1.57. 58.0 cm^3
1.59. 73.8 mL
1.61. 5.1 g/cm^3
1.63. Yes
1.65. 0.28 cm^3
1.67. Precise: techniques 1 and 3, accurate: techniques 2 and 3, precise and accurate: technique 3; ranges: technique 1, 2 mg; technique 2, 10 mg; technique 3, 2 mg
1.69. a, c, d, f
1.71. a. 17.4
b. 1×10^{-13}
c. 5.70×10^{-23}
d. 3.58×10^{-3}
1.73. Because the Celsius scale is based on the freezing and boiling points of a common liquid—water.
1.75. Zero is the lowest possible temperature.
1.77. −269.0°C
1.79. 285.4 K; 54.1°F
1.81. −89.2°C; 183.9 K
1.83. The T_c for $YBa_2Cu_3O_7$ is already expressed in kelvin, $T_c = 93.0$ K. The T_c of Nb_3Ge converted to K is 23.2 K. The T_c of $HgBa_2CaCu_2O_6$ converted to K is 127.0 K. The superconductor with the highest T_c is $HgBa_2CaCu_2O_6$.
1.85. 0.031 mg/L
1.87. Both mixtures a and b react so that there is neither sodium nor chlorine left over.
1.89. Days 1, 11, and 21
1.91. 5 times more administered than prescribed
1.93. (a) All three; (b) none

Chapter 2

2.1. The elements shaded purple (H, hydrogen) and dark blue (He, helium)
2.3. Purple (H, hydrogen)
2.5. a. Yellow (Cl, chlorine) and red (Ne, neon)
b. Red (Ne, neon)
c. Blue (Na, sodium), green (Au, gold), and orange (Lr, lawrencium)
2.7. Red arrow, alpha; green arrow, beta
2.9. a. Blue (K) and green (Ag)
b. Gray (Mg)
c. Yellow (Sc)
d. Purple (I)
e. Red (O)
2.11. Rutherford concluded that the positive charge in the atom could not be spread out (the pudding) in the atom but must result from a concentration of charge in the center of the atom (the nucleus). Most of the particles were deflected only slightly or passed directly through the gold foil; so he reasoned that the nucleus must be small compared to the size of the entire atom. The negatively charged electrons do not deflect the particles, and Rutherford reasoned that the electrons took up the remainder of the space of the atom outside the nucleus.
2.13. The fact that cathode rays were deflected by a magnetic field indicated that the rays were streams of charged particles.
2.15. Through the alpha decay of the radioactive uranium ore and its products
2.17. Greater than 1
2.19. Hydrogen (^1H)
2.21.

	Atom	Mass Number	Atomic Number = Number of Protons	Number of Neutrons = Mass Number − Atomic Number	Number of Electrons = Number of Protons
(a)	^{14}C	14	6	8	6
(b)	^{59}Fe	59	26	33	26
(c)	^{90}Sr	90	38	52	38
(d)	^{210}Pb	210	82	128	82

2.23.

Symbol	^{23}Na	^{89}Y	^{118}Sn	^{197}Au
Number of Protons	11	39	50	79
Number of Neutrons	12	50	68	118
Number of Electrons	11	39	50	79
Mass Number	23	89	118	197

2.25.

Symbol	$^{37}Cl^-$	$^{23}Na^+$	$^{81}Br^-$	$^{226}Ra^{2+}$
Number of Protons	17	11	35	88
Number of Neutrons	20	12	46	138
Number of Electrons	18	10	36	86
Mass Number	37	23	81	226

2.27. Group 2, RO; group 3, R_2O_3; group 4, RO_2
2.29. Mendeleev based his groups on chemical reactivity. No compounds of the noble gases existed to indicate their presence as a group.
2.31. C, N, and O
2.33. a. Palladium (Pd)
b. Rhodium (Rh)
c. Platinum (Pt)
2.35. Three (Na, Mg, and Al)
2.37. A *weighted average* takes into account the proportion of each value in the group of values to be averaged.
2.39. $(m_X + m_Y)/2$
2.41. ^{51}V
2.43. (a) ^{11}B; (b) ^{7}Li; (c) ^{14}N
2.45. 63.55 amu
2.47. Yes
2.49. 47.95 amu
2.51. a. CaF_2, 78.074 amu
b. Na_2S, 78.045 amu
c. Cr_2O_3, 151.989 amu
2.53. (a) 1; (b) 3; (c) 6; (d) 6
2.55. (e) CH_4 < (d) NH_3 < (a) CO < (c) CO_2 < (b) Cl_2
2.57. A dozen is too small a unit to express the very large number of atoms, ions, or molecules present in laboratory quantities such as a mole.
2.59. (a) 7.3×10^{-10} mol Ne; (b) 7.0×10^{-11} mol CH_4; (c) 4.2×10^{-12} mol O_3; (d) 8.1×10^{-15} mol NO_2
2.61. (a) 1 mol; (b) 2 mol; (c) 1 mol; (d) 3 mol
2.63. 10.3 g
2.65. a. 7.53×10^{22} atoms
b. 7.53×10^{22} atoms
c. 1.51×10^{23} atoms
d. 2.26×10^{23} atoms

