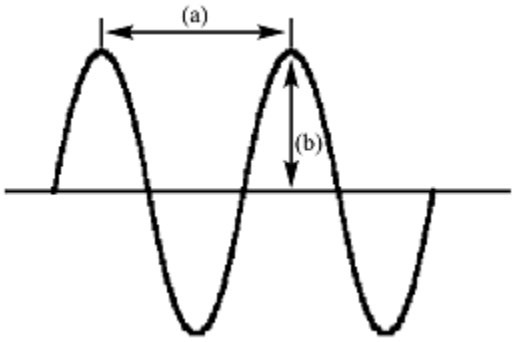
Chapter 07: The Electronic Structure of Atoms

1. In the following diagram of a wave



A) (a) is amplitude and (b) is wavelength
B) (a) is frequency and (b) is amplitude
C) (a) is wavelength and (b) is frequency
D) (a) is amplitude and (b) is frequency
E) (a) is wavelength and (b) is amplitude

3. What is the wavelength of radiation that has a frequency of 5.39×10^{14} s^{-1}? ($c = 2.9979 \times 10^8$ m/s)
A) 1.80×10^{-3} nm B) 556 nm C) 618 nm D) 6180 nm E) 1.61×10^{23} nm

5. Calculate the frequency of visible light having a wavelength of 486 nm.
A) 2.06×10^{14} /s
B) 2.06×10^{6} /s
C) 6.17×10^{14} /s
D) 1.20×10^{-15} /s
E) 4.86×10^{-7} /s

7. What is the energy in joules of one photon of microwave radiation with a wavelength 0.122 m? ($c = 2.9979 \times 10^8$ m/s; $h = 6.626 \times 10^{-34}$ J·s)
A) 2.70×10^{-43} J
B) 5.43×10^{-33} J
C) 1.63×10^{-24} J
D) 4.07×10^{-10} J
E) 2.46×10^{9} J

9. What is the energy in joules of a mole of photons associated with red light of wavelength 7.00×10^2 nm?
A) 256 kJ B) 1.71×10^5 J C) 4.72×10^{-43} J D) 12.4 kJ E) 2.12×10^{42} J

11. Complete this sentence: Atoms emit visible and ultraviolet light
    A) as electrons jump from lower energy levels to higher levels.
    B) as the atoms condense from a gas to a liquid.
    C) as electrons jump from higher energy levels to lower levels.
    D) as they are heated and the solid melts to form a liquid.
    E) as the electrons move about the atom within an orbit.

13. Calculate the wavelength, in nanometers, of the light emitted by a hydrogen atom when its electron falls from the n = 7 to the n = 4 principal energy level. Recall that the energy levels of the H atom are given by $E_n = -2.18 \times 10^{-18}\ J(1/n^2)$
    A) 4.45×10^{-20} nm
    B) 2.16×10^{-6} nm
    C) 9.18×10^{-20} nm
    D) 1.38×10^{14} nm
    E) 2.16×10^{3} nm

15. Calculate the frequency of the light emitted by a hydrogen atom during a transition of its electron from the n = 4 to the n = 1 principal energy level. Recall that for hydrogen $E_n = -2.18 \times 10^{-18}\ J(1/n^2)$
    A) 3.08×10^{15} /s
    B) 1.03×10^{8} /s
    C) 2.06×10^{14} /s
    D) 1.35×10^{-51} /s
    E) 8.22×10^{14} /s

17. The second line of the Balmer series occurs at a wavelength of 486.1 nm. What is the energy difference between the initial and final levels of the hydrogen atom in this emission process?
    A) 2.44×10^{18} J
    B) 4.09×10^{-19} J
    C) 4.09×10^{-22} J
    D) 4.09×10^{-28} J
    E) 1.07×10^{-48} J

19. A photon is roughly 1800 times more massive than an electron. If a proton and an electron have the same kinetic energy,
    A) the wavelength of the photon will be about 1800 times longer than the wavelength of the electron.
    B) the wavelength of the photon will be about $\sqrt{1800}$ times longer than the wavelength of the electron.
    C) the wavelength of the photon will be roughly equal to the wavelength of the electron.
    D) the wavelength of the electron will be about $\sqrt{1800}$ times longer than the wavelength of the photon.
    E) the wavelength of the electron will be about 1800 times longer than the wavelength of the photon.

