

AP Chemistry Formula and Strategy Guide

Atomic structure, bonding, intermolecular forces, reactions, kinetics, thermodynamics, equilibrium, acids and bases, and electrochemistry — the full AP Chemistry scope, with the particle-level reasoning free response rewards.

SECTIONS	8	WORKED EXAMPLES	2	FORMAT	Print friendly
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How to use this guide

A formula you cannot place is not knowledge yet. Work the recall drill below before the questions.

- AP Chemistry free response rewards particle-level explanations — connect every calculation back to what atoms and molecules are doing.
- Track units and significant figures through every step; a numerically correct answer with wrong units loses credit.
- Le Chatelier's principle, oxidation states, and dimensional analysis reappear across nearly every unit — know them cold.

1. Atomic structure and periodicity

NAME	FORMULA	WHEN TO USE
Electron configuration	fills orbitals in order of increasing energy	Predicting an element's chemical behavior.
Photoelectron spectroscopy (PES)	peaks show electron binding energy by sublevel	Identifying an element from experimental data.
Ionization energy trend	increases left to right, decreases top to bottom	Predicting how easily an atom loses an electron.
Coulomb's law	force is proportional to charge, inversely proportional to distance ²	Explaining trends in atomic/ionic size and bonding strength.

2. Molecular and ionic bonding

NAME	FORMULA	WHEN TO USE
Lewis structures	show bonding and lone pairs to satisfy the octet rule	Predicting a molecule's structure and reactivity.
VSEPR geometry	electron domains arrange to minimize repulsion	Predicting 3D molecular shape.
Bond polarity	based on electronegativity difference	Predicting whether a bond (and molecule) is polar.

NAME	FORMULA	WHEN TO USE
Types of solids	ionic, metallic, covalent network, molecular	Explaining a substance's melting point and conductivity.

3. Intermolecular forces and properties

NAME	FORMULA	WHEN TO USE
London dispersion	present in all molecules, strength increases with size	The only IMF in nonpolar molecules.
Dipole-dipole	between polar molecules	Explaining boiling point differences among similar-sized polar molecules.
Hydrogen bonding	strongest IMF, requires H bonded to N, O, or F	Explaining water's unusually high boiling point.
Solubility rule	like dissolves like (polar-polar, nonpolar-nonpolar)	Predicting whether two substances will mix.

4. Chemical reactions and stoichiometry

NAME	FORMULA	WHEN TO USE
Mole concept	6.022×10^{23} particles per mole	Converting between particles, mass, and moles.
Limiting reactant	the reactant that runs out first, caps product formed	Determining maximum possible yield.
Net ionic equation	shows only species that actually react, omits spectator ions	Representing what truly happens in solution.
Oxidation numbers	track electron loss/gain in redox reactions	Identifying oxidation and reduction.

WORKED EXAMPLE

Balance and identify the type: $_\text{Zn} + _\text{HCl} \rightarrow _\text{ZnCl}_2 + _\text{H}_2$.

- Balance: $\text{Zn} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$
- Zn goes from 0 to +2 (oxidized); H goes from +1 to 0 (reduced)
- This is a single-replacement redox reaction

Check: Charges and atom counts balance on both sides.

5. Kinetics

NAME	FORMULA	WHEN TO USE
Rate law	$\text{rate} = k[\text{A}]^m[\text{B}]^n$, exponents from experimental data	Predicting how concentration affects reaction rate.

NAME	FORMULA	WHEN TO USE
Reaction order	sum of the exponents in the rate law	Describing how sensitive the rate is to concentration.
Activation energy	the energy barrier a reaction must overcome	Explaining why some reactions are slow at room temperature.
Catalyst	speeds a reaction by lowering activation energy without being consumed	Explaining a rate increase without a stoichiometric change.

6. Thermodynamics

NAME	FORMULA	WHEN TO USE
Enthalpy (delta H)	heat absorbed/released at constant pressure	Determining if a reaction is exothermic or endothermic.
Hess's law	delta H of a multi-step reaction = sum of delta H of the steps	Finding an unknown enthalpy from known reactions.
Entropy (delta S)	measure of disorder; increases with more gas particles	Predicting the sign of entropy change.
Gibbs free energy	delta G = delta H - T delta S	Predicting whether a reaction is spontaneous.

WORKED EXAMPLE

A reaction has delta H = -50 kJ and delta S = -100 J/K at T = 300 K. Find delta G and determine spontaneity.

1. Convert delta S to kJ/K: -0.100 kJ/K
2. delta G = -50 - (300)(-0.100)
3. delta G = -50 + 30 = -20 kJ, spontaneous (negative)

Check: A negative delta G confirms the reaction is spontaneous at this temperature.

7. Equilibrium

NAME	FORMULA	WHEN TO USE
Equilibrium constant K	products over reactants, each raised to its coefficient	Describing the position of equilibrium.
Large K	favors products at equilibrium	K much greater than 1.
Small K	favors reactants at equilibrium	K much less than 1.
Le Chatelier's principle	a system shifts to relieve an applied stress	Predicting the effect of a change on equilibrium.

8. Acids, bases, and electrochemistry

NAME	FORMULA	WHEN TO USE
pH	$-\log[\text{H}_3\text{O}^+]$	Measuring acidity.
Strong acid/base	fully dissociates in water	Determining if $[\text{H}^+]$ equals the initial concentration directly.
Buffer	resists pH change; a weak acid/base + its conjugate	Explaining why a solution's pH stays nearly constant.
Galvanic cell	spontaneous redox reaction generates electrical energy	Explaining how a battery produces current.
Standard cell potential	$E_{\text{cell}} = E_{\text{cathode}} - E_{\text{anode}}$	Predicting whether a redox reaction is spontaneous.

Notes and tutor hand-off

Bring this page to your next session so the tutor can start from what actually blocked you.

Which unit (kinetics, thermo, or equilibrium) needs another pass?

One particle-level explanation you want to practice writing out fully:

Worksheet question numbers to review with a tutor:
