Pearson

Appendix III Answers to Selected End-of-Chapter Problems

Chapter E

19.

a. 0 °C

b. –321°

c. –78.3°

d. 310.2 K

21. –62.2 °C, 210.9 K

23.

a. 1.2 nm

b. 22 fs

c. 1.5 Gg

d. 3.5 ML

25.

a. 4.5×10^{-9}s

b. 1.8×10^{-14}s

c. 1.28×10^{-10}m

d. 3.5×10^{-5}m

27.

1245 kg	1.245×10^{6} g	1.245×10^{9} mg
515 km	5.15×10^{6} dm	5.15×10^{7} cm
122.355 s	1.22355×10^{5} ms	0.122355 ks
3.345 kJ	3.345×10^{3} J	3.345×10^{6} mJ

29.

a. 254.998 km

b. 2.54998×10^{-1} Mm

c. 254998×10^{3} mm

d. 254998×10^{2} cm

31. 10,000 1-cm squares

33.

a. 1.50 × 103 mL

b. 1.50×10^{3} cm^{3}

c. 3.96 gal

d. 15.9 qt

35. c

37.

a. 73.0 mL

b. 88.2 °C

c. 645 mL

39.

a. $1, 0\overline{\ }50\overline{\ }, 50\overline{\ }1$

b. $0.0020\overline{\ }$

c. 0.0000000000000002

d. $0.0010\overline{\ }90\overline{\ }$

41.

a. 3

b. ambiguous, without more information assume three significant figures

c. 3

d. 5

e. ambiguous, without more information assume one significant figure

43.

a. not exact

b. exact

c. not exact

d. exact

45.

a. 156.9

b. 156.8

c. 156.8

d. 156.9

47.

a. 1.84

b. 0.033

c. 0.500

d. 34

49.

a. 41.4

b. 133.5

c. 73.0

d. 0.42

51.

a. 391.3

b. 1.1×10^4

c. 5.96

d. 5.93×10^4

53. no

55. 1.26 g/cm^3

57.

a. 463 g

b. 3.7 L

59. $201. \times 10^3$ g

61.

a. 2.78×10^4 cm^3

b. 1.898×10^{-3} kg

c. 1.98×10^7 cm

63.

a. 60.6 in

b. 3.14×10^3 g

c. 3.7 qt

d. 4.29 in

65. 5.0×10^{1} min

67. 4.0×10^{1} mi/gal

69.

a. 1.95×10^{-4} km^2

b. 1.95×10^{4} dm^2

c. 1.95×10^{6} cm^2

71. 0.680 mi^2

73. 0.95 mL

75.

a. 1.92×10^{9} J

b. 51.4 cal

c. 2.37×10^{6} J

d. 681 cal

77.

a. 9.987×10^{6} J

b. 9.987×10^{3} kJ

c. 2.78 kWh

79. 4.35×10^{9} J

81.

a. mass of can of gold = 1.9×10^{4} g
mass of can of sand = 3.0×10^{3} g

b. Yes, the thief sets off the trap because the can of sand is lighter than the gold cylinder.

83. 21 in^3

85. 7.6 g/cm^3

87. 3.11×10^{5} lb

89. 3.3×10^{2} km

91. 6.8×10^{-15}

93. 2.4×10^{19} km

95. 488 g

97. 0.661 Ω

99. 0.492

101. $V_n = 8.2 \times 10^{-8}$ pm^3, $V_a = 1.4 \times 10^{6}$ pm^3, 5.9×10^{-12} %

103. 9×10^{1} mg CO

105. 13%

107. 343 cubes

109.

a. The dark block is denser.

b. The lighter-colored block is denser.

c. Relative densities cannot be determined.

114.

a. 8.2%

b. 24.4 million cubic kilometers

Chapter 1

35.

a. pure substance

b. pure substance

c. homogeneous mixture

d. heterogeneous mixture

37.

a. homogeneous mixture

b. pure substance, compound

c. pure substance, element

d. heterogeneous mixture

39.

Substance	Pure or Mixture	Type
Aluminum	Pure	Element
Apple juice	Mixture	Homogeneous
Hydrogen peroxide	Pure	Compound
Chicken soup	Mixture	Heterogeneous

41.

a. pure substance, compound

b. mixture, heterogeneous

c. mixture, homogeneous

d. pure substance, element

43.

a. theory

b. observation

c. law

d. observation

45. Several answers are possible.

47. 13.5 g

49. These results are not consistent with the law of definite proportions because sample 1 is composed of 11.5 parts Cl to 1 part C and sample 2 is composed of 9.05 parts Cl to 1 part C. The law of definite proportions states that a given compound always contains exactly the same proportion of elements by mass.

51. 23.8 g

53. For the law of multiple proportions to hold, the ratio of the masses of O combining with 1 g of Os in the compound should be a small whole number. 0.3369/0.168 = 2.00

55. Sample 1: 1.00 g O_2/1.00 g S;

Sample 2: 1.50 g O_2/1.00 g S

Sample 2/Sample 1 = 1.50/1.00 = 1.50

3 O atoms/2 O atoms = 1.5

57.

a. not consistent

b. consistent: Dalton's atomic theory states that the atoms of a given element are identical.

c. consistent: Dalton's atomic theory states that atoms combine in simple whole-number ratios to form compounds.

d. not consistent

59.

a. consistent: Rutherford's nuclear model states that the atom is largely empty space.

b. consistent: Rutherford's nuclear model states that most of the atom's mass is concentrated in a tiny region called the nucleus.

c. not consistent

d. not consistent

61. -2.3×10^{-19} C

63. **a, b, c**

65.

a. Ag-107

b. Ag-109

c. U-238

d. H-2

67.

a. $7\,{}^{1}_{1}\text{p}$ and $7\,{}^{0}_{1}\text{n}$

b. $11\,{}^{1}_{1}\text{p}$ and $12\,{}^{0}_{1}\text{n}$

c. $86\,{}^{1}_{1}\text{p}$ and $136\,{}^{0}_{1}\text{n}$

d. $82\,{}^{1}_{1}\text{p}$ and $126\,{}^{0}_{1}\text{n}$

69. $6\,{}^{1}_{1}\text{p}$ and $8\,{}^{1}_{0}\text{n}$, ${}^{14}_{6}\text{C}$

71.

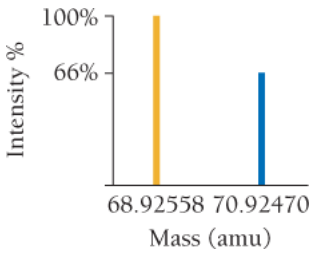
a. $28\,{}^{1}_{1}\text{p}$ and 26e^{-}

b. $16\,{}^{1}_{1}\text{p}$ and 18e^{-}

c. $35\,{}^{1}_{1}\text{p}$ and 36e^{-}

d. $24\,{}^{1}_{1}\text{p}$ and 21e^{-}

73.



75. The fluorine-19 isotope must have a large percent abundance, which would make fluorine produce a large peak at this mass. Chlorine has two isotopes (Cl-35 and Cl-37). The atomic mass is simply the weighted average of these two, which means that there is no chlorine isotope with a mass of 35.45 amu.

77. 121.8 amu, Sb

79. Br-79 78.92 amu 50.96%

81. 152 amu

83. 3.32×10^{24} atoms

85.

a. 0.295 mol Ar

b. 0.0543 mol Zn

c. 0.144 mol Ta

d. 0.0304 mol Li

87. 2.11×10^{22} atoms

89.

a. 1.01×10^{23} atoms

b. 6.78×10^{21} atoms

c. 5.39×10^{21} atoms

d. 5.6×10^{20} atoms

91.

a. 36 g

b. 0.187 g

c. 62 g

d. 3.1 g

93. 2.6×10^{21} atoms

95. 3.239×10^{-22} g

97. 1.50 g

99. 207 amu

101. Pa^{237}, U^{238}, Np^{239}, Pu^{240}, Ac^{235}, Ra^{234}, etc.

103. 6.0×10^{17} km

105. 4.76×10^{24} atoms

107. 75.0% gold

109. 2.4×10^{13} atoms

111. 106.91 amu

113. 0.423

115. 63.67 g/mol

117. 25.06 g/mol

119. 1×10^{78} atoms/universe

121. c

123.

a. law

b. theory

c. observation

d. law

125. greatest number of moles: Cr, greatest mass: Zn

130.

a. 2000, 0.24 $\mu g/m^3$; 2014, 0.030 $\mu g/m^3$

b. 2.9×10^8 atoms/cm^3

Chapter 2

35. 499 s

37.

i. d, c, b, a

ii. a, b, c, d

39.

a. 4.74×10^{14} Hz

b. 5.96×10^{14} Hz

c. 5.8×10^{18} Hz

41.

a. 3.14×10^{-19} J

b. 3.95×10^{-19} J

c. 3.8×10^{-15} J

43. 1.03×10^{16} photons

45.

a. 79.8 kJ/mol

b. 239 kJ/mol

c. 798 kJ/mol

47.

47.

49. 3.6×10^{6} m/s

51. 5.39 nm

53. 1.1×10^{-34} m. The wavelength of a baseball is negligible with respect to its size.

55. $\Delta v = 1.04 \times 10^{5}$ m/s

57. 2*s*

59.

a. $l = 0$

b. $l = 0, 1$

c. $l = 0, 1, 2$

d. $l = 0, 1, 2, 3$

61. c

63. See Figures 7.25 and 7.26. The 2*s* and 3*p* orbitals would, on average, be farther from the nucleus and have more nodes than the 1*s* and 2*p* orbitals.

65. $n = 1$

67. $2p \rightarrow 1s$

69.

a. 122 nm, UV

b. 103 nm, UV

c. 486 nm, visible

d. 434 nm, visible

71. $n = 2$

73. 344 nm

75. 6.4×10^{17} photons/s

77. 0.0547 nm

79. 91.2 nm

81.

a. 4

b. 9

c. 16

83.

$n = 4 \rightarrow n = 3, n = 5 \rightarrow n = 3,$
$n = 6 \rightarrow n = 3,$ respectively

85. $4.84 \times 10^{14}\ s^{-1}$

87. 11 m

89. 6.78×10^{-3} J

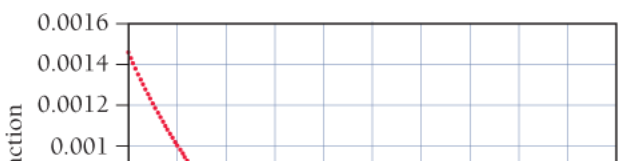
91. 632 nm

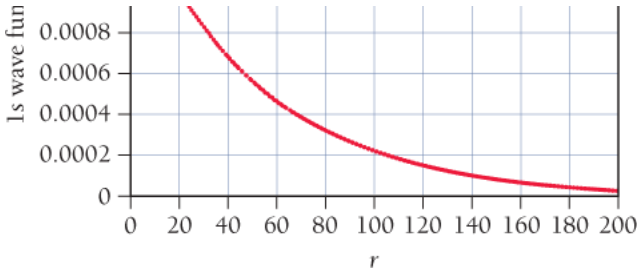
93.

a. $E_1 = 2.51 \times 10^{-18}$ J, $E_2 = 1.00 \times 10^{-17}$ J, $E_3 = 2.26 \times 10^{-17}$ J

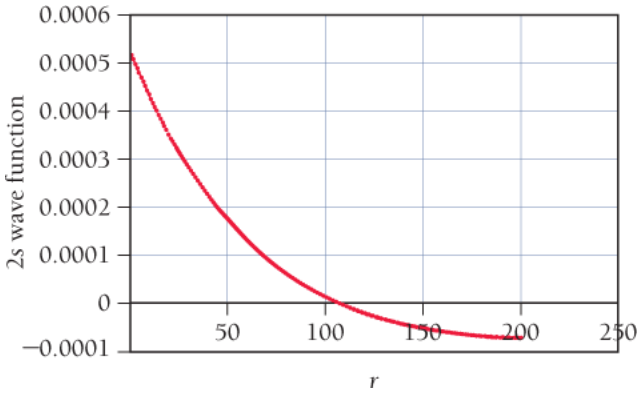
b. 26.5 nm, UV; 15.8 nm, UV

95. 1*s*:





2*s*:



The plot for the 2*s* wave function extends below the *x*-axis. The *x*-intercept represents the radial node of the orbital.

97. 7.39×10^5 m/s

99. $\Delta E = 1.1 \times 10^{-20}$ J, 7.0×10^2 nm

101. 11 m

103. In the Bohr model, electrons exist in specific orbits encircling the atom. In the quantum-mechanical model, electrons exist in orbitals that are really probability density maps of where the electron is likely to be found. The Bohr model is inconsistent with Heisenberg's uncertainty principle.

105.

a. yes

b. no

c. yes

d. no

112.

a. 5.93×10^{-19} J

b. 2-EHMC

c. 1.4×10^7 J

Chapter 3

41.

a. potassium, metal

b. barium, metal

c. iodine, nonmetal

d. oxygen, nonmetal

e. antimony, metalloid

43. a and b are main-group elements.

45.

a. $1s^2 2s^2 2p^6 3s^2 3p^2$

b. $1s^2 2s^2 2p^4$

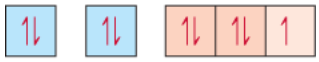
c. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$

d. $1s^2 2s^2 2p^6$

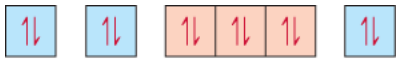
47.

a.

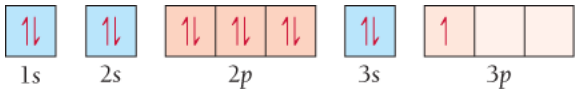
b.



c.



d.



49.

a. $[Ne]3s^2 3p^3$

b. $[Ar]4s^2 3d^{10} 4p^2$

c. $[Kr]5s^2 4d^2$

d. $[Kr]5s^2 4d^{10} 5p^5$

51.

a. 1

b. 10

c. 5

d. 2

53.

a. V, As

b. Se

c. V

d. Kr

55.

a. 2

b. 1

c. 10

d. 6

57. reactive metal: **a**, reactive nonmetal: **c**

59.

a. 1 valence electron, alkali metal

b. 7 valence electrons, halogen

c. 2 valence electrons, alkaline earth metal

d. 2 valence electrons, alkaline earth metal

e. 8 valence electrons, noble gas

61. Cl and F because they are in the same group or family. Elements in the same group or family have similar chemical properties.

63.

a. 2– [Ne]

b. 1+ [Ar]

c. 3+ [Ne]

d. 1+ [Kr]

65. **c**

67. The valence electrons of nitrogen will experience a greater effective nuclear charge. The valence electrons of both atoms are screened by two core electrons, but N has a greater number of protons and therefore a greater net nuclear charge.

69.

a. 1+

b. 2+

c. 6+

d. 4+

71.

a. In

b. Si

c. Pb

d. C

73. F, S, Si, Ge, Ca, Rb

75.

a. [Ne]

b. [Kr]

c. [Kr]

d. $[Ar]3d^6$

e. $[Ar]3d^9$

77.

a. [Ar] Diamagnetic

b. [Ar] ↑ ↑ ↑ _ _ Paramagnetic
3*d*

c. [Ar] ↑↓ ↑↓ ↑↓ ↑ ↑ Paramagnetic
3*d*

d. [Ar] ↑ ↑ ↑ ↑ ↑ Paramagnetic
3*d*

79.

a. Li

b. I^-

c. Cr

d. O^{2-}

81. O^{-2}, F^-, Na^+, Mg^{2+}

83.

a. Br

b. Na

c. cannot tell based on periodic trends

d. P

85. In, Si, N, F

87.

a. second and third

b. fifth and sixth

c. sixth and seventh

d. first and second

89.

a. Na

b. S

c. C

d. F

91.

a. Sr

b. Bi

c. cannot tell based on periodic trends

d. As

93. S, Se, Sb, In, Ba, Fr

95. Br: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$

Kr: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$

Krypton's outer electron shell is filled, giving it chemical stability. Bromine is missing an electron from its outer shell and subsequently has a high electron affinity. Bromine tends to be easily reduced by gaining an electron, giving the bromide ion stability due to the filled *p* subshell, which corresponds to krypton's chemically stable electron configuration.

97. V: $[Ar]4s^2 3d^3$

V^{3+}: $[Ar]3d^2$

Both V and V^{3+} contain unpaired electrons in their 3*d* orbitals.

99. A substitute for K^+ would need to exhibit a 1+ electric charge and have similar mass and atomic radius. Na^+ or Rb^+ might be good substitutes, but their radii are significantly smaller and larger, respectively. Based on mass, Ca^+ and Ar^+ are the closest to K^+. Because the first ionization energy of Ca^+ is closest to that of K^+, Ca^+ might be a good choice for a substitute. The difficulty lies in Ca's low second ionization energy, making it easily oxidized to form Ca^{2+}.

101. Si, Ge

103.

a. N: $[He]2s^2 2p^3$, Mg: $[Ne]3s^2$, O: $[He]2s^2 2p^4$, F: $[He]2s^2 2p^5$, Al: $[Ne]3s^2 3p^1$

b. Mg, Al, O, F, N

c. Al, Mg, O, N, F

d. Aluminum's first ionization energy is lower than Mg because its 3*p* electron is shielded by the 3*s* orbital. Oxygen's first ionization energy is lower than that of N because its fourth 2*p* electron experiences electron–electron repulsion by the other electron in its orbital.

105. For main-group elements, atomic radii decrease across a period because the addition of a proton in the nucleus and an electron in the outermost energy level increases Z_{eff}. This does not happen in the transition metals because the electrons are added to the $n_{\text{highest-1}}$ orbital and the Z_{eff} stays roughly the same.