21. If a hydrogen atom and a helium atom have the same kinetic energy,
    A) the wavelength of the hydrogen atom will be about 4 times longer than the wavelength of the helium atom.
    B) the wavelength of the hydrogen atom will be about 2 times longer than the wavelength of the helium.
    C) the wavelength of the hydrogen atom will be roughly equal to the wavelength of the helium atom.
    D) the wavelength of the helium atom will be about 2 times longer than the wavelength of the hydrogen atom.
    E) the wavelength of the helium atom will be about 4 times longer than the wavelength of the hydrogen atom.

23. Calculate the wavelength associated with a $^{20}Ne^{+}$ ion moving at a velocity of 2.0×10^{5} m/s. The atomic mass of Ne-20 is 19.992 amu.
    A) 1.0×10^{-13} m
    B) 1.0×10^{-16} m
    C) 1.0×10^{-18} m
    D) 9.7×10^{12} m
    E) 2.0×10^{-13} cm

25. A common way of initiating certain chemical reactions with light involves the generation of free halogen atoms in solution. If ΔH for the reaction $Cl_2(g) \rightarrow 2Cl(g)$ is 242.8 kJ/mol, what is the longest wavelength of light that will produce free chlorine atoms in solution?
    A) 246.3 nm B) 465.2 nm C) 349.3 nm D) 698.6 nm E) 492.6 nm

27. When photons with a wavelength of 310. nm strike a magnesium plate, the maximum velocity of the ejected electrons is 3.45×10^{5} m/s. Calculate the binding energy of electrons to the magnesium surface.
    A) 386 kJ/mol
    B) 419 kJ/mol
    C) 32.7 kJ/mol
    D) 321 kJ/mol
    E) 353 kJ/mol

29. A single pulse of a laser yields an average of 5.00×10^{18} photons with $\lambda = 633$ nm. If melting ice to water at 0°C requires 6.01 kJ/mol, what is the fewest number of laser pulses need to melt 10.0 g of ice?
    A) 3830 B) 3340 C) 38300 D) 2120 E) 212

31. Which one of the following sets of quantum numbers is not possible?

	n	l	m_l	m_s
A)	4	3	–2	+1/2
B)	3	2	–3	–1/2
C)	3	0	0	+1/2
D)	4	1	1	–1/2
E)	2	0	0	+1/2

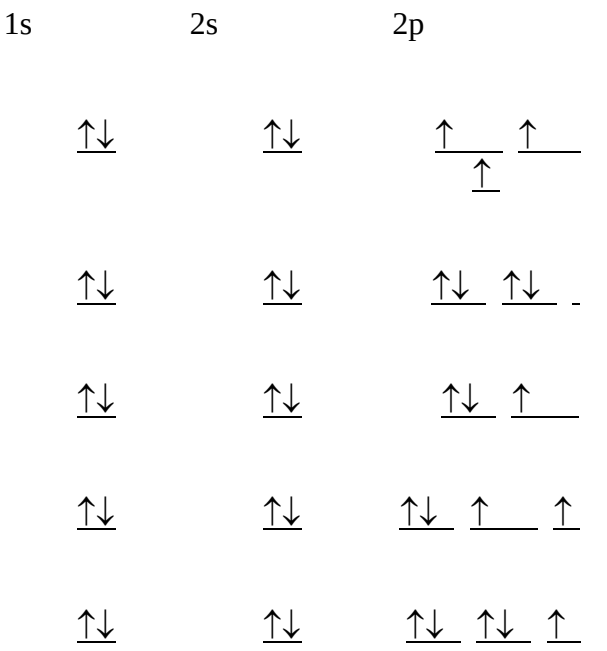
33. A possible set of quantum numbers for the last electron added to complete an atom of gallium (Ga) in its ground state is

	n	l	m_l	m_s
A)	4	0	0	–1/2
B)	3	1	0	–1/2
C)	4	1	0	+1/2
D)	3	1	1	+1/2
E)	4	2	1	+1/2

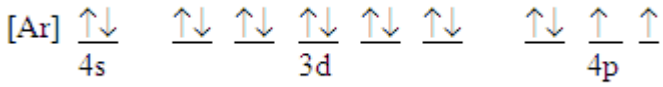
37. The maximum number of electrons that can occupy an energy level described by the principal quantum number, *n*, is
A) n B) $n + 1$ C) $2n$ D) $2n^2$ E) n^2

39. "No two electrons in an atom can have the same four quantum numbers" is a statement of
A) the Pauli exclusion principle.
B) Bohr's equation.
C) Hund's rule.
D) de Broglie's relation.
E) Dalton's atomic theory.

