NaOH$$

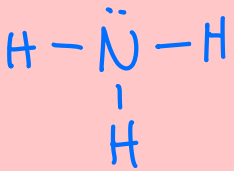
$$0.0285\ mol\ NaOH \cdot \frac{1\ mol\ H_2SO_4}{2\ mol\ NaOH} = 0.01425\ mol\ H_2SO_4$$

$$\frac{0.01425\ mol\ H_2SO_4}{0.092\ mol/L} = 0.155\,L = \boxed{155\,mL}$$

Molecular Geometry

Steric No.	Basic Geometry 0 lone pair	1 lone pair	2 lone pairs	3 lone pairs	4 lone pairs
2	 **Linear**				
3	 **Trigonal Planar**	 **Bent or Angular**			
4	 **Tetrahedral**	 **Trigonal Pyramid**	 **Bent or Angular**		
5	 **Trigonal Bipyramid**	 **Sawhorse or Seesaw**	 **T-shape**	 **Linear**	
6	 **Octahedral**	 **Square Pyramid**	 **Square Planar**	 **T-shape**	 **Linear**

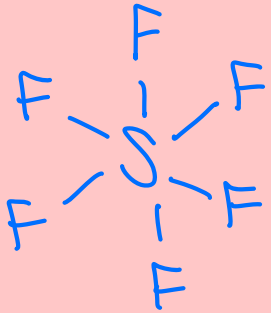
What is the molecular geometry of NH_3?



electronic geometry: tetrahedral

molecular geometry: trigonal pyramidal

What is the molecular geometry of SF_6?



electronic geometry: octahedral

molecular geometry: octahedral

Naming

Ionic Compounds

- Cation, then anion
- Normal ending for cation, -ide ending for anion
- Remember: polyatomic anion names may not adhere to this, use THEIR name
  - Ex. sulfate ion
- Transitions metals' charge indicated in name
  - Determine using deductive reasoning with anion
  - Ex. $FeCl_2$ is iron (II) chloride

Covalent Compounds

- Name non-metal furthest to the left by its elemental name
- Name the other non-metal by its elemental name and -ide ending
- Use prefixes to indicate the number of that element in the molecule
  - 1-mono, 2-di, 3-tri, 4-tetra, 5-penta, 6-hexa, 7-hepta, 8-octa, 9-nona, 10-deca-
- If mono is the first prefix, you do not need to include it
- Example: N_2O_4 is dinitrogen monoxide

What is the molecular formula of iron (III) oxide?

Fe^{3+} O^{2-}

Fe_2O_3

What is the molecular formula of carbon tetrachloride?

4

CCl_4

Empirical vs. Molecular Formula

Empirical vs. Molecular Formula

- Empirical formula
  - The simplest formula that shows the combination of atoms
  - No associated molar mass
- Molecular formula
  - Variant of empirical formula
  - Must be given molar mass in order to determine

A compound is 40.3% carbon, 6.7% hydrogen, and 53% oxygen by mass, and has a molar mass of 60.05 g/mol. What is it's molecular formula?

Assume 100g total

$\frac{40.3\,g\,C}{12\,g/mol} = \frac{3.358\,mol\,C}{3.313} = 1.01 \sim 1$

$\frac{6.7\,g\,H}{1\,g/mol} = \frac{6.7\,mol\,H}{3.313} = 2.02 \sim 2$

$\frac{53\,g\,O}{16\,g/mol} = \frac{3.313\,mol\,O}{3.313} = 1$

empirical: CH_2O

molar mass of empirical formula = 30 g/mol

$$\frac{60.05\ g/mol}{30\ g/mol} \approx 2$$

$$2(CH_2O)$$

$$\boxed{C_2H_4O_2}$$

Specific Heat

Specific Heat (c)

- Characteristic of a substance
  - Not dependent on total mass!
- Amount of heat per unit mass required to raise the temperature by 1ºC
- Equation: $q=mc\Delta t$
  - Question types
    - Can be asked about q, m, or Δt, and you will be given c and 2 variables
    - Can be asked to find c, given 2 variables (one of them being q)

Given that the specific heat of water is 4.184 J/g*C, if a water sample increases 3°C when given 50 J of heat, how much water was in the sample, in grams?

$C = 4.184\ J/g^\circ C$

$\Delta T = +3^\circ C$

$q = 50\ J$

$m = ?$

$q = mC\Delta T$

$m = \frac{q}{C\Delta T}$

$m = \frac{50\ J}{(4.184\ J/g^\circ C)(3^\circ C)}$

$m = 3.98\ g$