107. Noble gases are exceptionally unreactive due to the stability of their completely filled outer quantum levels and their high ionization energies. The ionization energies of Kr, Xe, and Rn are low enough to form some compounds.

109. 6A: $ns^2 np^4$, 7A: $ns^2 np^5$, group 7A elements require only one electron to achieve a noble gas configuration. Since group 6A elements require two electrons, their affinity for one electron is less negative because one electron will merely give them an np^5 configuration.

111. 85

113.

a. One If By Land (O, Ne, I, F, B, Y, La, Nd)

b. Atoms Are Fun (N, U, Fe, Ra, S, Mo, Ta backwards)

115. 1.390×10^3 kJ/mol, 86.14 nm

117.

a. $d_{Ar} \approx 2$ g/L, $d_{Xe} \approx 6.5$ g/L

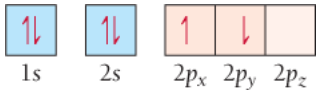
b. $d_{118} \approx 13$ g/L

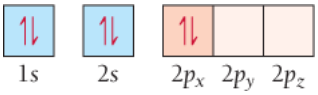
c. mass = 3.35×10^{-23} g/Neatom, density of Ne atom = 2.3×10^4 g/L. The separation of Ne atoms relative to their size is immense.

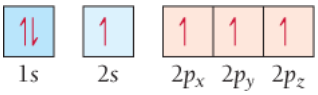
d. Kr: 2.69×10^{22} atoms/L, Ne: 2.69×10^{22} atoms/L. It seems Ar will also have 2.69×10^{22} atoms/L. $d_{Ar} = 1.78$ g/L. This corresponds to accepted values.

119. Density increases to the right because, though electrons are added successively across the period, they are added to the 3*d* subshell, which is not a part of the outermost principal energy level. As a result, the atomic radius does not increase significantly across the period while mass does.

121.

Longest λ: 

Next longest λ: 

Next longest λ: 

123. 168, noble gas

125. A relatively high effective nuclear charge is found in gallium with its completed 3*d* subshell and in thallium with its completed 4*f* subshell, accounting for the relatively high first ionization energies of these elements.

127. The second electron affinity requires the addition of an electron to something that is already negatively charged. The monoanions of both of these elements have relatively high electron density in a relatively small volume. As we shall see in Chapter 9, the dianions of these elements do exist in many compounds because they are stabilized by chemical bonding.

129. 120, 170

131.

a. any group 6A element

b. any group 5A element

c. any group 1A element

133.

a. true

b. true

c. false

d. true

135. Since Ca has valence electrons of $4s^2$, it has a relatively low ionization energy to lose 2 electrons. In contrast, F has a highly exothermic electron affinity when gaining 1 electron, but not a second electron because of its $2s^2 2p^5$ valence electrons. Therefore, calcium and fluoride combine in a 2:1 ratio.

141.

a. First ionization energy generally increases as you move from left to right across period 3 because effective nuclear charge increases from left to right.

b. Electron affinity generally decreases (becomes more exothermic) from left to right across period 3 because effective nuclear charge increases from left to right.

c. The overall energy change is approximately 150 kJ/mol. The exchange is endothermic.

Chapter 4

29.

a. molecular

b. ionic

c. ionic

d. molecular

31.

a. NO_2

b. C_5H_{12}

c. C_2H_5

33.

a. 3 Mg, 2 P, 8 O

b. 1 Ba, 2 Cl

c. 1 Fe, 2 N, 4 O

d. 1 Ca, 2 O, 2 H

35.

a. NH_3

b. C_2H_6

c. SO_3

37.

$1s^2\underline{2s^2 2p^3}$ ·N:

39.

a. ·Al·

b. Na^+

c. :Cl:

d. $[:Cl:]^-$

41.

a. $Na^+[:F:]^-$

b. $Ca^{2+}[:O:]^{2-}$

c. $Sr^{2+}\ 2[:Br:]^-$

d. $2\ K^+[:O:]^{2-}$

43.

a. SrSe

b. $BaCl_2$

c. Na_2S

d. Al_2O_3

45. One factor of lattice energy is the product of the charges of the two ions. The product of the ion charges for CsF is +1, while that for BaO is +4. Because this product is four times greater, the lattice energy is also four times greater.

47.

a. CaO

b. ZnS

c. RbBr

d. Al_2O_3

49.

a. $Ca(OH)_2$

b. $CaCrO_4$

c. $Ca_3(PO_4)_2$

d. $Ca(CN)_2$

51.

a. magnesium nitride

b. potassium fluoride

c. sodium oxide

d. lithium sulfide

e. cesium fluoride

f. potassium iodide

53.

a. tin(II) oxide

b. chromium(III) sulfide

c. rubidium iodide

d. barium bromide

55.

a. copper(I) nitrite

b. magnesium acetate

c. barium nitrate

d. lead(II) acetate

57.

a. $NaHSO_3$

b. $LiMnO_4$

c. $AgNO_3$

d. K_2SO_4

e. $RbHSO_4$

f. $KHCO_3$

59.

a. cobalt(II) sulfate heptahydrate

b. $IrBr_3 \cdot H_2O$

c. Magnesium bromate hexahydrate

d. $K_2CO_3 \cdot 2\,H_2O$

61.

a. H:H, filled duets

b.  , filled octets

c.  , filled octets

d.  , filled octets

63.

a. carbon monoxide

b. nitrogen triiodide

c. silicon tetrachloride

d. tetranitrogen tetraselenide

65.

a. PCl_3

b. ClO

c. S_2F_4

d. PF_5

67.

a. strontium chloride

b. tin(IV) oxide

c. diphosphorus pentasulfide

69.

a. potassium chlorate

b. diiodine pentoxide

c. lead(II) sulfate

71.

a. 46.01 amu

b. 58.12 amu

c. 180.16 amu

d. 238.03 amu

73.

a. 0.471 mol

b. 0.0362 mol

c. 968 mol

d. 0.279 mol

75.

a. 0.554 mol

b. 28.4 mol

c. 0.378 mol

d. 1093 mol

77.

a. 2.2×10^{23} molecules

b. 7.06×10^{23} molecules

c. 4.16×10^{23} molecules

d. 1.09×10^{23} molecules

79.

a. 0.0790 g

b. 0.84 g

c. 2.992×10^{-22} g

81. 0.10 mg

83.

a. 74.87% C

b. 79.88% C

c. 92.24% C

d. 37.23% C

85. NH_3: 82.27% N

$CO(NH_2)_2$: 46.65% N

NH_4NO_3: 35.00% N

$(NH_4)_2SO_4$: 21.20% N

NH_3 has the highest N content.

87. 20.8 g F

89. 196 μg KI

91.

a. 2 : 1

b. 4 : 1

c. 6 : 2 : 1

93.

a. 0.885 mol H

b. 5.2 mol H

c. 29 mol H

d. 33.7 mol H

95.

a. 3.3 g Na

b. 3.6 g Na

c. 1.4 g Na

d. 1.7 g Na

97.

a. Ag_2O

b. $Co_3As_2O_8$

c. $SeBr_4$

99.

a. C_5H_7N

b. $C_4H_5N_2O$

101. $C_{13}H_{18}O_2$

103. NCl_3

105.

a. $C_{12}H_{14}N_2$

b. $C_6H_3Cl_3$

c. $C_{10}H_{20}N_2S_4$

107. CH_2

109. C_2H_4O

111.

a. inorganic

b. organic

c. organic

d. inorganic

113.

a. functionalized hydrocarbon, alcohol

b. hydrocarbon

c. functionalized hydrocarbon, ketone

d. functionalized hydrocarbon, amine

115. 1.50×10^{24} molecules EtOH

117.

a. K_2CrO_4, 40.27, K, 26.78, Cr, 32.95, O

b. $Pb_3(PO_4)_2$, 76.60, Pb, 7.63, P, 15.77, O

c. $CoBr_2$, 26.94, Co, 73.06, Br

119. 1.80×10^2 g Cl/yr

121. M = Fe

123. estradiol = $C_{18}H_{24}O_2$

125. $C_{18}H_{20}O_2$

127. 7 H_2O

129. C_6H_9BrO

131. 1.87×10^{21} atoms

133. 92.93 amu

135. $x = 1, y = 2$

137. 41.7 mg

139. 0.224 g

141. 22.0% by mass

143. 1.6×10^7 kg Cl

145. 7.8×10^3 kg rock

147. $C_5H_{10}SI$

149. X_3Y_2

151. The sphere in the molecular models represents the electron cloud of the atom. On this scale, the nucleus would be too small to see.

153. The statement is incorrect because a chemical formula is based on the ratio of atoms combined, not the ratio of grams combined. The statement should read: "The chemical formula for ammonia (NH_3) indicates that ammonia contains three hydrogen atoms to each nitrogen atom."

159.

a. 110 ppmv

b. 2.0×10^6 km^3

c. 437 ppmv

Chapter 5

23.

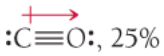
a. pure covalent

b. polar covalent

c. pure covalent

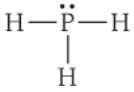
d. ionic bond

25.

 , 25%

27.

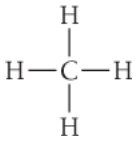
a.



b.

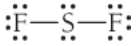
c.

d.

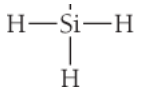


29.

a.



b.



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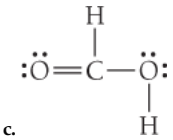

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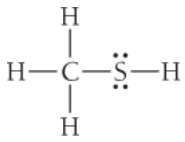
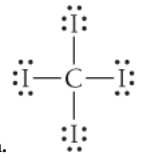


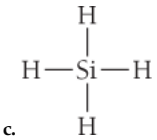
31.

a.

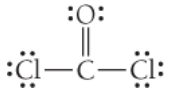


b.

c.

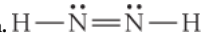


d.

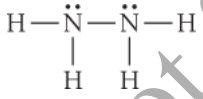


33.

a.

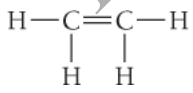


b.



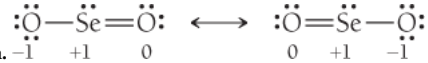
c.

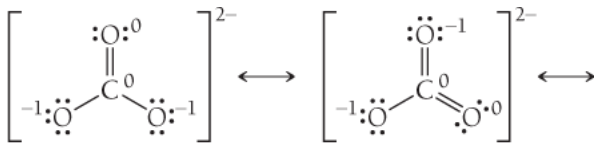
d.

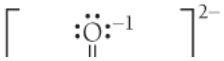


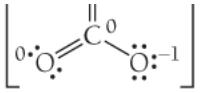
35.

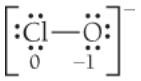
a.





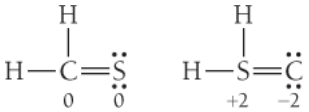


b. 

c. 

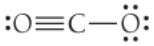
d. 

37.



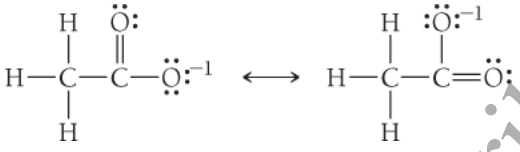
H_2CS is the better structure.

39.



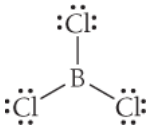
does not provide a significant contribution to the resonance hybrid as it has a +1 formal charge on a very electronegative atom (oxygen).

41.

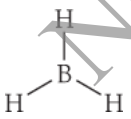


43. N has a formal charge of +1; O has a formal charge of –1.

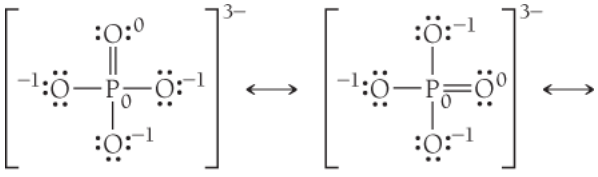
45.

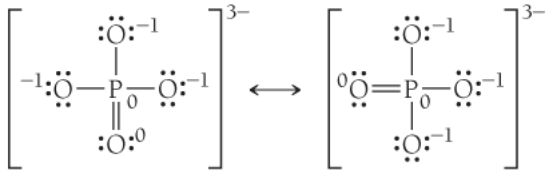
a. 

b. 

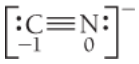
c. 

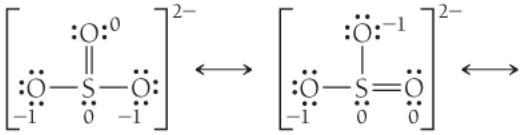
47.



a. 

b.





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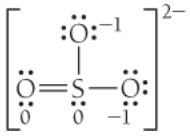
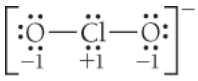
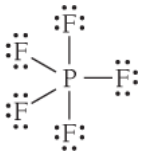


d.

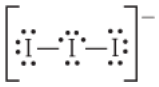


49.

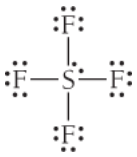
a.



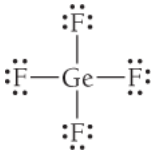
b.



c.



d.



51. H_3CCH_3, H_2CCH_2, HCCH

53. 4

55.

a. 4 e⁻ groups, 4 bonding groups, 0 lone pair

b. 5 e⁻ groups, 3 bonding groups, 2 lone pairs

c. 6 e⁻ groups, 5 bonding groups, 1 lone pair

57.

a. e⁻ geometry: tetrahedral

molecular geometry: trigonal pyramidal

idealized bond angle: 109.5°, deviation

b. e⁻ geometry: tetrahedral

molecular geometry: bent

idealized bond angle: 109.5°, deviation

c. e⁻ geometry: tetrahedral

molecular geometry: tetrahedral

idealized bond angle: 109.5°, deviation (due to large size of Cl compared to H)

d. e^- geometry: linear

molecular geometry: linear

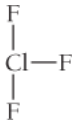
idealized bond angle: 180°

59. H_2O has a smaller bond angle due to lone pair–lone pair repulsions, the strongest electron group repulsion.

61.

a. seesaw,

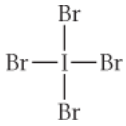
b. T-shape,



c. linear,

F–I–F

d. square planar,

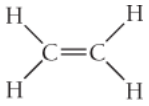


63.

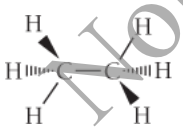
a. linear,

H–C–C≡H

b. Trigonal planar,



c. tetrahedral,



65.

a. The lone pair will cause lone pair–bonding pair repulsions, pushing the three bonding pairs out of the same plane. The correct molecular geometry is trigonal pyramidal.

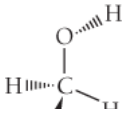
b. The lone pair should take an equatorial position to minimize 90° bonding pair interactions. The correct molecular geometry is seesaw.

c. The lone pairs should take positions on opposite sides of the central atom to reduce lone pair–lone pair interactions. The correct molecular geometry is square planar.

67.

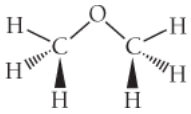
a. C: tetrahedral

O: bent

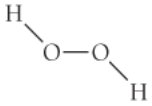


b. C's: tetrahedral

O: bent



c. O's: bent



69. The vectors of the polar bonds in both CO_2 and CCl_4 oppose each other with equal magnitude and sum to 0.

71. PF_3, polar

SBr_2, slightly polar or nonpolar

$CHCl_3$, polar

CS_2, nonpolar

73.

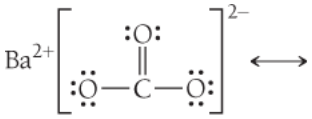
a. polar

b. polar

c. polar

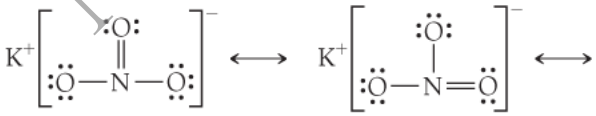
d. nonpolar

75.

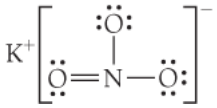


a.

b.



c.



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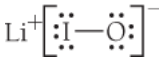

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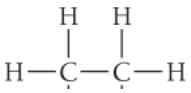
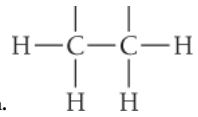


a.



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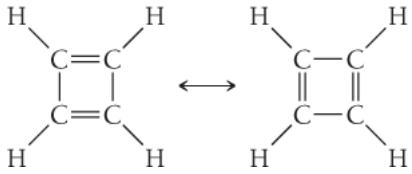

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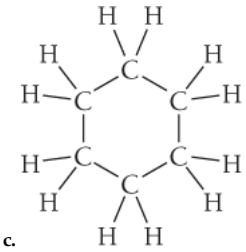

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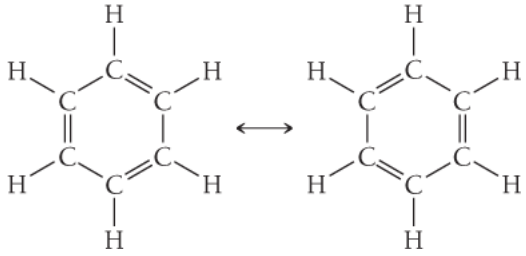
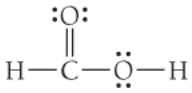


79. CH_2O_2,



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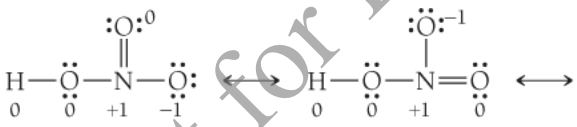
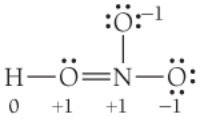


Most important

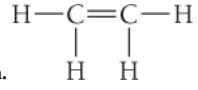


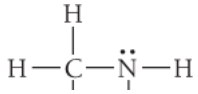
83.