41. The orbital diagram for a ground-state oxygen atom is

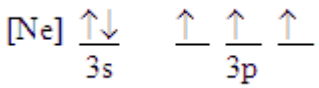


43. Which ground-state atom has an electron configuration described by the following *orbital diagram*?



A) phosphorus B) germanium C) selenium D) tellurium E) none of these

45. Which ground-state atom has an electron configuration described by the following *orbital diagram*?



A) phosphorus B) nitrogen C) arsenic D) vanadium E) none of these

47. A ground-state atom of arsenic has
A) no unpaired electrons.
B) one unpaired electron.
C) two unpaired electrons.
D) three unpaired electrons.
E) four unpaired electrons.

49. Which element has the following ground-state electron configuration?
$[Kr]5s^2 4d^{10} 5p^3$
A) Sn B) Sb C) Pb D) Bi E) Te

51. Which element has the following ground-state electron configuration?
$[Kr]5s^1 4d^5$
A) Mn B) Mo C) Nb D) Re E) Tc

53. The electron configuration of a ground-state Co atom is
A) $[Ar]4s^2 3d^7$.
B) $1s^2 2s^2 2p^6 3s^2 3d^9$.
C) $[Ne]3s^2 3d^7$.
D) $[Ar]4s^1 3d^5$.
E) $[Ar]4s^2 4d^7$.

55. The electron configuration of a ground-state copper atom is
A) $[Ar]4s^2 4d^4$.
B) $[Ar]4s^2 4p^6 3d^3$.
C) $[Ar]4s^2 3d^9$.
D) $[Ar]3d^9$.
E) $[Ar]4s^1 3d^{10}$.

57. Which of the following is the ground-state electron configuration of a calcium atom?
A) $[Ne]3s^2$ B) $[Ne]3s^2 3p^6$ C) $[Ar]4s^1 3d^1$ D) $[Ar]4s^2$ E) $[Ar]3d^2$

59. How many electrons are there in the 3rd principal energy level (n = 3) of a phosphorus atom?
A) 3 B) 5 C) 6 D) 8 E) 10

61. A ground-state atom of vanadium has ___ unpaired electrons and is _____.
A) 0, diamagnetic
B) 2, diamagnetic
C) 3, paramagnetic
D) 5, paramagnetic
E) 4, diamagnetic

63. Transition metal elements have atoms or ions with partially filled
A) *s* subshells.
B) *p* subshells.
C) *d* subshells.
D) *f* subshells.
E) *g* subshells.

65. Which choice lists two elements with ground-state electron configurations that are well known exceptions to the Aufbau principle?
A) Cu and C B) Cr and Cu C) Cs and Cl D) Rb and Co E) Fe and Co

67. Which of the following is the electron configuration of an excited state of an oxygen atom?
A) $1s^2 2s^2 2p^4$ B) $1s^2 2s^2 2p^5$ C) $1s^2 2s^2 2p^3 3s^1$ D) $1s^2 2s^2 2p^6$ E) $1s^2 2s^2 2p^3$

69. Which of the following is the electron configuration of an excited state of a copper atom?
A) $[Ar]4s^2 3d^9$
B) $[Ar]4s^1 3d^{10}$
C) $[Ar]4s^1 3d^8$
D) $[Ar]4s^2 3d^8$
E) $[Ar]4s^0 3d^{10}$

71. How many electrons in a ground-state tellurium atom are in orbitals labeled by $l = 1$?
A) 4 B) 10 C) 12 D) 16 E) 22

73. Which of the following ground-state atoms is diamagnetic?
A) Ca B) As C) Cu D) Fe E) none of these

75. Which of the following is diamagnetic both in its ground state and in all of its excited states?
A) Mg B) Ne C) Cu D) Zn E) none of these

77. The electron in a hydrogen atom falls from an excited energy level to the ground state in two steps, causing the emission of photons with wavelengths of 1870 and 102.5 nm. What is the quantum number of the initial excited energy level from which the electron falls?
A) 2 B) 3 C) 4 D) 6 E) 8

79. When the electron in a hydrogen atom falls from its first excited energy level to the ground state energy level, a photon with wavelength λ is emitted. A proton having this same wavelength would have a velocity of
A) 3.87 m/s. B) 5990 m/s. C) 1.21×10^{-7} m/s. D) 3.26 m/s. E) 5.99 m/s.