CHAPTER 5

Assessment

Reviewing Content

5.1 Models of the Atom

22. What was inadequate about Rutherford's model of the atom? Which subatomic particles did Thomson include in the plum-pudding model of the atom?

23. What did Bohr assume about the motion of electrons?

24. Describe Rutherford's model of the atom and compare it with the model proposed by his student Niels Bohr.

25. What is the significance of the boundary of an electron cloud?

26. What is an atomic orbital?

27. How many orbitals are in the $2p$ sublevel?

28. Sketch $1s$, $2s$, and $2p$ orbitals using the same scale for each.

29. How many sublevels are contained in each of these principal energy levels?
a. $n = 1$ **b.** $n = 2$ **c.** $n = 3$ **d.** $n = 4$

5.2 Electron Arrangement in Atoms

30. How many electrons are in the highest occupied energy level of these atoms?
a. barium **b.** sodium
c. aluminum **d.** oxygen

31. What are the three rules that govern the filling of atomic orbitals by electrons?

32. Write electron configurations for the elements that are identified only by these atomic numbers.
a. 15 **b.** 12 **c.** 9 **d.** 18

33. What is meant by $3p^3$?

34. Give electron configurations for atoms of these elements:
a. Na **b.** S **c.** Mg **d.** Ne **e.** K

35. Which of these orbital designations are invalid?
a. $4s$ **b.** $3f$ **c.** $2d$ **d.** $3d$

36. What is the maximum number of electrons that can go into each of the following sublevels?
a. $2s$ **b.** $3p$ **c.** $4s$ **d.** $3d$
e. $4p$ **f.** $5s$ **g.** $4f$ **h.** $5p$

37. Arrange the following sublevels in order of increasing energy:
$3d$, $2s$, $4s$, $3p$.

38. How many electrons are in the second energy level of an atom of each element?
a. chlorine **b.** phosphorus **c.** potassium

39. Write electron configurations for atoms of these elements.
a. selenium **b.** vanadium
c. nickel **d.** calcium

5.3 Physics and the Quantum Mechanical Model

40. List the colors of the visible spectrum in order of increasing wavelength.

41. What is meant by the frequency of a wave? What are the units of frequency? Describe the relationship between frequency and wavelength.

42. Use a diagram to illustrate each term for a wave.
a. wavelength
b. amplitude
c. cycle

43. Explain the difference between the energy lost or gained by an atom according to the laws of classical physics and according to the quantum model of an atom.

44. How are ultraviolet radiation and microwave radiation the same? How are they different?

45. Consider the following regions of the electromagnetic spectrum: (i) ultraviolet, (ii) X-ray, (iii) visible, (iv) infrared, (v) radio wave, (vi) microwave.
a. Use Figure 5.10 to arrange them in order of decreasing wavelength.
b. How does this order differ from that of decreasing frequency?

46. List one way in which each of the radiations listed in Question 45 is used.

47. What happens when a hydrogen atom absorbs a quantum of energy?

48. When white light is viewed through sodium vapor in a spectroscope, the spectrum is continuous except for a dark line at 589 nm. How can you explain this observation?

49. The transition of electrons from higher energy levels to the $n = 2$ energy level results in the emission of light from hydrogen atoms. In what part of the spectrum is the emitted light, and what is the name given to this transition series?

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Reviewing Content

22. could not explain why metals and metal compounds give off characteristic colors when heated, nor could it explain the chemical properties of the elements; electrons

23. that electrons traveled in circular paths around the nucleus

24. In Rutherford's model, negatively charged electrons surround a dense, positively charged nucleus. In Bohr's model, the electrons are assigned to concentric circular orbits of fixed energy.

25. An electron is found 90% of the time inside this boundary.

26. a region in space around the nucleus in which there is a high probability of finding an electron

27. 3

28. The $1s$ orbital is spherical. The $2s$ orbital is spherical with a diameter larger than that of the $1s$ orbital. The three $2p$ orbitals are dumbbell shaped and oriented at right angles to each other.

29. a. 1 **b.** 2 **c.** 3 **d.** 4

30. a. 2 **b.** 1 **c.** 3 **d.** 6

31. Electrons occupy the lowest possible energy levels. An atomic orbital can hold at most two electrons. One electron occupies each of a set of orbitals with equal energies before any pairing of electrons occurs.

32. a. $1s^22s^22p^63s^23p^3$ **b.** $1s^22s^22p^63s^2$
c. $1s^22s^22p^5$ **d.** $1s^22s^22p^63s^23p^6$

33. The p orbitals in the third quantum level have three electrons.

34. a. $1s^22s^22p^63s^1$ **b.** $1s^22s^22p^63s^23p^4$
c. $1s^22s^22p^63s^2$ **d.** $1s^22s^22p^6$
e. $1s^22s^22p^63s^23p^64s^1$

35. b and **c**

36. a. 2 **b.** 6 **c.** 2 **d.** 10 **e.** 6
f. 2 **g.** 14 **h.** 6

37. $2s, 3p, 4s, 3d$

38. a. 8 **b.** 8 **c.** 8

39. a. $1s^22s^22p^63s^23p^63d^{10}4s^24p^4$ **b.** $1s^22s^22p^63s^23p^63d^34s^2$ **c.** $1s^22s^22p^63s^23p^63d^84s^2$ **d.** $1s^22s^22p^63s^23p^64s^2$

40. Violet, indigo, blue, green, yellow, orange, red

41. Frequency is the number of wave cycles that pass a given point per unit time. Frequency units are cycles/s or s^{-1} or Hertz. Wavelength and frequency are inversely related.

42. diagrams similar to those in Figure 5.9

43. Classical physics views energy changes as continuous. In the quantum concept, energy changes occur in tiny discrete units called quanta.

44. Both travel at the same speed. Ultraviolet is short wavelength and high frequency; microwave is long wavelength and low frequency.

45. a. v, vi, iv, iii, i, ii **b.** It is the reverse.

46. Students may say that ultraviolet is used for tanning the skin and growing plants, X-rays for taking pictures of the interior of the body, visible for seeing, infrared for warmth, radio waves for communication, and microwaves for cooking.

47. The electron of the hydrogen atom is raised (excited) to a higher energy level.

48. The outermost electron of sodium absorbs photons of wavelength 589 nm as it jumps to a higher energy level.

49. visible spectrum, Balmer series