The fulminate ion is less stable because nitrogen is more electronegative than carbon and should therefore be terminal to accommodate the negative formal charge.

85.

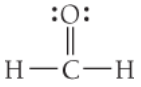
a.





b.

c.



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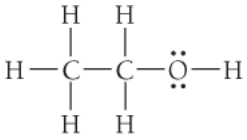
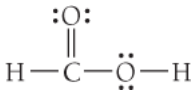


e.



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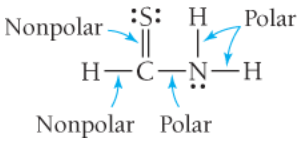
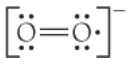


89.

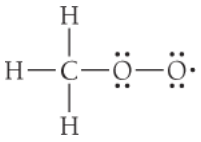
a.



b.

c.

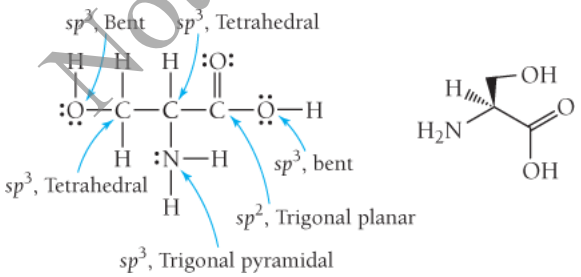
d.

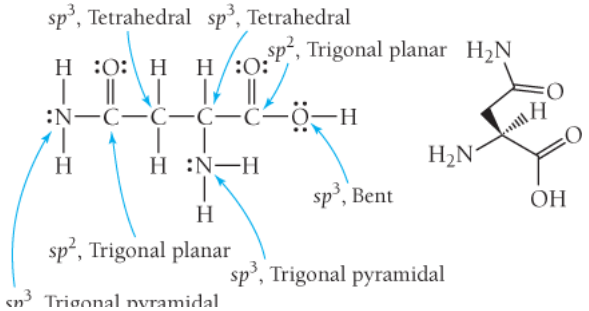


91. H–C≡C–H

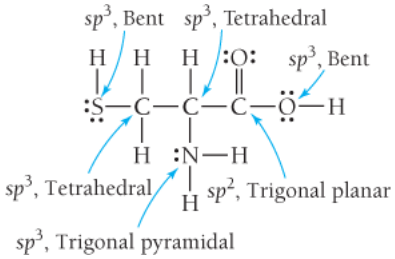
93.

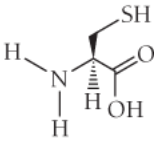
a.





b. sp^3, Trigonal pyramidal





c. sp^3, Trigonal pyramidal

95.

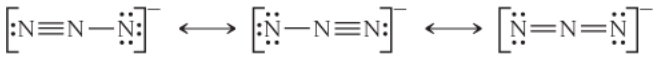
a. water soluble

b. fat soluble

c. water soluble

d. fat soluble

97.

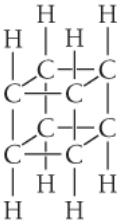


99.

r_{HCl} = 113 pm

r_{HF} = 84 pm

101.



103. The bond angle for the nitrogen closest to the C atom should be bent. The bond angle for the nitrogen closest to the terminal nitrogen should be linear. The nitrogen nitrogen bond closest to the terminal nitrogen atom should be shorter than the other nitrogen nitrogen bond (due to resonance).

105.

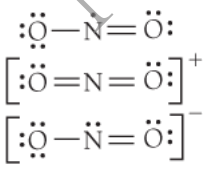
a. This is the best.

b. This statement is similar to a. but leaves out nonbonding lone-pair electron groups.

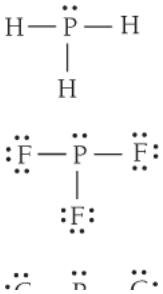
c. Molecular geometries are not determined by overlapping orbitals, but rather by the number and type of electron groups around each central atom.

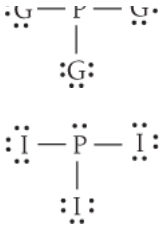
115.

a.



c.





e. The Lewis structures all have four electron groups, one lone pair, and three bonding groups. Based on VESPR, each of these molecules should have a bond angle of slightly less than 109.5°. However, the atomic radius increases in the following order: H < F < Cl < I. The increasing radius from H to I can explain the increasing bond angle in these compounds.

Chapter 6

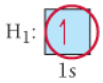
25.

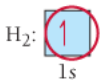
a. 0

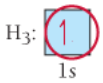
b. 3

c. 1

27.

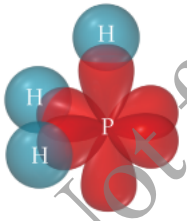






Expected bond angle = 90°

Valence bond theory is compatible with experimentally determined bond angle of 93.3° without hybrid orbitals.



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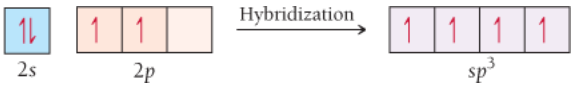
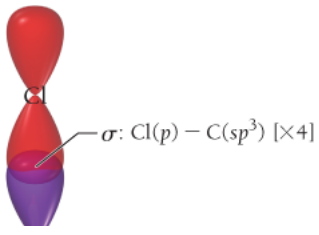
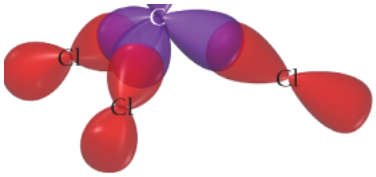


31. sp^2

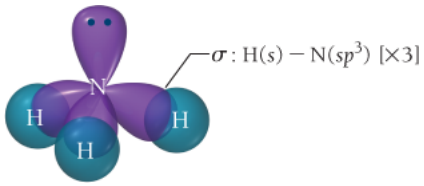
33.

a. sp^3

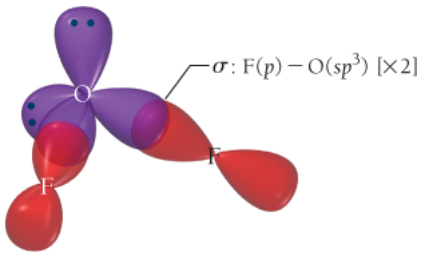




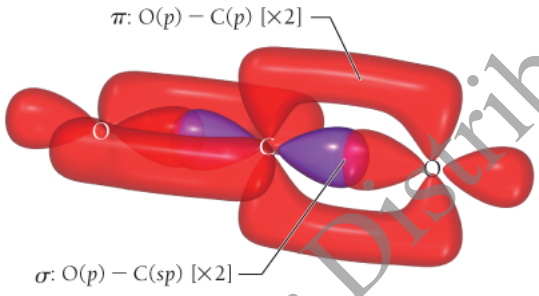
b. sp^3



c. sp^3

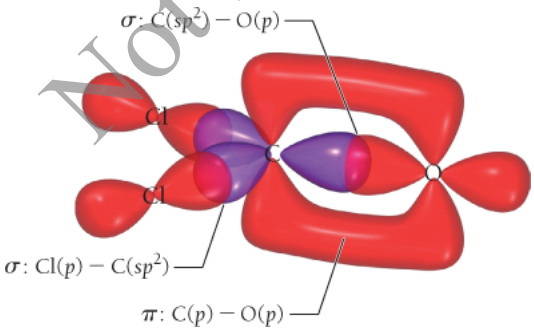


d. *sp*

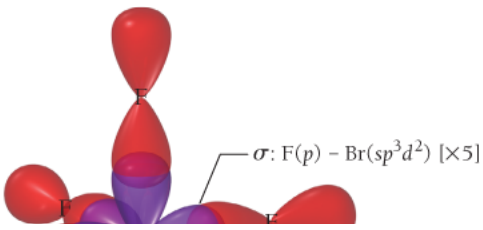


35.

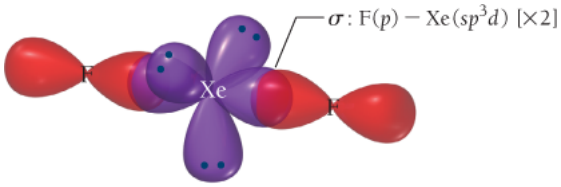
a. sp^2



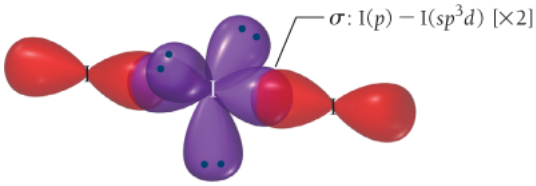
b. sp^3d^2



c. sp^3d

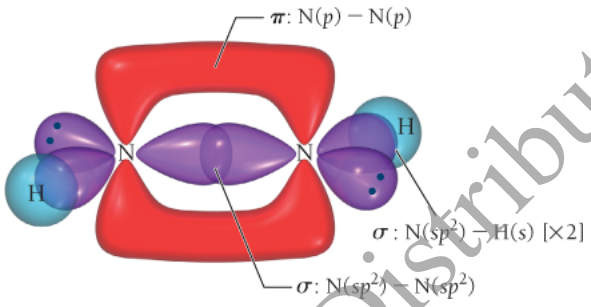


d. sp^3d

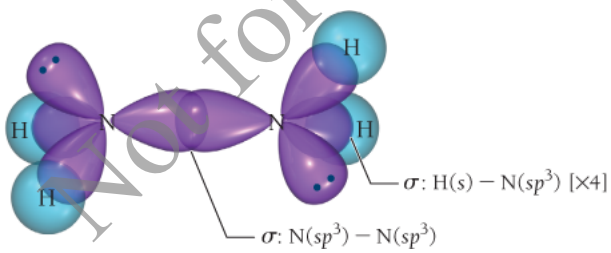


37.

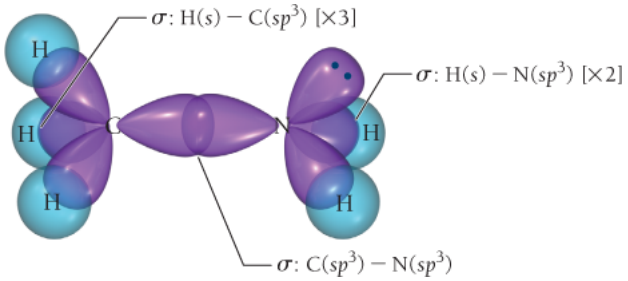
a. N's: sp^2



b. N's: sp^3



c. C: sp^3
N: sp^3



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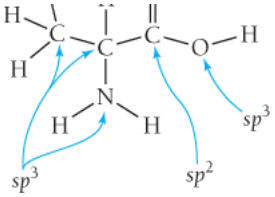

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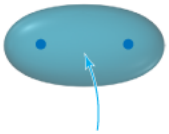


Constructive interference

43.

Be_2^+ 1 σ_{2s}^* Be_2^-

$\uparrow\downarrow$ σ_{2s} 1 σ_{2p}

$\uparrow\downarrow$ σ_{2s}^*

$\uparrow\downarrow$ σ_{2s}

bond order Be_2^+ = 1/2

bond order Be_2^- = 1/2

Both will exist in the gas phase.

45.

Bonding

Antibonding

47.

σ_{2p}^*

π_{2p}^*

σ_{2p}

π_{2p}

$\uparrow\downarrow$ σ_{2s}^*

$\uparrow\downarrow$ σ_{2s}

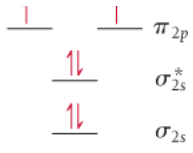
bond order = 0

a. diamagnetic

σ_{2p}^*

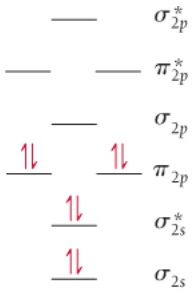
π_{2p}^*

σ_{2p}



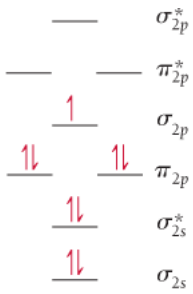
bond order = 1
diamagnetic

b.



bond order = 2
diamagnetic

c.



bond order = 2.5
diamagnetic

d.

49.

a. not stable

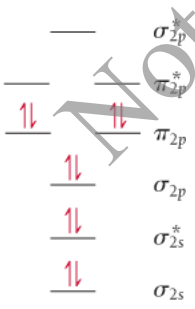
b. not stable

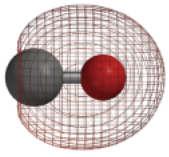
c. stable

d. not stable

51. C_2^- has the highest bond order, the highest bond energy, and the shortest bond length.

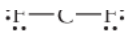
53.





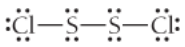
bond order = 3

55.



trigonal planar polar

a. C: sp^2



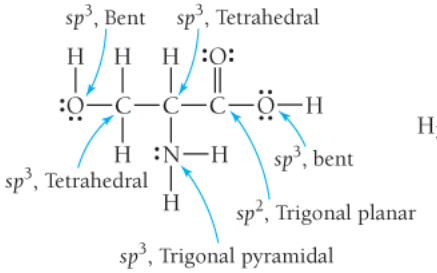
bent polar

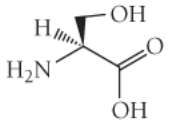
b. S's: sp^3

seesaw polar

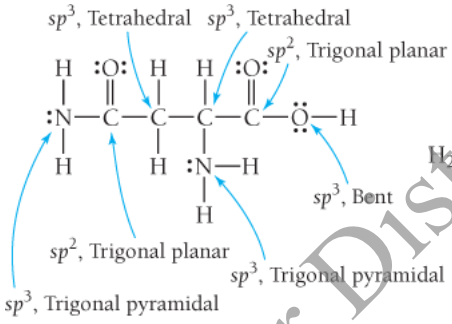
c. S: sp^3d

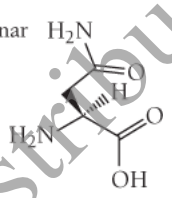
57.





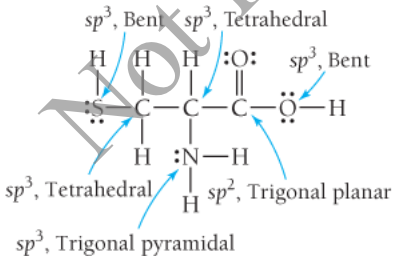
a.

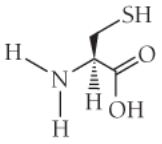




b.

c.



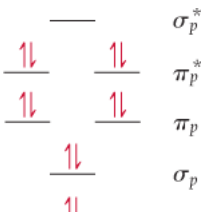


59. σ bonds: 25

π bonds: 4

lone pairs: on O's and N (without methyl group): sp^2orbitals on N's (with methyl group): sp^3orbitals

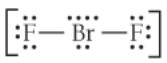
61.



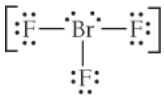
bond order = 1

63. BrF, unhybridized, linear

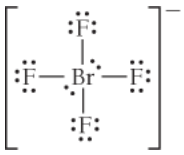
BrF_2^- has two bonds and three lone pairs on the central atom. The hybridization is sp^3d. The electron geometry is trigonal bipyramidal, with the three lone pairs equatorial. The molecular geometry is linear.



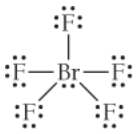
BrF_3 has three bonds and two lone pairs on the central atom. The hybridization is sp^3d. The electron geometry is trigonal bipyramidal, with the two lone pairs equatorial. The molecular geometry is T-shaped.



BrF_4^- has four bonds and two lone pairs on the central atom. The hybridization is sp^3d^2. The electron geometry is octahedral, with the two lone pairs on the same axis. The molecular geometry is square planar.



BrF_5 has five bonds and one lone pair on the central atom. The hybridization is sp^3d^2. The electron geometry is octahedral. The molecular geometry is square pyramidal.



65.

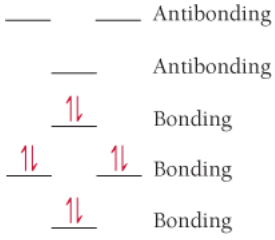
a. 10

b. 14

c. 2

67. According to valence bond theory, CH_4, NH_3, and H_2O are all sp^3 hybridized. This hybridization results in a tetrahedral electron group configuration with a 109.5° bond angle. NH_3 and H_2O deviate from this idealized bond angle because their lone electron pairs exist in their own sp^3 orbitals. The presence of lone pairs lowers the tendency for the central atom's orbitals to hybridize. As a result, as lone pairs are added, the bond angle moves further from the 109.5° hybrid angle and closer to the 90° unhybridized angle.

69. NH_3 is stable due to its bond order of 3.



71. In addition to the 2*s* and the three 2*p* orbitals, one more orbital is required to make 5 hybrid orbitals. The closest in energy is the 3*s* orbital. So the hybridization is s^2p^3. VSEPR predicts trigonal bipyramidal geometry for five identical substituents.

