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CHEMISTRY &
MATERIALS
SCIENCE

Introduction

Stoichiometry

All stoichiometric equations for quantities may be derived from

$$n_1/v_1 = n_2/v_2 \quad (1)$$

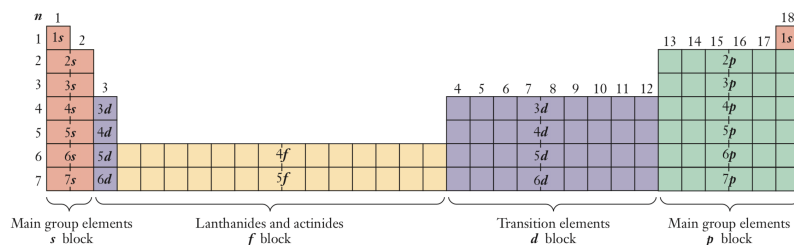
The percentage yield is defined as

$$\% \text{ yield} = \frac{\text{actual yield}}{\text{theo. yield}} \times 100\% \quad (2)$$

A crucial aspect in confirming stoichiometric results is using dimensional analysis; that is, using the dimensions of each unit in the equation(s) and confirming the final unit has the proper dimensions.

Bonding

The total number of orbitals is equal to n^2 , where n is the principle quantum number, wherein each orbital has a maximum of two electrons. This maximum occurs only if all subshells contain one electron originally, known as Hund's rule.



The formal charge is given by $q_f = n_v - n_l - \frac{1}{2}n_s$ in which $\sum q_f = 0$. Hybrid orbitals are dependent on molecular geometry, and filled by sp^3d^2 . The number of orbitals is equal to the number of electron pairs. The number of sigma and pi bonds is equal to

$$n_\sigma = \sum n_{\text{all}} \quad \text{and} \quad n_\pi = \sum n_{\text{dbl}} + 2 \sum n_{\text{tri}} \quad (3)$$

moles	$n = m/M = CV$
atoms	$n_{\text{atoms}} = \rho V N_a / M$
molarity	$C = mn/MV$
dilution	$n_1 = n_2$

Figure 1: Equations for quantities derived from Equation 1.

The orbitals are filled in the order of $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 \dots$

n_v is the total number of valence electrons; n_l is the number of lone pairs; and n_s is the number of electrons shared in bonds.

Atoms & Molecules

Other properties of the periodic table include

- Atomic size increases toward the bottom left;
- Ionization energy and electronegativity increase towards the top right;

Lewis dot structures are created via the following algorithm:

1. Count the total number of valence electrons in the molecule;
2. Place single bonds between all connected atoms;
3. Place the remaining valence electrons not accounted for in (2) on individual atoms, specifically as lone pairs whenever possible;
4. Create multiple bonds as needed for any atoms that do not have a full octet

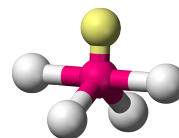


Figure 2: The seesaw VSEPR model constructed from a lewis diagram.

Chemical Equilibrium

Equilibrium Constants

A system is said to be at dynamic equilibrium if the rates of both reactions are equal but do not approach zero. For a general chemical reaction, the reaction quotient and equilibrium constant are

$$Q = \frac{[C]^c [D]^d}{[A]^a [B]^b} \quad \text{and} \quad K_c = \frac{[C]_{eq}^c [D]_{eq}^d}{[A]_{eq}^a [B]_{eq}^b} \quad (4)$$

A general equilibrium reaction is given by $aA + bB \rightleftharpoons cC + dD$, where a, b, \dots are the stoichiometric coefficients v .

respectively. For reactions which take place in the gas phase,

$$K_p = K_c RT^{\Delta n_g} \iff [X] \equiv P_X = [X]RT \quad (5)$$

where $\Delta n_g = c + d - (a + b)$. Reactions are homogeneous iff all constituents are either exclusively gaseous or aqueous. Incidentally, in a heterogeneous reaction, K only includes the compounds in the reaction which are not solid nor liquid. For a series of reactions,

$$K_n = \prod K_i \quad (6)$$