

General Chemistry Formulas Cheat Sheet

general chemistry formulas cheat sheet is an essential resource for students, educators, and anyone interested in mastering the fundamentals of chemistry. Whether you're preparing for exams, working on lab reports, or just brushing up your knowledge, having a comprehensive list of key formulas at your fingertips can significantly enhance your understanding and efficiency. Chemistry involves a variety of concepts, from atomic structure and chemical reactions to stoichiometry and thermodynamics. This cheat sheet aims to compile the most important formulas in a clear and organized manner, making it a handy reference for all levels of study.

Fundamental Concepts and Atomic Structure

Understanding the basics of atomic structure is crucial for grasping more complex chemical concepts. These formulas describe the properties of atoms, ions, and molecules.

Atomic and Molecular Mass

1. **Atomic mass (A):** Sum of protons and neutrons in an atom, measured in atomic mass units (amu or u).
2. **Molecular mass (M):** Sum of atomic masses of all atoms in a molecule.
3. **Formula:** $M = \sum (\text{atomic mass of each atom} \times \text{number of atoms})$

Avogadro's Number

1. **Number of particles (atoms, molecules, ions) in one mole:** 6.022×10^{23}

Mass, Moles, and Particles Relationship

1. **Number of particles (N):** $N = n \times N_A$
2. **Where:**
 1. n = number of moles
 2. N_A = Avogadro's number (6.022×10^{23})

Chemical Formulas and Stoichiometry

Stoichiometry involves the quantitative relationships in chemical reactions. Mastering these formulas helps in balancing equations and calculating yields.

Balancing Chemical Equations

- Ensure the number of atoms for each element is the same on both sides. - Use coefficients to balance.

Basic Mole Calculations

1. **Moles to grams:** $n = m / M$
 1. m = mass in grams
 2. M = molar mass in g/mol
2. **Grams to moles:** $m = n \times M$
3. **Particles to moles:** $n = N / N_A$
4. **Moles to particles:** $N = n \times N_A$

Reactant and Product Calculations

1. **Percent composition:** $(\text{mass of element} / \text{molar mass of compound}) \times 100\%$
2. **Empirical formula from percent composition** (by dividing each element's mass percentage by its atomic mass, then

dividing by the smallest number to get whole numbers).

3. **Molecular formula:** Empirical formula $\times$ (Molecular weight / Empirical formula weight)

Gas Laws and Volumetric Calculations

Gas laws describe the behavior of gases under various conditions of pressure, volume, temperature, and amount.

Ideal Gas Law

1. **PV = nRT**
2. Where:
 1. P = pressure (atm)
 2. V = volume (L)
 3. n = moles of gas
 4. R = ideal gas constant (0.0821 L·atm/mol·K)
 5. T = temperature (Kelvin)

Other Gas Laws

1. **Boyle's Law:** $P_1V_1 = P_2V_2$
2. **Charles's Law:** $V_1/T_1 = V_2/T_2$
3. **Gay-Lussac's Law:** $P_1/T_1 = P_2/T_2$
4. **Combined Gas Law:** $(P_1V_1)/T_1 = (P_2V_2)/T_2$

Solutions and Concentration

Understanding solution chemistry involves calculations related to molarity and dilution.

Molarity (M)

1. **Definition:** Moles of solute per liter of solution
2. **Formula:** $M = n / V \text{ (L)}$

Dilution Formula

1. $C_1V_1 = C_2V_2$
2. Where:
 1. C_1 = initial concentration
 2. V_1 = initial volume
 3. C_2 = final concentration
 4. V_2 = final volume

Thermodynamics and Equilibrium

Key formulas related to energy changes and reaction equilibria are fundamental in physical chemistry.

Enthalpy and Heat

1. $Q = mc\Delta T$
2. Q = heat absorbed or released (J or cal)
3. m = mass (g)
4. c = specific heat capacity (J/g·K)
5. ΔT = change in temperature (K)

Gibbs Free Energy

1. $\Delta G = \Delta H - T\Delta S$
2. Where:
 1. ΔG = change in Gibbs free energy
 2. ΔH = change in enthalpy
 3. ΔS = change in entropy
 4. T = temperature (Kelvin)

Equilibrium Constant

1. $K_{eq} = \frac{[\text{products}]^{\text{coefficients}}}{[\text{reactants}]^{\text{coefficients}}}$
2. For a general reaction: $aA + bB \rightleftharpoons cC + dD$
3. Expression: $K_{eq} = \frac{[C]^c \times [D]^d}{[A]^a \times [B]^b}$

Acids, Bases, and pH Calculations

A significant part of chemistry involves understanding acids, bases, and their interactions.