73. Lewis theory defines a single bond, double bond, and triple bond as a sharing of two electrons, four electrons, and six electrons, respectively, between two atoms. Valence bond theory defines a single bond as a sigma overlap of two orbitals, a double bond as a single sigma bond combined with a pi bond, and a triple bond as a double bond with an additional pi bond. Molecular orbital theory defines a single bond, double bond, and triple bond as a bond order of 1, 2, or 3, respectively, between two atoms.

75. According to valence bond theory, the bonds in each of these halide molecules result from overlap of atomic orbitals. Smaller atoms (Cl is the smallest atom and I is the largest atom) have smaller atomic orbtials, and hence, shorter bonds. The shorter the bond, the higher the bond energy.

79.

a. 1.31×10^3

b. 379 kJ/mol

Chapter 7

15.

a. chemical

b. physical

c. chemical

d. chemical

17.

a. physical

b. chemical

c. physical

19. physical, chemical, physical, physical, physical

21.

a. chemical

b. physical

c. physical

d. chemical

23. $2\ SO_2(g) + O_2(g) + 2\ H_2O(l) \rightarrow 2\ H_2SO_4(aq)$

25. $2\ Na(s) + 2\ H_2O(l) \rightarrow H_2(g) + 2\ NaOH(aq)$

27. $C_{12}H_{22}O_{11}(s) + H_2O(l) \rightarrow 4\ C_2H_5OH(aq) + 4\ CO_2(g)$

29.

a. $PbS(s) + 2\ HBr(aq) \rightarrow PbBr_2(s) + H_2S(g)$

b. $CO(g) + 3\ H_2(g) \rightarrow CH_4(g) + H_2O(l)$

c. $4\ HCl(aq) + MnO_2(s) \rightarrow MnCl_2(aq) + 2\ H_2O(l) + Cl_2(g)$

d. $C_5H_{12}(l) + 8\ O_2(g) \rightarrow 5\ CO_2(g) + 6\ H_2O(g)$

31. $Na_2CO_3(aq) + CuCl_2(aq) \rightarrow CuCO_3(s) + 2NaCl(aq)$

33.

a. $2CO_2(g) + CaSiO_3(s) + H_2O(l) \rightarrow SiO_2(s) + Ca\left(HCO_3\right)_2(aq)$

b. $2Co\left(NO_3\right)_3(aq) + 3\left(NH_4\right)_2(aq) \rightarrow Co_2S_3(s) + 6NH_4NO_3(aq)$

c. $Cu_2O(s) + C(s) \rightarrow 2Cu(s) + CO(g)$

d. $H_2O(g) + Cl_2(g) \rightarrow 2HCl(g)$

35. $2C_6H_{14}(g) + 19O_2(g) \rightarrow 12CO_2(g) + 14H_2O(g), 68molO_2$

37.

37.

a. $5.0 \text{mol} NO_2$

b. $14 \text{mol} NO_2$

c. $0.281 \text{mol} NO_2$

d. $53.1 \text{mol} NO_2$

39.

mol SiO_2	mol C	mol SiC	mol CO
3	9	3	6
2	6	2	4
5	15	5	10
2.8	8.4	2.8	5.6
0.517	1.55	0.517	1.03

41.

a. 9.3 g HBr, 0.12 g H_2

43.

a. 5.56 g $BaCl_2$

b. 6.55 g $CaCO_3$

c. 6.09 g MgO

d. 6.93 g Al_2O_3

45.

a. Na

b. Na

c. Br_2

d. Na

47. 3 molecules Cl_2

49.

a. 2 mol

b. 7 mol

c. 9.40 mol

51. 0.5 mol O_2

53.

a. 2.5 g

b. 31.1 g

c. 1.16 g

55. 2.91 grams CO_2remaining

57. limiting reactant: Pb^{2+}, theoretical yield: 34.5 g $PbCl_2$, percent yield: 85.3%

59. limiting reactant: NH_3, theoretical yield: 240.5 kg CH_4N_2O, percent yield: 70.01%

61.

a. $S(s) + O_2(g) \rightarrow SO_2(g)$

b. $2\ C_3H_6(g) + 9\ O_2(g) \rightarrow 6\ CO_2(g) + 6\ H_2O(g)$

c. $2\ Ca(s) + O_2(g) \rightarrow 2\ CaO(g)$

d. $C_5H_{12}S(l) + 9\ O_2(g) \rightarrow 5\ CO_2(g) + SO_2(g) + 6\ H_2O(g)$

63. $Sr(s) + I_2(g) \rightarrow SrI_2(s)$

65. $2\ Li(s) + 2\ H_2O(l) \rightarrow 2\ Li^+(aq) + 2\ OH^-(aq) + H_2(g)$

67. $H_2(g) + Br_2(g) \rightarrow 2\ HBr(g)$

69. 3.1 kg

71. limiting reactant: $C_7H_6O_3$, theoretical yield: 1.63 g $C_9H_8O_4$, percent yield: 74.8%

73. **b**

75. 0.333 g PH_3

77. 30.8 kg CO_2

79. 1.6 g C_2H_2

81. 2.0 mg

83. 96.6 g Mn

85. **d**

87. **a**

90.

a. Experiments 1, 2, and 3

b. 2 A + 1 B

c. 2 C

Chapter 8

21.

a. 1.17 M LiCl

b. 0.123 M $C_6H_{12}O_6$

c. 0.00453 M NaCl

23.

a. 0.150 M NO_3^-

b. 0.300 M NO_3^-

c. 0.450 M NO_3^-

25.

a. 1.3 mol

b. 1.5 mol

c. 0.211 mol

27. 37 g

29. 0.27 M

31. 6.0 L

33. 37.1 mL

35. 2.1 L

37. barium nitrate, 2.81 g $Ba(NO_3)_2$, 87.1%

39.

a. yes

b. no

c. yes

d. no

41.

a. soluble Ag^+, NO_3^-

b. soluble Pb^{2+}, $C_2H_3O_2^-$

c. soluble K^+, NO_3^-

d. soluble NH_4^+, S^{2-}

43.

a. NO REACTION

b. NO REACTION

c. $CrBr_2(aq) + Na_2CO_3(aq) \rightarrow CrCO_3(s) + 2\ NaBr(aq)$

d. $3\ NaOH(aq) + FeCl_3(aq) \rightarrow Fe(OH)_3(s) + 3\ NaCl(aq)$

45.

a. $K_2CO_3(aq) + Pb\left(NO_3\right)_2(aq) \rightarrow PbCO_3(s) + 2\ KNO_3(aq)$

b. $Li_2SO_4(aq) + Pb\left(C_2H_3O_2\right)_2(aq) \rightarrow PbSO_4(s) + 2\ LiC_2H_3O_2(aq)$

c. $Cu\left(NO_3\right)_2(aq) + MgS(aq) \rightarrow CuS(s) + Mg\left(NO_3\right)_2(aq)$

d. NO REACTION

47.

a. Complete: $H^+(aq) + Cl^-(aq) + Li^+(aq) + OH^-(aq) \rightarrow H_2O(l) + Li^+(aq) + Cl^-(aq)$

Net: $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

b. Complete: $Mg^{2+}(aq) + S^{2-}(aq) + Cu^{2+}(aq) + 2\ Cl^-(aq) \rightarrow CuS(s) + Mg^{2+}(aq) + 2\ Cl^-(aq)$

Net: $Cu^{2+}(aq) + S^{2-}(aq) \rightarrow CuS(s)$

c. Complete: $Na^{2+}(aq) + OH^-(aq) + H^+(aq) + {NO_3}^-(aq) \rightarrow H_2O(l) + Na^+(aq) + {NO_3}^-(aq)$

Net: $OH^-(aq) + H^+(aq) \rightarrow H_2O(l)$

d. Complete: $6\ Na^+(aq) + 2\ {PO_4}^{3-}(aq) + 3\ Ni^{2+}(aq) + 6\ Cl^-(aq) \rightarrow Ni_3\left(PO_4\right)_2(s) + 6\ Na^+(aq) + 6\ Cl^-(aq)$

Net: $3\ Ni^{2+}(aq) + 2\ {PO_4}^{3-}(aq) \rightarrow Ni_3\left(PO_4\right)_2(s)$

49. Complete: $Hg_2{}^{2+}(aq) + 2\ {NO_3}^-(aq) + 2\ Na^+(aq) + 2\ Cl^-(aq) \rightarrow Hg_2Cl_2(s) + 2\ Na^+(aq) + 2\ {NO_3}^-(aq)$

Net: $Hg_2{}^{2+}(aq) + 2\ Cl^-(aq) \rightarrow Hg_2Cl_2(s)$

51.

a. hydroiodic acid

b. nitric acid

c. carbonic acid

53.

a. HF

b. HBr

c. H_2SO_3

55. Molecular: $HBr(aq) + KOH(aq) \rightarrow H_2O(l) + KBr(aq)$

Net ionic: $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

57.

a. $H_2SO_4(aq) + Ca(OH)_2(aq) \rightarrow 2\ H_2O(l) + CaSO_4(s)$

b. $HClO_4(aq) + KOH(aq) \rightarrow H_2O(l) + KClO_4(aq)$

c. $H_2SO_4(aq) + 2\ NaOH(aq) \rightarrow 2\ H_2O(l) + Na_2SO_4(aq)$

59.

a. Complete ionic $H^+(aq) + Br^-(aq) + Na^+(aq) + OH^-(aq) \rightarrow H_2O(l) + Na^+(aq) + Br^-(aq)$

Net ionic $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

b. Complete ionic $HF(aq) + Na^+(aq) + OH^-(aq) \rightarrow H_2O(l) + Na^+(aq) + F^-(aq)$

Net ionic $HF(aq) + OH^-(aq) \rightarrow H_2O(l) + F^-(aq)$

c. Complete ionic $HC_2H_3O_2(aq) + Rb^+(aq) + OH^-(aq) \rightarrow H_2O(l) + Rb^+(aq) + {C_2H_3O_2}^-(aq)$

Net ionic $HC_2H_3O_2(aq) + OH^-(aq) \rightarrow H_2O(l) + {C_2H_3O_2}^-(aq)$

61. 0.1810 M $HClO_4$

63.

a. $2\ HBr(aq) + NiS(s) \rightarrow H_2S(s) + NiBr_2(aq)$

b. $NH_4I(aq) + NaOH(aq) \rightarrow H_2O(l) + NH_3(g) + NaI(aq)$

c. $2\ HBr(aq) + Na_2S(aq) \rightarrow H_2S(g) + 2\ NaBr(aq)$

d. $2\ HClO_4(aq) + Li_2CO_3(aq) \rightarrow H_2O(l) + CO_2(g) + 2\ LiClO_4(aq)$

65. $2\ HClO_4(aq) + Li_2CO_3(aq) \rightarrow H_2O(l) + CO_2(g) + 2\ LiClO_4(aq)$

67.

a. Ag: 0

b. Ag : +1

c. Ca: +2, F: −1

d. H : +1, S: −2

e. C: +4, O: −2

f. Cr : +6, O: −2

69.

a. +2

b. +6

c. +3

71.

a. redox reaction, oxidizing agent: O_2, reducing agent: Li

b. redox reaction, oxidizing agent: Fe^{2+}, reducing agent: Mg

c. not a redox reaction

d. not a redox reaction

73. b and c occur spontaneously in the forward direction

75. Fe, Cr, Zn, Mn, Al, Mg, Na, Ca, K, Li

77. Mg

79. 3.32 M

81. 1.1 g

83. **b**

85.

a. $2\ HCl(aq) + Hg_2\left(NO_3\right)_2(aq) \rightarrow Hg_2Cl_2(s) + 2\ HNO_3(aq)$

b. $KHSO_3(aq) + HNO_3(aq) \rightarrow H_2O(l) + SO_2(g) + KNO_3(aq)$

c. $2\ NH_4Cl(aq) + Pb\left(NO_3\right)_2(aq) \rightarrow PbCl_2(s) + 2\ NH_4NO_3(aq)$

d. $2\ NH_4Cl(aq) + Ca(OH)_2(aq) \rightarrow 2\ NH_3(g) + 2\ H_2O(g) + CaCl_2(aq)$

87. 22 g

89. 6.9 g

91. 0.531 L HCl

93. Br is the oxidizing agent, Au is the reducing agent, 38.8 g $KAuF_4$.

95. 11.8 g AgI

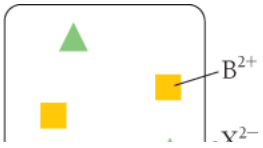
97. 5.5% by mass

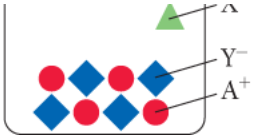
99. Ca^{2+} and Cu^{2+} present in the original solution

Net ionic for first precipitate:
$Ca^{2+}(aq) + SO_4{}^{2-}(aq) \rightarrow CaSO_4(s)$

Net ionic for second precipitate:
$Cu^{2+}(aq) + CO_3{}^{2-}(aq) \rightarrow CuCO_3(s)$

101.





103. The charge of an ion is that actual charge it has due to gaining or losing electrons. The oxidation state of an atom is the charge *it would have* in a compound if all of the bonding electrons were assigned to the more electronegative atom.

108.

a. 10.3 ppb; 3.81 ppb, 1.69 ppb

b. If the water providers used first-draw samples, they would have been required to take action. If they used 2 min flush samples, they woud not have been required to take action. Residents probably don't flush their pipes before taking water, so the first-draw technique is probably closer to actual practice.

Chapter 9

31. **d**

33.

a. heat, +

b. work, –

c. heat, +

35. -7.27×10^2 kJ

37. 311 kJ

39. The drinks that went into cooler B had more thermal energy than the refrigerated drinks that went into cooler A. The temperature difference between the drinks in cooler B and the ice was greater than the difference between the drinks and the ice in cooler A. More thermal energy was exchanged between the drinks and the ice in cooler B, which resulted in more melting.

41. 4.7×10^5 J

43.

a. 7.6×10^2°C

b. 4.3×10^2°C

c. 1.3×10^2°C

d. 49 °C

45. -2.8×10^2 J

47. 489 J

49. ΔE = –3463 J, ΔH = –3452 kJ

51.

a. exothermic, –

b. endothermic, +

c. exothermic, –

53. -4.30×10^3 kJ

55. 6.46×10^4 kJ

57. 9.5×10^2 g CO_2

59. mass of silver 77.1 g

61. Final temperature 28.4 °C

63. Specific heat capacity of substance A 1.10 J/g · °C

65. Measurement B corresponds to conditions of constant pressure. Measurement A corresponds to conditions of constant volume. When a fuel is burned under constant pressure, some of the energy released does work on the atmosphere by expanding against it. Less energy is manifest as heat due to this work. When a fuel is burned under constant volume, all of the energy released by the combustion reaction is evolved as heat.

67. -6.3×10^3 kJ/mol

69. -1.6×10^5 J

71.

a. $-\Delta H_1$

b. $2\,\Delta H_1$

c. $-\frac{1}{2}\Delta H_1$

73. –23.9 kJ

75. –173.2 kJ

77. –128 kJ

79. –614 kJ

81.

a. $N_2(g) + 3\,H_2(g) \rightarrow 2\,NH_3(g), \Delta H_f^\circ = -45.9$ kJ/mol

b. $C(s, \text{graphite}) + O_2(g) \rightarrow CO_2(g), \Delta H_f^\circ = -393.5$ kJ/mol

c. $2\,Fe(s) + 3/2\,O_2(g) \rightarrow Fe_2O_3(s), \Delta H_f^\circ = -824.2$ kJ/mol

d. $C(s, \text{graphite}) + 2\,H_2(g) \rightarrow CH_4(g), \Delta H_f^\circ = -74.6$ kJ/mol

83. –380.2 kJ/mol

85.

a. –137.1 kJ

b. –41.2 kJ

c. –137 kJ

d. –290.7 kJ

87. $6\,CO_2(g) + 6\,H_2O(l) \rightarrow C_6H_{12}O_6(s) + 6\,O_2(g), \Delta H_{rxn}^\circ = 2803$ kJ

89. –113.0 kJ/mol

91. As the size of the alkaline earth metal ions increases, so does the distance between the metal cations and oxygen anions. Therefore, the magnitude of the lattice energy decreases accordingly because the potential energy decreases as the distance increases.

93. One factor of lattice energy is the product of the charges of the two ions. The product of the ion charges for CsF is –1, while that for BaO is –4. Because this product is four times greater, the lattice energy is also four times greater.

95. –708 kJ/mol

97. $\Delta E = -1.7$ J, $q = -0.5$ J, $w = -1.2$ J

99. 78 g

101. $\Delta H = 6.0$ kJ/mol, 1.1×10^2 g

103. 26.1 °C

105. palmitic acid: 9.9378 Cal/g, sucrose: 3.938 Cal/g, fat contains more Cal/g than sugar.

107. 5.7 Cal/g

109. $\Delta E = 0$, $\Delta H = 0$, $q = -w = 3.0 \times 10^3$ J

111. –294 kJ/mol

113. 23.9 °C

115. The reaction is exothermic due to the energy released when the Al_2O_3 lattice forms.

117.

$\Delta H_{rxn}\left(H_2\right) = -243$ kJ/mol $= -121$ kJ/g

$\Delta H_{rxn}\left(CH_4\right) = -802$ kJ/mol $= -50.0$ kJ/g

CH_4 yields more energy per mole, while H_2 yields more energy per gram.

