Modified from *College Physics*, 8th Ed., Serway and Vuille.

For the quizzes and tests, you should know all the concepts and equations in this summary.

Section 28.3: The Bohr Atom

The Bohr model of the atom is successful in describing the spectra of atomic hydrogen and hydrogen-like ions. One of the basic assumptions of the model is that the electron can exist only in certain orbits such that its angular momentum \( mvr \) is an integral multiple of \( \hbar \), where \( \hbar \) is Planck's constant divided by \( 2\pi \). Assuming circular orbits and a Coulomb force of attraction between electron and proton, the energies of the quantum states for hydrogen are

\[
E_n = -\frac{m_e^2 k_e^2 e^4}{2\hbar^2} \left( \frac{1}{n^2} \right) = -E_1 \left( \frac{1}{n^2} \right) \quad n = 1, 2, 3, \ldots \tag{28.13}
\]

Only memorize the second form.

where \( k_e \) is the Coulomb constant, \( e \) is the charge on the electron, and \( n \) is an integer called the principal quantum number.

If the electron in the hydrogen atom jumps from an orbit having quantum number \( n_i \) to an orbit having quantum number \( n_f \), it emits a photon of frequency \( f \), given by

\[
f = \frac{\left| E_1 \right|}{2\pi \hbar} \left( \frac{1}{n_f^2} - \frac{1}{n_i^2} \right) \tag{28.15}
\]

The correspondence principle states that quantum mechanics is in agreement with classical physics when the quantum numbers for a system are very large.

Section 28.4: Quantum Mechanics and the Hydrogen Atom

One of the many successes of quantum mechanics is that the quantum numbers \( n \), \( \ell \), and \( m_\ell \) associated with atomic structure arise directly from the mathematics of the theory. The quantum number \( n \) is called the principal quantum number, \( \ell \) is the angular momentum quantum number (or orbital quantum number), and \( m_\ell \) is the (orbital) magnetic quantum number. These quantum numbers can take only certain values: \( 1 \leq n < \infty \) in integer steps, \( 0 \leq \ell \leq n - 1 \), and \( -\ell \leq m_\ell \leq \ell \). In addition, a fourth quantum number, called the spin magnetic quantum number \( m_s \), is needed to explain a fine doubling of lines in atomic spectra, with \( m_s = \pm \frac{1}{2} \).

Section 28.5: The Exclusion Principle and the Periodic Table

An understanding of the periodic table of the elements became possible when Pauli formulated the exclusion principle, which states that no two electrons in an atom in the same atom can have the same values for the set of quantum numbers \( n \), \( \ell \), \( m_\ell \), and \( m_s \). A particular set of these
quantum numbers is called a quantum state. The exclusion principle explains how different energy levels in atoms are populated. Once one subshell is filled, the next electron goes into the vacant subshell that is lowest in energy. Atoms with similar configurations in their outermost shell have similar chemical properties and are found in the same column of the periodic table.