

KEY TERMS

blackbody radiation (p. 752)

ultraviolet catastrophe
(p. 753)

photoelectric effect (p. 756)

photon (p. 757)

work function (p. 757)

Compton shift (p. 760)

emission spectrum (p. 764)

absorption spectrum (p. 764)

uncertainty principle (p. 775)

PROBLEM SOLVING

See **Appendix D: Equations** for a summary of the equations introduced in this chapter. If you need more problem-solving practice, see **Appendix I: Additional Problems**.

KEY IDEAS

Section 1 Quantization of Energy

- Blackbody radiation and the photoelectric effect contradict classical physics, but they can be explained with the assumption that energy comes in discrete units, or is quantized.
- The energy of a light quantum, or photon, depends on the frequency of the light. Specifically, the energy of a photon is equal to frequency multiplied by Planck's constant.
- Planck's constant (h) is approximately equal to $6.63 \times 10^{-34} \text{ J}\cdot\text{s}$.
- The relation between the electron volt and the joule is as follows:
 $1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$.
- The minimum energy required for an electron to escape from a metal depends on the threshold frequency of the metal.
- The maximum kinetic energy of photoelectrons depends on the work function and the frequency of the light shining on the metal.

Section 2 Models of the Atom

- Rutherford's scattering experiment revealed that all of an atom's positive charge and most of an atom's mass are concentrated at its center.
- Each gas has a unique emission and absorption spectrum.
- Atomic spectra are explained by Bohr's model of the atom, in which electrons move from one energy level to another when they absorb or emit photons.

Section 3 Quantum Mechanics

- Light has both wave and particle characteristics.
- De Broglie proposed that matter has both wave and particle characteristics.
- Simultaneous measurements of position and momentum cannot be made with infinite accuracy.

Variable Symbols

Quantities		Units	
E	photon energy	J	joules
		eV	electron volts
f_t	threshold frequency	Hz	hertz
hf_t	work function	eV	electron volts
KE_{\max}	maximum kinetic energy	eV	electron volts