119. 333 kJ/mol

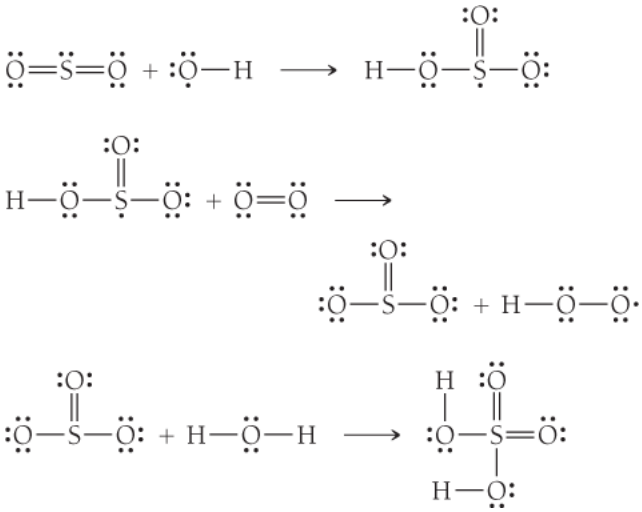
121. 7.3×10^3 g H_2SO_4

123. 7.2×10^2 g

125. 78.2 °C

127. $q = 1030$ kJ, $\Delta H = 1030$ kJ, $\Delta E = 952$ kJ, $w = -78$ kJ

129.



$\Delta H_{rxn} = -172$ kJ

131. –2162 kJ/mol

133. **d**

135. Refrigerator A contains only air, which will cool quickly but will not stabilize the temperature. Refrigerator B contains containers of water, which require a great deal of energy to cool on day 1 but will remain stable at a cold temerature on day 2.

137. Substance A

139. The internal energy of a chemical system is the sum of its kinetic energy and its potential energy. It is this potential energy that is the energy source in an exothermic chemical reaction. Under normal circumstances, chemical potential energy (or simply chemical energy) arises primarily from the electrostatic forces between the protons and electrons that compose the atoms and molecules within the system. In an exothermic reaction, some bonds break and new ones form, and the protons and electrons go from an arrangement of high potential energy to one of lower potential energy. As they rearrange, their potential energy is converted into kinetic energy. Heat is emitted in the reaction, and so it feels hot to the touch.

141. a

148.

a. $C_3H_8(g) + 5\ O_2(g) \rightarrow 3\ CO_2(g) + 4\ H_2O(l)$

$C_3H_8(g) + 5\ O_2(g) \rightarrow 3\ CO_2(g) + 4\ H_2O(g)$

b. LHV because the water formed is the gaseous state

Chapter 10

25.

a. 0.832 atm

b. 632 mmHg

c. 12.2 psi

d. 8.43×10^4 Pa

27.

a. 809.0 mmHg

b. 1.064 atm

c. 809.0 torr

d. 107.9 kPa

29.

a. 832 mmHg

b. 718 mmHg

31. 4.4×10^2 mmHg

33. 58.9 mL

35. 4.22 L

37. 3.0 L The volume would not be different if the gas was argon.

39. 1.16 atm

41. 2.1 mol

43. Yes, the final gauge pressure is 43.5 psi, which exceeds the maximum rating.

45. 16.2 L

47. 286 atm, 17.5 bottles purged

49. **b**

51. 4.76 atm

53. 37.3 L

55. 9.43 g/L

57. 44.0 g/mol

59. 4.00 g/mol

61. P_{tot} = 434 torr, $mass_{N_2}$ = 0.437 g, $mass_{O_2}$ = 0.237 g, $mass_{He}$ = 0.0340 g

63. 1.84 atm

65. $\chi_{N_2} = 0.627, \chi_{O_2} = 0.373, P_{N_2} = 0.687$ atm, $P_{O_2} = 0.409$ atm

67. $P_{H_2} = 0.921$ atm, $mass_{H_2} = 0.0539$ g

69. 7.47×10^{-2} g

71.

a. Yes

b. No

c. No. Even though the argon atoms are more massive than the helium atoms, both have the same kinetic energy at a given temperature. The argon atoms therefore move more slowly, and so exert the same pressure as the helium atoms.

d. He

73.

$F_2: u_{rms} = 442$ m/s, $KE_{avg} = 3.72 \times 10^3$ J;

$Cl_2: u_{rms} = 324$ m/s, $KE_{avg} = 3.72 \times 10^3$ J;

$Br_2: u_{rms} = 216$ m/s, $KE_{avg} = 3.72 \times 10^3$ J;

rankings: $u_{rms}: Br_2 < Cl_2 < F_2$, $KE_{avg}: Br_2 = Cl_2 = F_2$

rate of effusion: $Br_2 < Cl_2 < F_2$

75. rate UF_6^{238}/rate UF_6^{235} = 0.99574

77. krypton

79. A has the higher molar mass, B has the higher rate of effusion.

81. 38 L

83. $V_{H_2} = 48.2$ L, $CO_2 = 24.1$ L

85. 22.8 g NaN_3

87. 60.4%

89. F_2, 2.84 g ClF_3

91. That the volume of gas particles is small compared to the space between them breaks down under conditions of high pressure. At high pressure, the particles themselves occupy a significant portion of the total gas volume.

93. 0.05826 L (ideal); 0.0708 L (V.D.W.); difference because of high pressure, at which Ne no longer acts ideally

95. 97.8%

97. 27.8 g/mol

99. C_4H_{10}

101. 4.70 L

103. $2\ HCl(aq) + K_2S(s) \rightarrow H_2S(g) + 2\ KCl(aq)$, 0.191 g $K_2S(s)$

105. 11.7 L

107. $mass_{air} = 8.56$ g, $mass_{He} = 1.20$ g, mass difference = 7.36 g

109. 4.76 L/s

111. total force = 6.15×10^3 pounds; no, the can cannot withstand this force.

113. 5.8×10^3 balloons

115. 4.0 cm

117. 77.7%

119. 0.32 g

121. 311 K

123. 5.0 g

125. C_3H_8

127. 0.39 g Ar

129. 74.0 mmHg

131. 25 % N_2H_4

133. 25%

135.

$P_{CH_4} = 7.30 \times 10^{-2}$ atm, $P_{O_2} = 4.20 \times 10^{-1}$ atm,

$P_{NO} = 2.79 \times 10^{-3}$ atm, $P_{CO_2} = 5.03 \times 10^{-3}$ atm,

$P_{H_2O} = 5.03 \times 10^{-3}$ atm, $P_{NO_2} = 2.51 \times 10^{-2}$ atm,

$P_{OH} = 1.01 \times 10^{-2}$ atm, $P_{tot} = 0.542$ atm

137. 0.42 atm

139. Because helium is less dense than air, the balloon moves in a direction opposite the direction in which the air inside the car is moving due to the acceleration and deceleration of the car.

141. –29%

143.

a. false

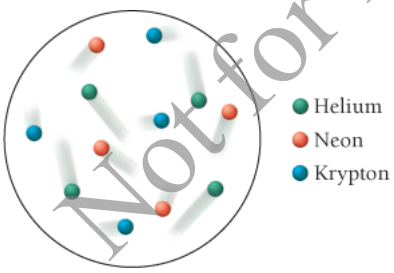
b. false

c. false

d. true

145. Four times the intial pressure

147. Although the velocity "tails" have different lengths, the average length of the tails on the helium atoms is longer than the average length of the tails on the neon atoms, which is in turn longer than the average length of the tails on the krypton atoms. The lighter the atom, the faster they must move on average to have the same kinetic energy.



153.

a. Inverse

b. 1.3×10^{-6} mol

c. Yes, because in these equations, 1 mole of O_3 reacts to form 1 mole of NO_2.

Chapter 11

35.

a. dispersion

b. dispersion, dipole–dipole, hydrogen bonding

c. dispersion, dipole–dipole

d. dispersion

37.

a. dispersion, dipole–dipole

b. dispersion, dipole–dipole, hydrogen bonding

c. dispersion

d. dispersion

39. **a, b, c, d,** Boiling point increases with increasing intermolecular forces. The molecules increase in their intermolecular forces as follows:

a. dispersion forces;

b. stronger dispersion forces (broader electron cloud);

c. dispersion forces and dipole–dipole interactions;

d. dispersion forces, dipole–dipole interactions, and hydrogen bonding.

41.

a. CH_3OH, hydrogen bonding

b. CH_3CH_2OH, hydrogen bonding

c. CH_3CH_3, greater mass, broader electron cloud causes greater dispersion forces

43.

a. Br_2, smaller mass results in weaker dispersion forces

b. H_2S, lacks hydrogen bonding

c. PH_3, lacks hydrogen bonding

45.

a. not homogeneous

b. homogeneous, dispersion, dipole–dipole, hydrogen bonding, ion–dipole

c. homogeneous, dispersion

d. homogeneous, dispersion, dipole–dipole, hydrogen bonding

47. Water. Surface tension increases with increasing intermolecular forces, and water can hydrogen bond while acetone cannot.

49. compound A

51. When the tube is clean, water experiences adhesive forces with glass that are stronger than its cohesive forces, causing it to climb the surface of a glass tube. Water does not experience strong intermolecular forces with oil, so if the tube is coated in oil, the water's cohesive forces will be greater and it will not be attracted to the surface of the tube.

53. The water in the 12-cm dish will evaporate more quickly. The vapor pressure does not change, but the surface area does. The water in the dish evaporates more quickly because the greater surface area allows for more molecules to obtain enough energy at the surface and break free.

55. Water is more volatile than vegetable oil. When the water evaporates, the endothermic process results in cooling.

57. 0.405 L

59. 91 °C

61. ΔH_{vap} = 24.7 kJ/mol, bp = 239 K

63. 41 torr

65. 22.0 kJ

67. 2.7 °C

69. 30.5 kJ

71.

a. solid

b. liquid

c. gas

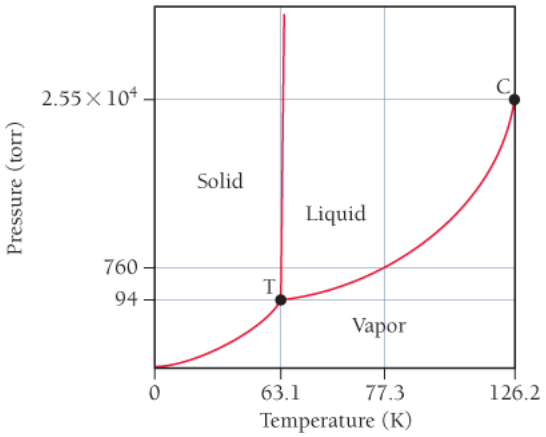
d. supercritical fluid

e. solid/liquid

f. liquid/gas

g. solid/liquid/gas

73. N_2 has a stable liquid phase at 1 atm.



75.

a. 0.027 mmHg

b. rhombic

77. Water has strong intermolecular forces. It is polar and experiences hydrogen bonding.

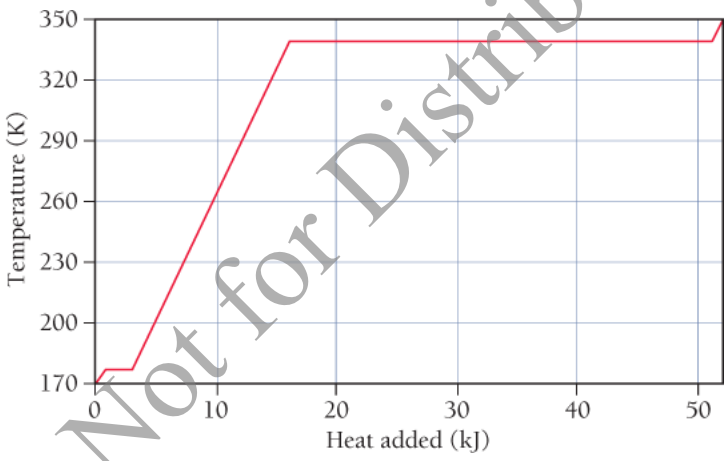
79. Water's exceptionally high specific heat capacity has a moderating effect on Earth's climate. Also, its high ΔH_{vap} causes water evaporation and condensation to have a strong effect on temperature.

81. The general trend is that melting point increases with increasing mass. This is because the electrons of the larger molecules are held more loosely and a stronger dipole moment can be induced more easily. HF is the exception to the rule. It has a relatively high melting point due to hydrogen bonding.

83. yes, 1.22 g

85. 26 °C

87.



89. 3.4×10^3 g H_2O

91. 26 mmHg

93. Decreasing the pressure will decrease the temperature of liquid nitrogen. Because the nitrogen is boiling, its temperature must be constant at a given pressure. As the pressure decreases, the boiling point decreases, and therefore so does the temperature. If the pressure drops below the pressure of the triple point, the phase change will shift from vaporization to sublimation and the liquid nitrogen will become solid.

95. 70.7 L

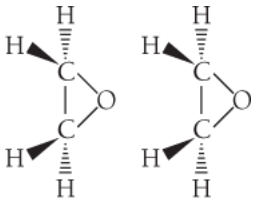
97. The melting of an ice cube in a glass of water will not raise or lower the level of the liquid in the glass as long as the ice is always floating in the liquid. This is because the ice will displace a volume of water based on its mass. By the same logic, melting floating icebergs will not raise ocean levels (assuming that the dissolved solids content, and thus the density, will not change when the icebergs melt). Dissolving ice formations that are supported by land will raise the ocean levels, just as pouring more water into the glass will raise the liquid level in the glass.

99. Substance A

101. The liquid segment will have the least steep slope because it takes the most kJ/mol to raise the temperature of the phase.

103. There are substantial intermolecular attractions in the liquid but virtually none in the gas.

105.



111.

a. No. Although it does correlate for H_2S, H_2Se, and H_2Te, it does not correlate for H_2O.

b. Water has the highest dipole moment; that together with the small size of the hydrogen atom accounts for the anomalously high boiling point.

Chapter 12

27. 162 pm

29.

a. 1

b. 2

c. 4

31. 68%

33. l = 393 pm, d 21.3 g/cm^3

35. 134.5 pm

37. 6.0×10^{23} atoms/mol

39.

a. atomic

b. molecular

c. ionic

d. atomic

41. LiCl(s). The other three solids are held together by intermolecular forces, while LiCl is held together by stronger coulombic interactions between the cations and anions of the crystal lattice.

43.

a. $TiO_2(s)$, ionic solid

b. $SiCl_4(s)$, larger, stronger dispersion forces

c. Xe(s), larger, stronger dispersion forces

d. CaO, ions have greater charge and therefore stronger coulombic forces

45. TiO_2

47. Cs : 1(1) = 1

Cl : 8(1/8) = 1

1 : 1

CsCl

Ba : 8(1/8) + 6(1/2) = 4

Cl : 8(1) = 8

4 : 8 = 1 : 2

$BaCl_2$

49. cesium chloride: none of these; barium(II) chloride: fluorite structure

51. face-centered cubic

53.

a. nonoxide

b. silicate

c. nonoxide

55. boron oxide, B_2O_3

57. Ca : +2; Si : +2; O : –2

59.

a. Zn(*s*)

61. 0.807 mol orbitals

63. insulator

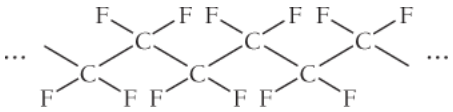
65.

a. p-type

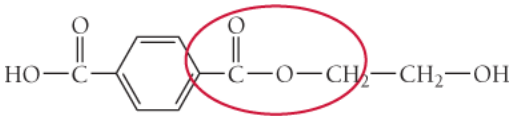
b. n-type

67. Yes, it has sufficient energy.

69.

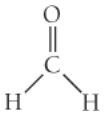


71.



73. H–C≡C–H

75.



77. CsCl has a higher melting point than AgI because of its higher coordination number. In CsCl, one anion bonds to eight cations (and vice versa), while in AgI, one anion bonds to only four cations.

79.

a. $4r$

$c^2 = a^2 + b^2 c = 4r, a = l, b = l$

$(4r)^2 = l^2 + l^2$

$16r^2 = 21l^2$

b. $8r^2 = l^2$

$l = \sqrt[3]{8r^2}$

$l = 2\sqrt{2r}$

81. 8 atoms/unit

83. 55.843 g/mol

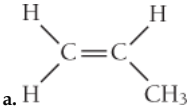
85. 2.00 g/cm^3

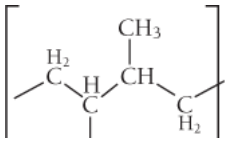
87. body diagonal = $\sqrt{6r}$, radius = $\left(\sqrt{3} - \sqrt{2}\right)r/\sqrt{2} = 0.2247r$

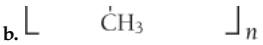
89. The higher-level electron transitions with their smaller energy gaps would not give off enough energy to create X-rays.

91.

a.





b. 

To obtain this structure, the monomer from part a would react in a head-to-head (or tail-to-tail) addition as opposed to the head-to-tail addition that leads to the structure shown in Table 12.2.

93. Because the structure is face-centered cubic, there are four C_{60} molecules per unit cell. Thus, there must be $3 \times 4 = 12$ Rb atoms per unit cell, and all sites (tetrahedral and octahedral) are occupied.

95. The liquid must be cooled quickly in order to prevent the formation of an organized crystal structure, and instead achieve an amorphous product.

97. Both structures may be viewed as having essentially a face-centered cubic unit cell, with half of the tetrahedral holes filled. Diamond, however, consists of only one type of atom (C) and is covalently bound, whereas zinc blende has S^{2-} ions at the face-centered cubic sites and Zn^{2+} ions in the tetrahedral holes, and is held together by ionic forces.

99. **d.** All of the above would likely lead to an increase in electrical conductivity.

