Conceptual Questions

21. Explain why all of the wavelengths in an element's absorption spectrum are also found in that element's emission spectrum.

22. More emission lines than absorption lines are usually observed in the atomic spectra of most elements. Explain why this occurs.

Practice Problems

For problems 23–24, see Sample Problem C.

23. Electrons in the ground state of hydrogen (energy level E_1) have an energy of -13.6 eV. Use this value and the energy-level diagram in Sample Problem C to calculate the frequencies of photons emitted when electrons drop to the ground state from the following energy levels:

a. E_2
b. E_3
c. E_4
d. E_5

24. Sketch an emission spectrum showing the relative positions of the emission lines produced by the photons in problem 23. In what part of the electromagnetic spectrum are these lines?

QUANTUM MECHANICS

Review Questions

25. Name two situations in which light behaves like a wave and two situations in which light behaves like a particle.

26. What does Heisenberg's uncertainty principle claim?

27. How do de Broglie's matter waves account for the "allowed" electron orbits?

28. Describe the quantum-mechanical model of the atom. How is this model similar to Bohr's model? How are the two different?

Conceptual Questions

29. How does Heisenberg's uncertainty principle conflict with the Bohr model of hydrogen?

30. Why can the wave properties of an electron be observed, while those of a speeding car cannot?

31. An electron and a proton are accelerated from rest through the same potential difference. Which particle has the longer wavelength? (Hint: Note that $\Delta PE = q\Delta V = \Delta KE$.)

32. Discuss why the term *electron cloud* is used to describe the arrangement of electrons in the quantum-mechanical view of the atom.

Graphing Calculator Practice

De Broglie Wavelength

In 1924, Louis de Broglie proposed the radical new idea that all forms of matter have both wave and particle properties. As you learned earlier in this chapter, this idea is demonstrated in the de Broglie equation.

$$\lambda = \frac{h}{mv}$$

In this equation, mass (m) and velocity (v) are particle properties, and wavelength (λ) is a wave property.

In this graphing calculator activity, you will use this equation to study the de Broglie wavelengths associated with moving particles of various masses and various speeds. You will discover why this equation has very different consequences for subatomic particles, such as electrons and neutrons, than for macroscopic particles, such as baseballs.

Visit go.hrw.com and type in the keyword **HF6ATMX** to find this graphing calculator activity. Refer to **Appendix B** for instructions on downloading the program for this activity.