2.67. (a) Both contain the same; (b) N_2O_4; (c) CO_2
2.69. (a) 3.00 mol; (b) 4.50 mol; (c) 1.50 mol
2.71. a. 64.063 g/mol
b. 47.997 g/mol
c. 44.009 g/mol
d. 108.009 g/mol
2.73. a. 152.148 g/mol
b. 164.203 g/mol
c. 148.204 g/mol
d. 132.161 g/mol
2.75. 41.63 mol
2.77. 0.25 mol; 10 g
2.79. (a) NO; (b) CO_2; (c) O_2
2.81. 0.752 mol
2.83. Diamond
2.85. First formed (d) quark, last formed (a) deuteron
2.87. Energy is released in fusion processes when product has $Z < 26$ (Fe) because binding energy per nucleon is relatively high but drops off after Fe.
2.89. Because for fusion of helium, we have to force together two nuclei of higher positive charge and higher temperatures are required to overcome the higher repulsion.
2.91. The expanding universe was cooling and expanding and therefore could not support the high temperatures and densities needed for fusion to produce elements heavier than lithium.
2.93. The effect of β decay on the neutron-to-proton ratio is to decrease it as a neutron is transformed into a proton plus β particle.
2.95. a. ${}^{16}_{8}O$
b. ${}^{24}_{12}Mg$
c. ${}^{36}_{18}Ar$
2.97. a. ${}^{99}_{43}Tc$
b. ${}^{121}_{51}Sb$
c. ${}^{110}_{80}Hg$
2.99. The transformation of ${}^{137}I$ to ${}^{137}Xe$ can be balanced as
${}^{137}_{53}I \rightarrow {}^{137}_{54}Xe + {}^{0}_{-1}\beta$.
The transformation of ${}^{137}Xe$ to ${}^{137}Cs$ can be balanced as
${}^{137}_{54}Xe \rightarrow {}^{137}_{53}Cs + {}^{0}_{-1}\beta$.
Both of the nuclear reactions involve β emission.
2.101. ${}^{209}_{83}Bi + 2\,{}^{1}_{0}n \rightarrow {}^{211}_{85}At + 2\,{}^{0}_{-1}\beta$
2.103. a. ${}^{32}_{15}P$
b. $4\,{}^{1}_{0}n$
c. $2\,{}^{1}_{1}H$
d. ${}^{125}_{54}Xe$, ${}^{0}_{-1}\beta$
2.105. a. ${}^{0}_{-1}\beta$
b. ${}^{122}_{53}I$
c. ${}^{10}_{5}B$
d. ${}^{67}_{30}Zn$
2.107. a. Electrons
b. The negatively charged electrons were attracted to the positively charged plate as the electrons passed through the electric field.
c. If the polarities of the plates were switched, the electron would still be deflected toward the positively charged plate, which would now be at the opposite side of the screen.
2.109. 10.00% ${}^{25}Mg$ and 11.01% ${}^{26}Mg$
2.111. ${}^{11}_{5}B + {}^{1}_{0}n \rightarrow {}^{12}_{5}B \rightarrow {}^{8}_{3}Li + {}^{4}_{2}He$
${}^{11}_{5}B + {}^{1}_{0}n \rightarrow {}^{12}_{5}B \rightarrow {}^{12}_{6}C + {}^{0}_{-1}\beta$
2.113. ${}^{208}_{82}Pb + {}^{62}_{28}Ni \rightarrow {}^{269}_{110}Ds + {}^{1}_{0}n$
2.115. (a) 0.7580 mol C; (b) 4.565×10^{23} atoms C

Chapter 3

3.1. a. Purple (Na), red (Cr), and orange (Au)
b. Blue (Ne)
c. Orange (Au)
d. Red (Cr)
e. Blue (Ne) and green (Cl)
3.3. a. Green (Cl)
b. Purple (Na)
3.5. Blue (Rb), green (Sr), and orange (Y)
3.7. c
3.9. a
3.11. All these forms of light have perpendicular, oscillating electric and magnetic fields that travel together through space.
3.13. The lead shield must protect the parts of your body that might be exposed to X-rays but are not being imaged. Lead is a very high density metal with many electrons, which interact with X-rays and absorb nearly all the X-rays before they can reach your body.
3.15. It still emits infrared radiation.
3.17. $4.87 \times 10^{14}\ s^{-1}$
3.19. (a) 3.32 m; (b) 3.14 m; (c) 3.04 m; (d) 2.79 m
3.21. The radio station has the lower frequency.
3.23. 8.317 min
3.25. The absorption spectrum consists of dark lines at wavelengths specific to that element. The emission spectrum has bright lines on a dark background with the lines appearing at the exact same wavelengths as the dark lines in the absorption spectrum.
3.27. Because each element shows distinctive and unique absorption and emission lines, the bright emission lines observed for the pure elements could be matched to the many dark absorption lines in the spectrum of sunlight. This approach can be used to deduce the sun's elemental composition.
3.29. The quantum is the smallest indivisible amount of radiant energy that an atom can absorb or emit.
3.31. From Figure 3.11 we see that tungsten as a blackbody metal will emit in the visible range at 1000 K and that it will glow red-orange.
3.33. 6.62×10^{-19} J
3.35. b
3.37. 6.93×10^{-19} J
3.39. No
3.41. Potassium; 8.04×10^{5} m/s
3.43. 3.17×10^{18} photons/s
3.45. The Rydberg equation is more general then the Balmer equation; the Balmer equation is equivalent to the Rydberg when $n_1 = 2$.
3.47. It is the difference between n levels that determines emission energy.
3.49. a
3.51. No
3.53. At $n = 7$, the wavelength of the electron's transition ($n = 7$ to $n = 2$) has moved out of the visible region.
3.55. 1875 nm; infrared
3.57. No, because for hydrogen the transition is in the ultraviolet region and as Z increases the wavelength will shorten further.
3.59. 72.9 nm
3.61. In the de Broglie equation, λ is the wavelength the particle of mass m exhibits as it travels at speed u, where h is Planck's constant. This equation states that (1) any moving particle has wavelike properties because a wavelength can be calculated