105.

a. 20% Cr and 80% Ni; 1405°

b. 97% Cr and 3% Ni; body-centered cubic

Chapter 13

25.

a. hexane, toluene, or CCl_4; dispersion forces

b. water, methanol; dispersion, dipole–dipole, hydrogen bonding

c. hexane, toluene, or CCl_4; dispersion forces

d. water, acetone, methanol, ethanol; dispersion, ion–dipole

27. $HOCH_2CH_2CH_2OH$

29.

a. water; dispersion, dipole–dipole, hydrogen bonding

b. hexane; dispersion

c. water; dispersion, dipole–dipole

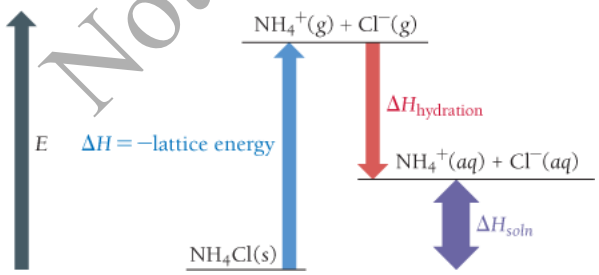
d. water; dispersion, dipole–dipole, hydrogen bonding

31.

a. endothermic

b. The lattice energy is greater in magnitude than the heat of hydration.

c.



d. The solution forms because chemical systems tend toward greater entropy.

33. –797 kJ/mol

35. $\Delta H_{soln} = -6 \times 10^1$ kJ/mol, –7 kJ of energy evolved

37. unsaturated

39. About 31 g will precipitate.

41. Boiling water releases any O_2 dissolved in it. The solubility of gases decreases with increasing temperature.

43. As pressure increases, nitrogen will more easily dissolve in blood. To reverse this process, divers should

ascend to lower pressures.

45. 1.1 g

47. 1.92 M, 2.0 *m*, 10.4%

49. 0.340 L

51. 1.6×10^6 g Ag

53. 1.4×10^4 g

55. Add water to 7.31 mL of concentrated solution until a total volume of 1.15 L is acquired.

57.

a. Add water to 3.73 g KCl to a volume of 100 mL.

b. Add 3.59 g KCl to 96.41 g H_2O.

c. Add 5.0 g KCl to 95 g H_2O.

59.

a. 0.417 M

b. 0.444 *m*

c. 7.41% by mass

d. 0.00794

e. 0.794% by mole

61. 0.89 M

63. 15 *m*, 0.22

65. The level has decreased more in the beaker filled with pure water. The dissolved salt in the seawater decreases the vapor pressure and subsequently lowers the rate of vaporization.

67. 30.7 torr

69.

a. P_{hep} = 24.24 torr, P_{oct} = 5.09 torr

b. 29.5 torr

c. 80.8% heptane by mass, 19.2% octane by mass

d. The vapor is richer in the more volatile component.

71. P_{chl} = 5.19 torr, P_{ace} = 274 torr, P_{tot} = 326 torr. The solution is not ideal. The chloroform–acetone interactions are stronger than the chloroform–chloroform and acetone–acetone interactions.

73. freezing point (fp) = −1.27°C, bp = 100.349°C

75. freezing point (fp) = 1.0 °C, boiling point (bp) = 82.4 °C

77. 1.8×10^2 g/mol

79. 26.1 atm

81. 6.36×10^3 g/mol

83.

a. fp = −0.558 °C, bp = 100.154 °C

b. fp = −1.98 °C, bp = 100.546 °C

c. fp = −2.5 °C, bp = 100.70 °C

85. 160 g

87.

a. −0.632 °C

b. 5.4 atm

c. 100.18 °C

89. 2.3

91. 3.4

93. 23.0 torr

95. Chloroform is polar and has stronger solute–solvent interactions than nonpolar carbon tetrachloride.

97. ΔH_{soln} = 51 kJ/mol, −8.7 °C

99. 2.2×10^{-3} M/atm

101. 1.3×10^4 L

103. 0.24 g

105. −24 °C

107.

a. 1.1% by mass/V

b. 1.6% by mass/V

c. 5.3% by mass/V

109. 2.484

111. 0.229 atm

113. χ_{CHCl_3}(original) = 0.657, P_{CHCl_3}(condensed) = 0.346 atm

115. 1.74 M

117. $C_6H_{14}O_2$

119. 12 g

121. 6.4×10^{-3} L

123. 22.4 % glucose by mass, 77.6 % sucrose by mass

125. P_{iso} = 0.131 atm, P_{pro} = 0.068 atm. The major intermolecular attractions are between the OH groups. The OH group at the end of the chain in propyl alcohol is more accessible than the one in the middle of the chain in isopropyl alcohol. In addition, the molecular shape of propyl alcohol is a straight chain of carbon atoms, while that of isopropyl alcohol is a branched chain and is more like a ball. The contact area between two ball-like objects is smaller than that of two chain-like objects. The smaller contact area in isopropyl alcohol means the molecules don't attract each other as strongly as do those of propyl alcohol. As a result of both of these factors, the vapor pressure of isopropyl alcohol is higher.

127. 0.0097 m

129. Na_2CO_3 0.050 M, $NaHCO_3$ 0.075 M

131. The water should not be immediately cycled back into the river. As the water was warmed, dissolved oxygen would have been released, since the amount of a gas able to be dissolved into a liquid decreases as the temperature of the liquid increases. As such, the water returned to the river would lack dissolved oxygen if it was still hot. To preserve the dissolved oxygen necessary for the survival of fish and other aquatic life, the water must first be cooled.

133.

b. NaCl

140.

a. The salinity of seawater is generally higher near the equator and lower near the poles.

b. −2.3 °C

Chapter 14

27.

a. rate $= -\frac{1}{2}\frac{\Delta[HBr]}{\Delta t} = \frac{\Delta[H_2]}{\Delta t} = \frac{\Delta[Br_2]}{\Delta t}$

b. 1.8×10^{-3} M/s

c. 0.040 mol Br_2

29.

a. rate $= -\frac{1}{2}\frac{\Delta[A]}{\Delta t} = -\frac{\Delta[B]}{\Delta t} = \frac{1}{3}\frac{\Delta[C]}{\Delta t}$

b. $\frac{\Delta[B]}{\Delta t} = -0.0500$ M/s, $\frac{\Delta[C]}{\Delta t} = 0.150$ M/s

31.

$\Delta[Cl_2]/\Delta t$	$\Delta[F_2]/\Delta t$	$\Delta[ClF_3]/\Delta t$	Rate
−0.012 M/s	−0.036 M/s	0.024 M/s	0.012 M/s

33.

a. $0 \rightarrow 10\text{ s}: \text{rate} = 8.7 \times 10^{-3}\text{ M/s}$
$40 \rightarrow 50\text{ s}: \text{rate} = 6.0 \times 10^{-3}\text{ M/s}$

b. $1.4 \times 10^{-2}\text{ M/s}$

35.

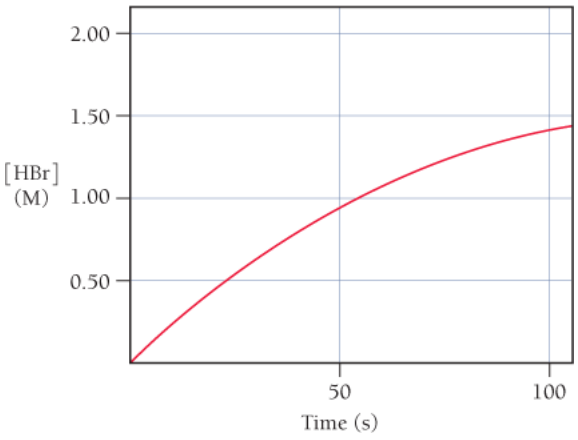
a.

i. $1.0 \times 10^{-2}\text{ M/s}$

ii. $8.5 \times 10^{-3}\text{ M/s}$

iii. 0.013 M/s

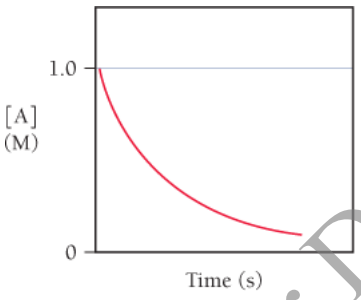
b.



37.

a. first order

b.



c. rate = $k[\text{A}]^1$, $k = 0.010\text{ s}^{-1}$

39.

a. s^{-1}

b. $\text{M}^{-1}\text{s}^{-1}$

c. $\text{M} \cdot \text{s}^{-1}$

41.

a. rate = $k[\text{A}][\text{B}]^2$

b. third order

c. 2

d. 4

e. 1

f. 8

43. second order, rate = $5.25\text{ M}^{-1}\text{s}^{-1}[\text{A}]^2$

45. rate = $k\left[\text{NO}_2\right]\left[\text{F}_2\right]$, $k = 2.57\text{ M}^{-1}\text{s}^{-1}$, second order

47.

a. zero order

b. first order

c. second order

49. second order, $k = 2.25 \times 10^{-2}\ M^{-1}s^{-1}$, [AB] at 25 s = 0.619 M

51. first order, $k = 1.12 \times 10^{-2}\ s^{-1}$, rate = 2.8×10^{-2} M/s

53.

a. $4.5 \times 10^{-3}\ s^{-1}$

b. rate = $4.5 \times 10^{-3}\ s^{-1}$[A]

c. 1.5×10^{2} s

d. [A] = 0.0908 M

55.

a. 4.88×10^{3} s

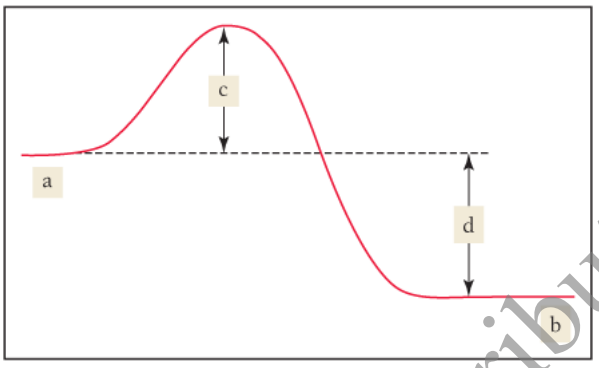
b. 9.8×10^{3} s

c. 1.7×10^{3} s

d. 0.146 M at 200 s, 0.140 M at 500 s

57. 6.8×10^{8} yr; 1.8×10^{17} atoms

59.



61. $17\ s^{-1}$

63. 61.90 kJ/mol

65. $E_a = 251$ kJ/mol, $A = 7.93 \times 10^{11}\ s^{-1}$

67. $E_a = 23.0$ kJ/mol, $A = 8.05 \times 10^{10}\ M^{-1}\ s^{-1}$

69.

a. 122 kJ/mol

b. $0.101\ s^{-1}$

71. 47.85 kJ/mol

73. **a**

75. The mechanism is valid.

77.

a. $Cl_2(g) + CHCl_3(g) \rightarrow HCl(g) + CCl_4(g)$

b. $Cl(g)$, $CCl_3(g)$

c. rate = $k\left[Cl_2\right]^{1/2}\left[CHCl_3\right]$

79. Heterogeneous catalysts require a large surface area because catalysis can only happen at the surface. A greater surface area means greater opportunity for the substrate to react, which results in a faster reaction.

81. 10^{12}

83.

a. first order, $k = 0.0462\ hr^{-1}$

b. 15 hr

c. 5.0×10^{1} hr

85. 0.0531 M/s

87. rate $= 4.5 \times 10^{-4}\left[CH_3CHO\right]^2$, $k = 4.5 \times 10^{-4}$, 0.37 atm

89. 219 torr

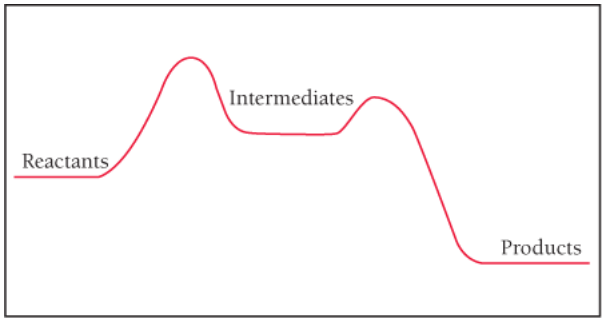
91. 1×10^{-7} s

93. 1.6×10^{2} seconds

95.

a. 2

b.



c. first step

d. exothermic

97.

a. 5.41 s

b. 2.2 s for 25% 5.4 s for 50%

c. 0.28 at 10 s, 0.077 at 20 s

99.

a. $E_a = 89.5$ kJ/mol, $A = 4.22 \times 10^{11}\ s^{-1}$

b. $2.5 \times 10^{-5}\ M^{-1}s^{-1}$

c. 6.0×10^{-4} M/s

101.

a. No

b. No bond is broken, and the two radicals attract each other.

c. Formation of diatomic gases from atomic gases

103. 1.35×10^{4} yr

105.

a. Both are valid. For both, all steps sum to overall reaction, and the predicted rate law is consistent with experimental data.

b. buildup of I(g)

107. rate $= k_2\left[\left(k_1/k_{-1}\right)\left[Br_2\right]\right]^{1/2}\left[H_2\right]$

The rate law is 3/2 order overall.

109.

a. 0%

b. 25%

c. 33%

111. 174 kJ

113.

a. second order

$$CH_3NC + CH_3NC \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} CH_3NC^* + CH_3NC \quad \text{(fast)}$$

$$CH_3NC^* \xrightarrow{k_1} CH_3CN \quad \text{(slow)}$$

$$\text{rate} = k_3[CH_3NC^*]$$

$$k_1[CH_3NC]^2 = k_2[CH_3NC^*][CH_3NC]$$

$$[CH_3NC^*] = \frac{k_1}{k_2}[CH_3NC]$$

$$\text{rate} = k_3 \times \frac{k_1}{k_2}[CH_3NC]$$

b. $\text{rate} = k[CH_3NC]$

115.

$$\text{rate} = k[A]^2$$

$$\text{rate} = -\frac{d[A]}{dt}$$

$$\frac{d[A]}{dt} = -k[A]^2$$

$$-\frac{d[A]}{[A]^2} = k\,dt$$

$$\int_{[A]_0}^{[A]} -\frac{1}{[A]^2}d[A] = \int_0^t k\,dt$$

$$\left[\frac{1}{[A]}\right]_{[A]_0}^{[A]} = k\,[t]_0^t$$

$$\frac{1}{[A]} - \frac{1}{[A]_0} = kt$$

$$\frac{1}{[A]} = kt + \frac{1}{[A]_0}$$

117. $\text{rate} = k[CO]\left[CO_2\right]^{\frac{3}{2}}$

119. $\left[Cl_2\right] = 0.0084$ mol/L, [NO] = 0.017 mol/L

121. B is first order and A is second order. B will be linear if you plot ln[B] versus time; A will be linear if you plot 1/[A] versus time.

125.

a. The reaction is first order in $CH_4$and first order in O_3.

b. 1.7×10^{-18} M/s

Chapter 15

21.

a. $K = \dfrac{\left[SbCl_3\right]\left[Cl_2\right]}{\left[SbCl_5\right]}$

b. $K = \dfrac{[NO]^2\left[Br_2\right]}{[BrNO]^2}$

c. $K = \dfrac{\left[CS_2\right]\left[H_2\right]^4}{\left[CH_4\right]\left[H_2S\right]^2}$

d. $K = \dfrac{\left[CO_2\right]^2}{[CO]^2\left[O_2\right]}$

23. The concentration of the reactants will be greater. No, this is not dependent on initial concentrations; it is dependent on the value of K_c.

25.

a. figure v

b. The change in the decrease of reactants and increase of products would be faster.

c. No, catalysts affect kinetics, not equilibrium.

27.

a. 4.42×10^{-5}, reactants favored

b. 1.50×10^{2}, products favored

c. 1.96×10^{-9}, reactants favored

29. 1.3×10^{-29}

31.

a. 2.56×10^{-23}

b. 1.3×10^{22}

c. 81.9

33.

a. $K_c = \dfrac{\left[HCO_3^-\right]\left[OH^-\right]}{\left[CO_3^{2-}\right]}$

b. $K_c = \left[O_2\right]^3$

c. $K_c = \dfrac{\left[H_3O^+\right]\left[F^-\right]}{[HF]}$

d. $K_c = \dfrac{\left[NH_4^+\right]\left[OH^-\right]}{\left[NH_3\right]}$

35. 136

37.

T(K)	$[N_2]$	$[H_2]$	$[NH_3]$	K_c
500	0.115	0.105	0.439	1.45×10^{-3}
575	0.110	0.249	0.128	9.6
775	0.120	0.140	4.39×10^{-3}	0.0584

39. 234 torr

41. 18

43. 3.3×10^2

45. 764

47. More solid will form.

49. Additional solid will not dissolve.

51.

a. [A] = 0.20 M, [B] = 0.80 M

b. [A] = 0.33 M, [B] = 0.67 M

c. [A] = 0.38 M, [B] = 1.2 M

53. $\left[N_2O_4\right]$ = 0.0115 M, $\left[NO_2\right]$ = 0.0770 M

55. 0.19$\bar{}$9 M

57. 1.9×10^{-3}m

59. 7.84 torr

61.

a. [A] = 0.38 M, [B] = 0.62 M, [C] = 0.62 M

b. [A] = 0.90 M, [B] = 0.095 M, [C] = 0.095 M

c. [A] = 1.0 M, [B] = 3.2×10^{-3} M, [C] = 3.2×10^{-3} M

63.

a. shift left

b. shift right

c. shift right

65.

a. shift right

b. no effect

c. no effect

d. shift left

67.

a. shift right

b. shift left

c. no effect

69. Increase temperature → shift right, decrease temperature → shift left. Increasing the temperature will increase the equilibrium constant.

