

Review Sheet - Exam #3

Chemical Reactions - a shorthand description indicating the relative numbers of all **reactants** and **products** of a chemical reaction.

Balancing Equations - The number of each type of atom cannot change in a chemical reaction: Every atom must be accounted for. This can be accomplished using the following general procedure.

1. Write the correct formulas for all reactants and products.
2. Select the 'simplest' atom, which only occurs in one molecule each in reactants and products.
3. Changing *only* the coefficients, balance the equation for this atom.
4. Repeat for all of the remaining atoms in the equation.

Molecular/Formula Weights - The M.W. of any molecule or the F.W. of any ionic compound can be determined by adding the masses of all atoms in a structure (multiplying by the number of each). For example, N_2O_5 has a molecular weight of $(2 \times 14.0 + 5 \times 16.0 = 108.0)$.

Mass/Mole Relationships

The mass of a single atom of carbon-12 = 12.00 amu.

Given that one **mole** = 6.022×10^{23} items, and that $1g = 6.022 \times 10^{23} amu$, it can be shown that:

The mass of 1.000 moles of carbon-12 = 12.00 grams

On the periodic table, the mass values given for each element are in units of $\frac{amu}{atom} = \frac{grams}{mole}$. This can be extended to molecules. For example, the molecular weight of ethanol (C_2H_6O) = $46.1 amu = 46.1 \frac{grams}{mole}$

Sample Problems

Grams \rightarrow Moles

How many moles in 5.00 grams ethanol?

$$5.00 \text{ g ethanol} \times \frac{1 \text{ mole}}{46.1 \text{ grams ethanol}} = 0.108 \text{ moles}$$

Moles \rightarrow Grams

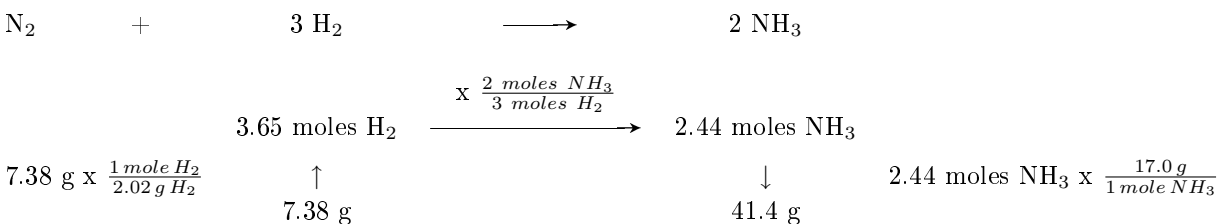
How many grams in 5.00 moles ethanol?

$$5.00 \text{ moles ethanol} \times \frac{46.1 \text{ grams}}{1 \text{ moles ethanol}} = 231 \text{ grams}$$

Stoichiometry

In these types of problems, the question will be to determine how much of a product can be formed from a given reactant in a balanced chemical equation. This can be done using the procedure illustrated in the following example.

Question: How many grams of NH_3 can be produced from 7.38 grams of H_2 ?

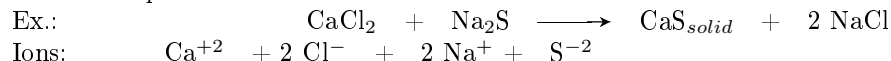


Limiting Reagents - The reactant that gives the least amount of product is the limiting reagent.

Percent Yield - The percent yield = $\frac{\text{experimental mass (actual)}}{\text{theoretical mass}} \times 100\%$

Reactions of Ionic Solutions

A reaction between two ionic compounds in solution will occur if either (1) an insoluble product is formed, or (2) water is formed. The insoluble product is referred to as a precipitate, and can be determined based on solubility rules. The products of these reactions can be determined from ‘swapping’ the positively-charged ions (cations). To determine the products, the formulas **MUST** be determined **FIRST**. Then, balance the equation. Be able to write the net ionic equation for these reactions.



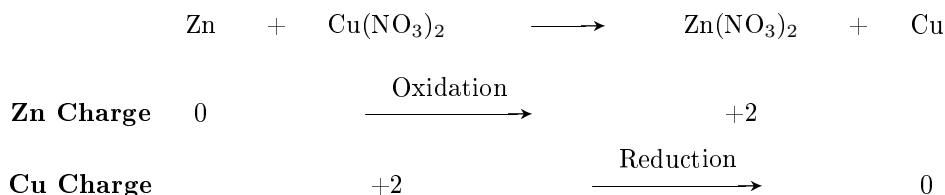
Solubility Rules

1. All ions containing Na^+ , K^+ , NH_4^+ , NO_3^- and CH_3COO^- are soluble
2. All Cl^- and Br^- salts are soluble except AgCl , AgBr , PbCl_2 , and PbBr_2
3. All SO_4^{-2} salts are soluble except BaSO_4 and PbSO_4
4. All CO_3^{-2} , PO_4^{-3} , S^{-2} , and OH^- salts are **insoluble** (unless one of above rules applies).

Redox Reactions

	Inorganic	Organic/Biochemical
Oxidation	Loss of electron(s)	Gain of O and/or Loss of H
Reduction	Gain of electron(s)	Gain of H and/or Loss of O

Example



Gas Laws

Ideal Gas Law: $PV = nRT$ $R = 0.0821 \frac{\text{L atm}}{\text{mol K}}$
 Partial Pressure: $P_{\text{total}} = P_A + P_B + \dots$ $\%A = \frac{P_A}{P_{\text{total}}}$

Intermolecular Forces

Weak forces between molecules. In decreasing order of strength (strongest to weakest):

- Hydrogen Bonds: Requires a donor (**H-F**, **H-O**, or **H-N**) and an acceptor (:F, :O, or :N).
- Dipole-Dipole: Interaction between polar molecules
- London (van der Waals): Interaction between any types of molecules. Increases with increasing number of electrons.

Intermolecular forces affect the properties of liquids in a predictable manner. Surface tension and Viscosity increase with stronger intermolecular forces. Vapor Pressure decreases and Boiling Point increases with stronger intermolecular forces (stronger attractions, so harder for molecules to escape to gas phase).

Phase Changes

Phase transitions occur at a constant temperature, but require or release heat throughout the phase change (which is why water doesn't instantly evaporate after it reaches its boiling point). The following equations apply:

$$q = s m \Delta T \quad (\text{for heating/cooling of a single phase}) \quad q = m \Delta H \quad (\text{for phase change})$$