PH and pOH

1. $pH = -\log [H^+]$
2. $pOH = -\log [OH^-]$
3. $pH + pOH = 14$ (at 25°C)

Hydronium and Hydroxide Ion Concentrations

1. $[H^+] = 10^{-pH}$

$$2. [\text{OH}^-] = 10^{-\text{pOH}}$$

Acid and Base Strengths

1. **Strong acids:** HCl, HNO₃, H₂SO₄, etc.

2. **Weak acids**

General Chemistry Formulas Cheat Sheet: Your Ultimate Guide to Mastering Chemistry Calculations Chemistry is a foundational science that involves understanding the behavior, composition, and properties of matter. Whether you're a student preparing for exams, a researcher, or simply an enthusiast, having a comprehensive grasp of fundamental chemistry formulas is essential. This cheat sheet aims to serve as a detailed, organized resource that covers key formulas used across various branches of general chemistry, helping you navigate calculations with confidence and precision.

1. Atomic and Molecular Structure Formulas

Understanding the basic structure of atoms and molecules is crucial for chemistry calculations. These formulas help determine molar masses, molecular formulas, and atomic compositions.

1.1 Atomic Mass and Atomic Number

- Atomic Mass (Atomic Weight): The weighted average mass of an atom of an element, measured in atomic mass units (amu).

$$\text{Atomic Mass (amu)} = \sum (\text{isotope mass}) \times \text{abundance}$$
 - Atomic Number (Z): Number of protons in the nucleus; defines the element.

1.2 Molar Mass (Molecular Weight)

- Definition: The mass of one mole of a substance (g/mol).
 - Calculation:
$$M = \sum_i (n_i \times M_i)$$
 where n_i is the number of atoms of element i in the molecule, and M_i is the atomic mass of element i .

1.3 Empirical and Molecular Formulas

- Empirical Formula: The simplest whole-number ratio of atoms in a compound. - Molecular Formula:
$$\text{Molecular Formula} = \text{Empirical Formula} \times n$$
 where $n = \frac{\text{Molecular Weight}}{\text{Empirical Formula Weight}}$

2. Stoichiometry and Chemical Reactions

Stoichiometry involves quantitative relationships between reactants and products in chemical reactions. Mastering the formulas here is vital for predicting yields, limiting reagents, and reaction calculations.

2.1 Mole Conversions

- Number of Moles: $n = \frac{m}{M}$ where n = moles, m = mass of substance (g), M = molar mass (g/mol)
- Moles to Particles (Atoms, Molecules, Ions): $\text{Particles} = n \times N_A$ where N_A = Avogadro's number (6.022×10^{23} particles/mol)

2.2 Reaction Stoichiometry

- Balanced Chemical Equation: Use coefficients to relate moles of reactants and products. - Conversion Between Reactants and Products:
$$n_{\text{product}} = n_{\text{reactant}} \times \frac{\text{Coefficient of product}}{\text{Coefficient of reactant}}$$

2.3 Limiting Reactant and Theoretical Yield

- Limiting Reactant Calculation: 1. Convert all reactants to moles. 2. Use the stoichiometry to determine which reactant produces the least amount of product. 3. The limiting reactant is the one that runs out first. - Theoretical Yield:
$$\text{Theoretical Yield} = n_{\text{limiting}} \times \text{molar mass of product}$$
 - Percent Yield:
$$\% \text{Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100$$

3. Gas Laws and Calculations

Gases obey specific laws that relate pressure, volume, temperature, and amount. These are fundamental for understanding reactions involving gases.

3.1 Ideal Gas Law

$PV = nRT$ - Variables: - P = Pressure (atm, Pa) - V = Volume (L, m³) - n = Moles of gas - R = Ideal gas constant (0.08206 L·atm·mol⁻¹·K⁻¹) or (8.314 J·mol⁻¹·K⁻¹) - T = Temperature (K) - Applications: - Calculating moles from gas volume, pressure, and temperature. - Converting between conditions (e.g., STP to other conditions).