71. **b, d**

73.

a. 1.7×10^2

b. $\frac{[\text{Hb—CO}]}{[\text{Hb—O}_2]} = 0.85$ or $17/20$

CO is highly toxic, as it blocks O_2uptake by hemoglobin. CO at a level of 0.1% will replace nearly half of the O_2in blood.

75.

a. 1.68 atm

b. 1.41 atm

77. 0.406 g

79. **b, c, d**

81. 0.0144 atm

83. 3.1×10^2 g, 20% yield

85. 0.12 atm

87. 0.72 atm

89. 0.017 g

91. 0.226

93.

a. 29.3

b. 169 torr

95. $P_{NO} = P_{Cl_2} = 429$ torr

97. 1.27×10^{-2}

99. $K_p = 5.1 \times 10^{-2}$

101. Yes, because the volume affects Q.

103. a = 1, b = 2

110.

a. For system 1, $K_p = 0.011$; for system 2, $K_p = 91$.

b. System 1 is more likely.

Chapter 16

31.

a. acid, $HNO_3(aq) \rightarrow H^+(aq) + NO_3^-(aq)$

b. acid, $NH_4^+(aq) \rightleftharpoons H^+(aq) + NH_3(aq)$

c. base, $KOH(aq) \rightarrow K^+(aq) + OH^-(aq)$

d. acid, $HC_2H_3O_2(aq) \rightleftharpoons H^+(aq) + C_2H_3O_2^-(aq)$

33.

a. $H_2CO_3(aq)_{\text{acid}} + H_2O(l)_{\text{base}} \rightleftharpoons H_3O^+(aq)_{\text{conj.acid}} + HCO_3^-(aq)_{\text{conj.base}}$

b. $NH_3(aq)_{\text{base}} + H_2O(l)_{\text{acid}} \rightleftharpoons NH_4^+(aq)_{\text{conj.acid}} + OH^-(aq)_{\text{conj.base}}$

c. $HNO_3(aq)_{\text{acid}} + H_2O(l)_{\text{base}} \rightleftharpoons H_3O^+(aq)_{\text{conj.acid}} + NO_3^-(aq)_{\text{conj.base}}$

d. $C_5H_5N(aq)_{\text{base}} + H_2O(l)_{\text{acid}} \rightleftharpoons C_5H_5NH^+(aq)_{\text{conj.acid}} + OH^-(aq)_{\text{conj.base}}$

35.

a. Cl^-

b. HSO_3^-

c. CHO_2^-

d. F^-

37.

$$H_2PO_4^-(aq) + H_2O(l) \rightleftharpoons HPO_4^{2-}(aq) + H_3O^+(aq)$$

$$H_2PO_4^-(aq) + H_2O(l) \rightleftharpoons H_3PO_4(aq) + OH^-(aq)$$

39.

a. HCl, weaker bond

b. HF, bond polarity

c. H_2Se, weaker bond

41.

a. H_2SO_4, more oxygen atoms bonded to S

b. $HClO_2$, more oxygen atoms bonded to Cl

c. HClO, Cl has higher electronegativity.

d. CCl_3COOH, Cl has higher electronegativity.

43. S^{2-}, its conjugate acid (H_2S), is a weaker acid than H_2S.

45.

a. strong

b. strong

c. strong

d. weak, $K_a = \dfrac{[H_3O^+][HSO_3^-]}{[H_2SO_3]}$

47. **a, b, c**

49.

a. 8.3×10^{-7}, basic

b. 1.2×10^{-10}, acidic

c. 2.9×10^{-13}, acidic

51.

a. pH = 7.77, pOH = 6.23

b. pH = 7.00, pOH = 7.00

c. pH = 5.66, pOH = 8.34

53.

$[H_3O^+]$	$[OH^-]$	pH	Acidic or Basic
7.1×10^{-4}	1.4×10^{-11}	3.15	Acidic
3.7×10^{-9}	2.7×10^{-6}	8.43	Basic
7.9×10^{-12}	1.3×10^{-3}	11.1	Basic
6.3×10^{-4}	1.6×10^{-11}	3.20	Acidic

55. $[H_3O^+] = 1.5 \times 10^{-7}$ M, pH = 6.81

57. pH = 1.36, 1.35, 1.34 A difference of 1 in the second significant digit in a concentration value produces a difference of 0.01 in pH. Therefore, the second significant digit in value of the concentration corresponds to the hundredths place in a pH value.

59.

a. [H3O+]=0.25 M,[OH−]=4.0×10−14 M,pH=0.60

b. [H3O+]=0.015 M,[OH−]=6.7×10−13 M,pH=1.82

c. [H3O+]=0.072 M,[OH−]=1.4×10−13 M,pH=1.14

d. [H3O+]=0.105 M,[OH−]=9.5×10−14 M,pH=0.979

61.

a. 1.8 g

b. 0.57 g

c. 0.045 g

63. 2.21

65. [H3O+]=2.5×10−3 M,pH=2.59

67.

a. 1.82 (approximation valid)

b. 2.18 (approximation breaks down)

c. 2.72 (approximation breaks down)

69. 2.75

71. 6.8×10−6

73. 0.0063%

75.

a. 0.42%

b. 0.60%

c. 1.3%

d. 1.9%

77. 3.61×10−5

79.

a. pH = 1.89; percent ionization = 5.1%

b. pH = 2.10; percent ionization = 7.9%

c. pH = 2.26; percent ionization = 11%

81.

a. 0.939

b. 1.07

c. 2.19

d. 3.02

83.

a. [OH−]=0.15 M,[H3O+]=6.7×10−14 M,pH=13.17,pOH=0.83

b. [OH+]=0.003 M,[H3O+]=3.3×10−12 M,pH=11.48,pOH=2.52

c. [OH−]=9.6×10−4 M,[H3O+]=1.0×10−11 M,pH=10.98,pOH=3.02

d. [OH−]=8.7×10−5 M,[H3O+]=1.1×10−10 M,pH=9.93,pOH=4.07

85. 13.842

87. 0.104 L

89.

a. NH3(aq)+H2O(l)⇌NH4+(aq)+OH−(aq),Kb=[NH4+][OH−][NH3]

b. HCO3−(aq)+H2O(l)⇌H2CO3(aq)+OH−(aq),Kb=[H2CO3][OH−][HCO3−]

c. CH3NH2(aq)+H2O(l)⇌CH3NH3+(aq)+OH−(aq),Kb=[CH3NH3+][OH−][CH3NH2]

91. [OH−]=1.6×10−3 M,pOH=2.79,pH=11.21

93. 7.48

95. 6.7×10−7

97.

a. neutral

b. basic,ClO−(aq)+H2O(l)⇌HClO(aq)+OH−(aq)

c. basic,CN−(aq)+H2O(l)⇌HCN(aq)+OH−(aq)

d. neutral

99. [OH−]=2.0×10−6 M,pH=8.30

101.

a. acidic, NH4+(aq)+H2O(l)⇌NH3(aq)+H3O+(aq)

b. neutral

c. acidic, Co(H2O)63+(aq)+H2O(l)⇌Co(H2O)5(OH)2+(aq)+H3O+(aq)

d. acidic, CH2NH3+(aq)+H2O(l)⇌CH2NH2(aq)+H3O+(aq)

103.

a. acidic

b. basic

c. neutral

d. acidic

e. acidic

105. NaOH,NaHCO3,NaCl,NH4ClO2,NH4Cl

107.

a. 5.13

b. 8.87

c. 7.0

109. [K+]=0.15 M,[F−]=0.15 M,[HF]=2.1×10−6 M,[H3O+]=4.8×10−9 M

111.

a. F−

b. NO2−

c. ClO−

113.

H3PO4(aq)+H2O(l)⇌H2PO4−(aq)+H3O+(aq),Kai=[H3O+][H2PO4−][H3PO4]H3PO4−(aq)+H2O(l)⇌HPO42−(aq)+H3O+(aq),Ka2=[H3O·

115.

a. [H3O+]=0.048 M,pH=1.32

b. [H3O+]=0.12 M,pH=0.92

117.

[H2SO3]=0.418 M[HSO3−]=0.082 M[SO32−]=6.4×10−8 M[H3O+]=0.082 M

119.

a. [H3O+]=0.50 M,pH=0.30

b. [H3O+]=0.11 M,pH=0.96(*x is small* approximation breaks down)

c. [H3O+]=0.059 M,pH=1.23

121.

a. Lewis acid

b. Lewis acid

c. Lewis base

d. Lewis base

123.

a. acid: Fe3+, base: H2O

b. acid: Zn2+, base: NH3

c. acid: BF3, base: (CH3)3N

125.

a. weak

b. strong

c. weak

d. strong

127. If blood became acidic, the H+concentration would increase. According to Le Châtelier's principle,

equilibrium would be shifted to the left and the concentration of oxygenated Hb would decrease.

129. All acid will be neutralized.

131. [H3O+](Great Lakes)=3×10−5 M,

[H3O+](West Coast)=4×10−6 M,. The rain over the Great Lakes is about 8 times more concentrated.

133. 2.7

135.

a. 2.000

b. 1.52

c. 12.95

d. 11.12

e. 5.03

137.

a. 1.260

b. 8.22

c. 0.824

d. 8.57

e. 1.171

139.

a. CN−(aq)+H+(aq)⇌HCN(aq)

b. NH4+(aq)+OH−(aq)⇌NH3(aq)+H2O(l)

c. CN−(aq)+HH4+(aq)⇌HCN(aq)+NH3(aq)

d. HSO4−(aq)+C2H3O2−(aq)⇌SO42−(aq)+HC2H3O2(aq)

e. no reaction between the major species

141. 0.794

143. Ka=8.3×10−4

145. The student forgot to account for the dissociation of water. Correct pH is 6.79.

147. 2.14

149.

[A−]=4.5×10−5 M[H+]=2.2×10−4 M[HA2−]=1.8×10−4 M

151. 9.28

153. 50.1 g NaHCO3

155. **b**

157. CH3COOH<CH2ClCOOH<CHCl2COOH<CCl3COOH

164.

a. 9.2 g SO2

b. S2O52−(aq)+H2O(l)→2 HSO3−(aq)

c. 16 g for (a) and 15 g for (b)

Chapter 17

25. **d**

27.

a. 3.62

b. 9.11

29. pure water: 2.1%, in NaC7H5O2: 0.065%. The percent ionization in the sodium benzoate solution is much smaller because the presence of the benzoate ion shifts the equilibrium to the left.

31.

a. 2.14

b. 8.32

c. 3.46

33. HCl+NaC2H3O2→HC2H3O2+NaClNaOH+HC2H3O2→NaC2H3O2+H2O

35.

a. 3.62

b. 9.11

37.

a. 7.60

b. 11.18

c. 4.61

39.

a. 3.86

b. 8.95

41. 3.5

43. 3.7 g

45.

a. 4.74

b. 4.68

c. 4.81

47.

a. initial 7.00
after 1.70

b. initial 4.71
after 4.56

c. initial 10.78
after 10.66

49. 1.2 g; 2.7 g

51.

a. yes

b. no

c. yes

d. no

e. no

53.

a. 7.4

b. 0.3 g

c. 0.14 g

55. KClO/HClO = 0.79

57.

a. does not exceed capacity

b. does not exceed capacity

c. does not exceed capacity

d. does not exceed capacity

59.

i.

a. pH=8,

b. pH=7

ii.

a. weak acid,

b. strong acid

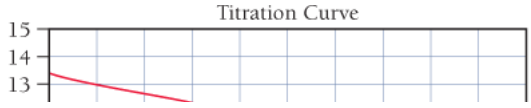
61.

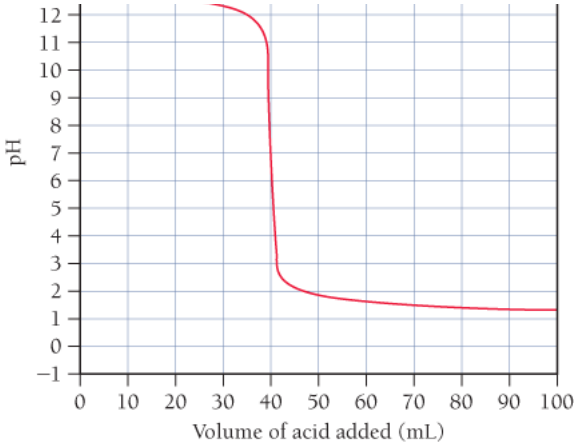
a. 40.0 mL HI for both

b. KOH: neutral, CH_3NH_2: acidic

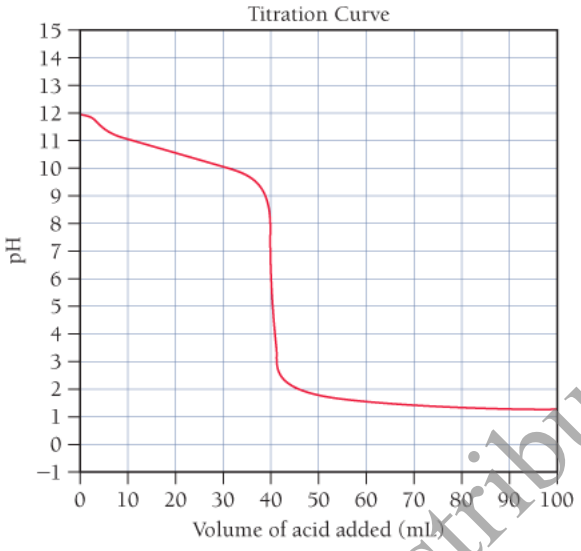
c. CH_3NH_2

d. Titration of KOH with HI:





Titration of CH_3NH_2 with HI:



63.

a. pH=9,added base=30 mL

b. 0 mL

c. 15 mL

d. 30 mL

e. 30 mL

65.

a. 0.757

b. 30.6 mL

c. 1.038

d. 7

e. 12.15

67.

a. 13.06

b. 28.8 mL

c. 12.90

d. 7

e. 2.07

69.

a. 2.86

b. 16.8 mL

c. 4.37

d. 4.74

e. 8.75

f. 12.17

71.

a. 11.94

b. 29.2 mL

c. 11.33

d. 10.64

e. 5.87

f. 1.90

73.

i. (a)

ii. (b)

75. pKa=3,82 g/mol

77. first equivalence: 22.7 mL

second equivalence: 45.4 mL

79. The indicator will appear red. The pH range is 4 to 6.

81.

a. phenol red, *m*-nitrophenol

b. alizarin, bromothymol blue, phenol red

c. alizarin yellow R

83.

a. BaSO4(s)⇌Ba2+(aq)+SO42−(aq),Ksp=[Ba2+][SO42−]

b. PbBr2(s)⇌Pb2+(aq)+2 Br−(aq),Ksp=[Pb2+][Br−]2

c. Ag2CrO4(s)⇌2 Ag+(aq)+CrO42−(aq),Ksp=[Ag+][CrO42−]

85.

a. 7.31×10−7m

b. 3.72×10−5m

c. 3.32×10−4m

87.

a. 1.07×10−21

b. 7.14×10−7

c. 7.44×10−11

89. AX2

91. 2.07×10−5g/100 mL

93.

a. 0.0183 M

b. 0.00783 M

c. 0.00109 M

95.

a. 5×1014 M

b. 5×108 M

c. 5×104 M

97.

a. more soluble, CO32−is basic

b. more soluble, S2−is basic

c. not, neutral

d. not, neutral

99. Precipitate will form, CaF2.

101. Precipitate will form, Mg(OH)2.

103.

a. 0.018 M

b. 1.4×10−7m

c. 1.1×10−5m

105.

a. BaSO4,1.1×10−8 M

b. 3.0×10−8m

107. 8.7×10−10m

109. 5.6×1016

111. 4.03

113. 3.57

115. HCl, 4.7 g

117.

a. NaOH(aq)+KHC8H4O4(aq)→Na+(aq)+K+(aq)+C8H4O42−(aq)+H2O(l)

b. 0.1046 M

119. 4.73

121. 176 g/mol; 1.0×10−4

123. 14.2 L

125. 1.6×10−7m

127. 8.0×10−8m

129. 6.29

131. 0.172 M

133. The ratio by mass of dimethyl ammonium chloride to dimethyl amine needed is 3.6.

135. 0.18 M benzoic acid, 0.41 M sodium benzoate

137. 51.6 g

139. 1.8×10−11(based on this data)

141.

a. 5.5×10−25M

b. 5.5×10−4 M

143. 1.38 L

145. 12.97

147.

a. pH<pKa

b. pH>pKa

c. pH=pKa

d. pH>pKa

149. **b**

151.

a. no difference

b. less soluble

c. more soluble

157.

a. 30.0 mL

b. 1.0×102 g/mol

c. Trimethylamine

Chapter 18

27. **a, c**

29. System B has the greatest entropy. There is only one energetically equivalent arrangement for System A. However, the particles of System B may exchange positions for a second energetically equivalent arrangement.

31. 29.2 J/K

33. –24.7 J/K

35.

a. ΔS>0

b. ΔS<0

c. ΔS<0

d. ΔS<0

37.

a. ΔSsys>0,ΔSsurr>0, spontaneous at all temperatures

b. ΔSsys<0,ΔSsurr<0, nonspontaneous at all temperatures

c. ΔSsys<0,ΔSsurr<0, nonspontaneous at all temperatures

d. ΔSsys>0,ΔSsurr>0, spontaneous at all temperatures

39.

a. 1.29×103 J/K

b. 5.00×103 J/K

c. –3.83×102 J/K

d. –1.48×103 J/K

41.

a. –649 J/K >, nonspontaneous

b. 649 J/K, spontaneous

c. 123 J/K, spontaneous

d. –76 J/K, nonspontaneous

43.

a. 1.93×105 J, nonspontaneous

b. –1.93×105 J, spontaneous

c. –3.7×104 J, spontaneous

d. 4.7×104 J, nonspontaneous

45. –2.247×106 J, spontaneous

47.