3.2 Combined Gas Law

$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$ - Used when pressure, volume, and temperature change.

3.3 Dalton's Law of Partial Pressures

$P_{\text{total}} = P_1 + P_2 + \dots + P_n$ - Total pressure is the sum of individual partial pressures.

3.4 Boyle's Law

$P_1 V_1 = P_2 V_2$ - For constant temperature and moles.

3.5 Charles's Law

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ - At constant pressure and moles.

3.6 Gay-Lussac's Law

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$ - At constant volume and moles.

4. Solutions and Concentrations

Understanding solution chemistry involves calculating concentrations, dilutions, and molarity.

4.1 Molarity (M)

$M = \frac{n}{V}$ quad mol/L - n = moles of solute - V = volume of solution in liters

4.2 Dilution Formula

$M_1 V_1 = M_2 V_2$ - Used to find the concentration or volume after dilution.

4.3 Percent Concentration

- Percent by mass: $\% \text{mass} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 100$ - Percent by volume:

$\% \text{volume} = \frac{\text{volume of solute}}{\text{volume of solution}} \times 100$

4.4 Mole Fraction

$X_i = \frac{n_i}{\sum n_i}$ - Used in vapor pressure and Raoult's law calculations.

4.5 Osmotic Pressure

$\Pi = i M R T$ - i = van't Hoff factor (number of particles the solute dissociates into)

5. Thermodynamics and Energy Calculations

Thermodynamic formulas help understand reaction spontaneity, energy changes, and equilibrium.

5.1 Enthalpy Change (ΔH)

- Standard Enthalpy Change: $\Delta H^\circ = \sum \Delta H^\circ_{\text{products}} - \sum \Delta H^\circ_{\text{reactants}}$

5.2 Entropy Change (ΔS)

- Calculated based on disorder or randomness; more complex but essential for spontaneity analysis.

5.3 Gibbs Free Energy (ΔG)

$\Delta G = \Delta H - T \Delta S$ - Spontaneity Criterion: - $\Delta G < 0$: Reaction is spontaneous. - $\Delta G > 0$: Reaction is non-spontaneous. - $\Delta G = 0$: Equilibrium.

5.4 Relationship Between ΔG and Equilibrium Constant (K)

$\Delta G^\circ = -RT \ln K$ - Predicts the position of equilibrium.

6. Acid-Base and pH Calculations

Acid-base chemistry relies heavily on pH, pOH, and related formulas to understand solution acidity and basicity.

6.1 pH and pOH

$\text{pH} = -\log [H^+]$

Questions & Answers About general chemistry formulas cheat sheet

No	Question	Answer
1	What are the key formulas for calculating molar mass in general chemistry?	Molar mass is calculated by summing the atomic masses of all atoms in a chemical formula, expressed as g/mol. For example, H ₂ O has a molar mass of $(2 \times 1.008) + 16.00 = 18.016$ g/mol.
2	How do I calculate the number of moles from mass and molar mass?	Use the formula: moles = mass (g) / molar mass (g/mol). This helps convert between mass and moles for any substance.
3	What is the ideal gas law and its formula?	The ideal gas law is $PV = nRT$, where P is pressure, V is volume, n is moles, R is the gas constant (8.314 J/mol·K), and T is temperature in Kelvin.
4	How do I calculate the concentration of a solution in molarity?	Molarity (M) = moles of solute / liters of solution. For example, 2 mol of NaCl in 1 L solution gives a concentration of 2 M.
5	What is the formula for calculating pH from hydrogen ion concentration?	$pH = -\log[H^+]$, where $[H^+]$ is the molar concentration of hydrogen ions in the solution.
6	How do I determine the empirical formula from percent composition?	Convert percentages to grams, then divide each by its atomic mass to find molar ratios, and simplify to the smallest whole numbers to get the empirical formula.
7	What is the formula for calculating percentage composition?	Percentage composition = (mass of element in compound / molar mass of compound) $\times$ 100%. It shows the percentage of each element in a compound.
8	How do I find the limiting reagent in a chemical reaction using formulas?	Calculate moles of each reactant, then divide by their respective coefficients in the balanced equation. The reactant with the smallest ratio is the limiting reagent.

chemistry formulas, periodic table, stoichiometry, atomic structure, chemical reactions, molar mass, acid-base formulas, bonding theories, gas laws, solution concentration