ΔH	ΔS	ΔG	Low Temperature	High Temperature
−	+	−	Spontaneous	Spontaneous
−	−	Temperature dependent	Spontaneous	Nonspontaneous
+	+	Temperature dependent	Nonspontaneous	Spontaneous
+		+	Nonspontaneous	Nonspontaneous

49. It increases.

51.

a. CO2(g), greater molar mass and complexity

b. CH3OH(g), gas phase

c. CO2(g), greater molar mass and complexity

d. SiH4(g), greater molar mass

e. CH3CH2CH3(g), greater molar mass and complexity

f. NaBr(*aq*) aqueous

53.

a. He,Ne,SO2,NH3,CH3CH2OH. From He to Ne there is an increase in molar mass; beyond that, the molecules increase in complexity.

b. H2O(s),H2O(l),H2O(g); increase in entropy in going from solid to liquid to gas phase

c. CH4,CF4,CCl4; increasing entropy with increasing molar mass

55.

a. –120.8 J/K, decrease in moles of gas

b. 133.9 J/K, increase in moles of gas

c. –42.0 J/K, small change because moles of gas stay constant

d. –390.8 J/K, decrease in moles of gas

57. –89.3 J/K, decrease in moles of gas

59. ΔHrxn°=–1277 kJ,ΔSrxn°=313.6 J/K,ΔGrxn°=–1.370×103 kJ;yes

61.

a. ΔHrxn°=57.2 kJ,ΔSrxn°=175.8 J/K,ΔGrxn°=4.8×103 J/mol;nonspontaneous, becomes spontaneous at high temperatures

b. ΔHrxn°=176.2 kJ,ΔSrxn°=285.1 J/K,ΔGrxn°=91.2 kJ;nonspontaneous, becomes spontaneous at high temperatures

c. ΔHrxn°=98.8 kJ,ΔSrxn°=141.5 J/K,ΔGrxn°=56.6 kJ;nonspontaneous, becomes spontaneous at high temperatures

d. ΔHrxn°=–91.8 kJ,ΔSrxn°=–198.1 J/K,ΔGrxn°=–32.8 kJ;spontaneous

63.

a. 2.8 kJ

b. 91.2 kJ

c. 56.4 kJ

d. –32.8 kJ

Values are comparable. The method using $\Delta H°$ and $\Delta S°$ can be used to determine how $\Delta G°$ changes with temperature.

65.

a. –72.5 kJ, spontaneous

b. –11.4 kJ, spontaneous

c. 9.1 kJ, nonspontaneous

67. –29.4 kJ

69.

a. –19.3 kJ

b.

i. –2.9 kJ

ii. –2.9 kJ

c. The partial pressure of iodine is very low.

71. 11.9 kJ

73.

a. 1.48×1090

b. 2.09×10–26

75.

a. –24.8 kJ

b. 0

c. –9.4 kJ

77.

a. 1.90×1047

b. 1.51×10–13

79. ΔH = 50.6 kJ $\Delta S°$ = 226 J/K

81. 4.8

83.

a. +

b.

b. –

c. –

85.

a. ΔG°=175.2 kJ,K=1.95×10−31, nonspontaneous

b. 133 kJ, yes

87.

Cl2:ΔHrxn°=−182.1 kJ,00ΔSrxn°=−134.4 J/K,ΔGrxn°=−142.0 kJ000000000K=7.94×1024Br2:ΔHrxn°=−121.6 kJ,00ΔSrxn°=−134.2 J/K,ΔGrxn

Cl2is the most spontaneous, I2is the least. Spontaneity is determined by the standard enthalpy of formation of

the dihalogenated ethane. Higher temperatures make the reactions less spontaneous.

89.

a. 107.8 kJ

b. 5.0×10−7 atm

c. spontaneous at higher temperatures, T=923.4 K

91.

a. 2.22×105

b. 94.4 mol

93.

a. ΔG°=−689.6 kJ, Δ*G*° becomes less negative

b. ΔG°=−665.2 kJ, Δ*G*° becomes less negative

c. ΔG°=−632.4 kJ, Δ*G*° becomes less negative

d. ΔG°=−549.3 kJ, Δ*G*° becomes less negative

95. With one exception, the formation of any oxide of nitrogen at 298 K requires more moles of gas as reactants than are formed as products. For example, 1 mol of N2Orequires 0.5 mol of O2and 1 mol of N2, 1

mol of N2O3requires 1 mol of N2and 1.5 mol of O2, and so on. The exception is NO, where 1 mol of NO

requires 0.5 mol of O2and 0.5 mol of N2:

12N2(g)+12O2(g)→NO(g)

This reaction has a positive Δ*S* because what is essentially mixing of the N and O has taken place in the product.

97. 15.0 kJ

99.

a. Positive, the process is spontaneous. It is slow unless a spark is applied.

b. Positive, although the change in the system is not spontaneous; the overall change, which includes such processes as combustion or water flow to generate electricity, is spontaneous.

c. Positive, the acorn oak/tree system is becoming more ordered, so the processes associated with growth are not spontaneous. But they are driven by spontaneous processes such as the generation of heat by the sun and the reactions that produce energy in the cell.

101. At 18.3 mmHg ΔG=0, At 760 mmHg ΔG°=55.4 kJ

103.

a. 3.24×10−3

b.

NH3+ATP+H2O→NH3—Pi+ADPNH3—Pi+C5H8O4N−→C5H9O3N2+Pi+H2ONH3+C5H8O4N−+ATP→C5H9O3N2+ADP+Pi¯ΔG°=−16.3

105.

a. −95.3 kJ/mol. Since the numbers of moles of reactants and products are the same, the decrease in volume affects the entropy of both equally, so there is no change in Δ*G*.

b. 102.8 kJ/mol. The entropy of the reactants (1.5 mol) is decreased more than the entropy of the product (1 mol). Since the product is relatively more favored at lower volume, Δ*G* is less positive.

c. 204.2 kJ/mol. The entropy of the product (1 mol) is decreased more than the entropy of the reactant (0.5 mol). Since the product is relatively less favored, Δ*G* is more positive.

107. ΔH°=−93 kJ,ΔS°=−2.0×102 J/K

109.

ΔSvap diethyl ether=86.1 J/mol K,ΔSvap acetone=88.4 J/mol

K,ΔSvap benzene=87.3 J/mol,ΔSvap=chloroform=88.0 J/mol K

. Because water and ethanol hydrogen bond, they are more ordered in the liquid and we expect ΔSvapto be more positive. Ethanol 38600/351.0=110 J/mol K,=H2O=40700/373.2=109 J/mol K

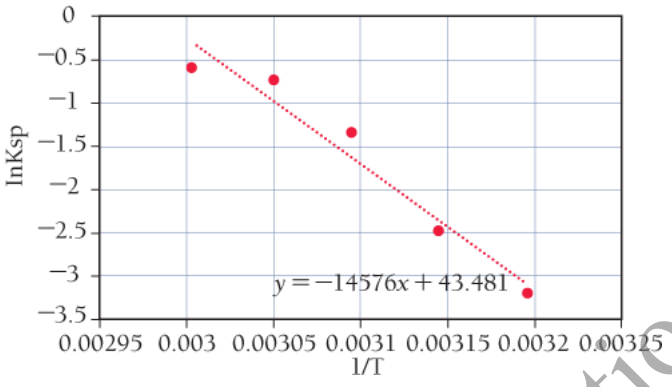
111. **a** and **c** will both increase the entropy of the surroundings because they are both exothermic reactions (adding thermal energy to the surroundings).

113. **c.** If entropy of a system is increasing, the enthalpy of a reaction can be overcome (if necessary) by the entropy change as long as the temperature is high enough. If the entropy change of the system is decreasing, the reaction must be exothermic in order to be spontaneous since the entropy is working against spontaneity.

115. **a** and **b** are both true. Since ΔGrxn=ΔGrxn°+R T ln Qand ΔGrxn°=−42.5 kJ, in order for ΔGrxn=0the second term must be positive. This necessitates that Q>1or that we have more product than reactant. Any reaction at equilibrium has ΔGrxn=0.

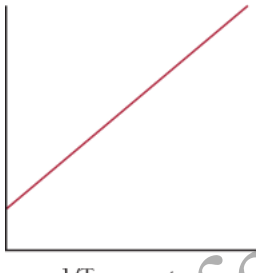
122.

a.



b. 362 J/K

c.



Chapter 19

33.

a. 3 K(s)+Cr3+(aq)→Cr(s)+3 K+(aq)

b. 2 Al(s)+3 Fe2+(aq)→2 Al3+(aq)+3 Fe(s)

c. 2 BrO3−(aq)+3 N2H4(g)→2 Br−(aq)+3 N2(g)+6 H2O(l)

35.

a. PbO2(s)+2 I−(aq)+4 H+(aq)→Pb2+(aq)+I2(s)+2 H2O(l)

b. 5 SO32−(aq)+2 MnO4−(aq)+6 H+(aq)→5 SO42−(aq)+2 Mn2+(aq)+3 H2O(l)

c. S2O32−(aq)+4 Cl2(g)+5 H2O(l)→2 SO42−(aq)+8 Cl−(aq)+10 H+(aq)

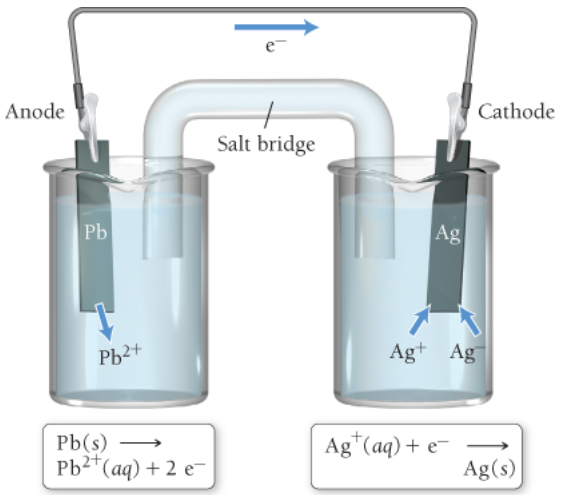
37.

a. H2O2(aq)+2 ClO2(aq)+2 OH−(aq)→O2(g)+2 ClO2−(aq)+2 H2O(l)

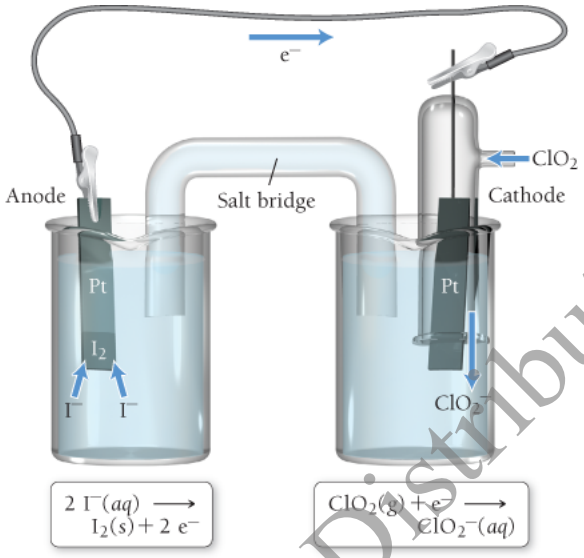
b. Al(s)+MnO4−(aq)+2 H2O(l)→Al(OH)4−(aq)+MnO2(s)

c. Cl2(g)+2 OH−(aq)+Cl−(aq)→ClO−(aq)+H2O(l)

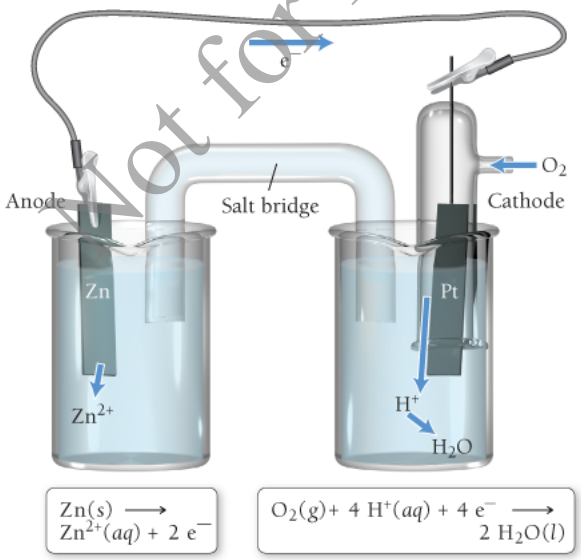
39.



a.



b.



c.

41.

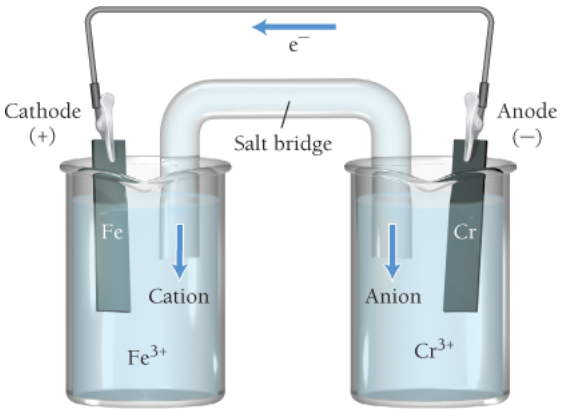
a. 0.93 V

b. 0.41 V

c. 1.99 V

43.

a, c, d



b. Cr(s)+Fe3+(aq)→Cr3+(aq)+Fe(s),Ecell°=0.69 V

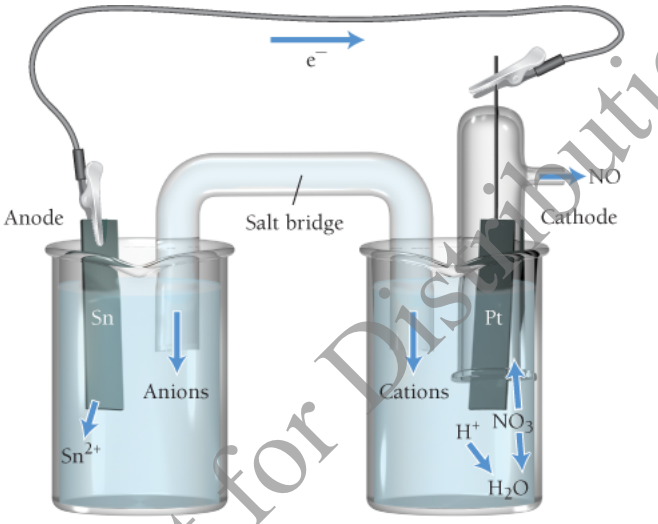
45.

a. Pb(s)|Pb2+(aq)||Ag2+(aq)|Ag(s)

b. Pt(s),I2(s)|I−(aq)||ClO2−(aq)|ClO2(g)|Pt(s)

c. Zn(s)|Zn2+(aq)||H2O(l)|H+(aq)|O2(g)|Pt(s)

47.



3 Sn(s)+2 NO3−(aq)+8 H+(aq)→3 Sn2+(aq)+2 NO(g)+4 H2O(l),Ecell°=1.10 V

49. **b**, c occur spontaneously in the forward direction.

51. aluminum

53.

a. yes, 2 Al(s)+6 H+(aq)→2 Al3+(aq)+3 H2(g)

b. no

c. yes, Pb(s)+2 H+(aq)→Pb2+(aq)+H2(g)

55.

a. yes, 3 Cu(s)+2 NO3−(aq)+8 H+(aq)→3 Cu2+(aq)+2 NO(g)+4 H2O(l)

b. no

57.

a. −1.70 V, nonspontaneous

b. 1.97 V, spontaneous

c. −1.51, nonspontaneous

59. **a**

61.

a. −432 kJ

b. 52 kJ

c. –1.7×102 kJ

63.

a. 5.31×1075

b. 7.7×10−10

c. 6.3×1029

65. 5.6×105

67. ΔG°=−7.97 kJ,Ecell°=0.041 V

69.

a. 1.04 V

b. 0.97 V

c. 1.11 V

71. 1.87 V

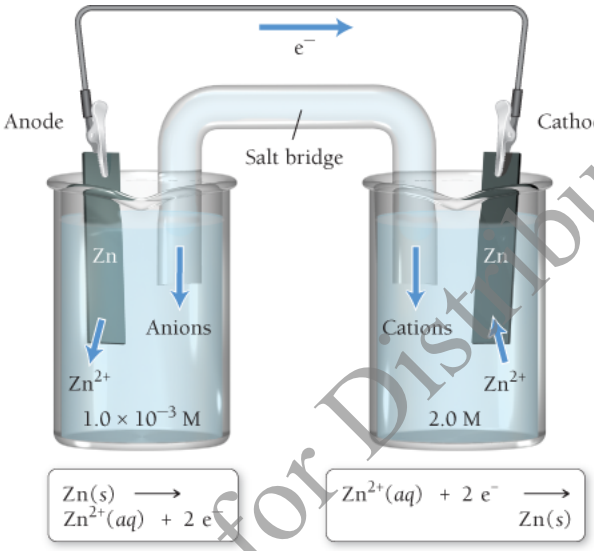
73.

a. 0.56 V

b. 0.52 V

c. [Ni2+]=0.003 M,[Zn2+]=1.60 M

75.



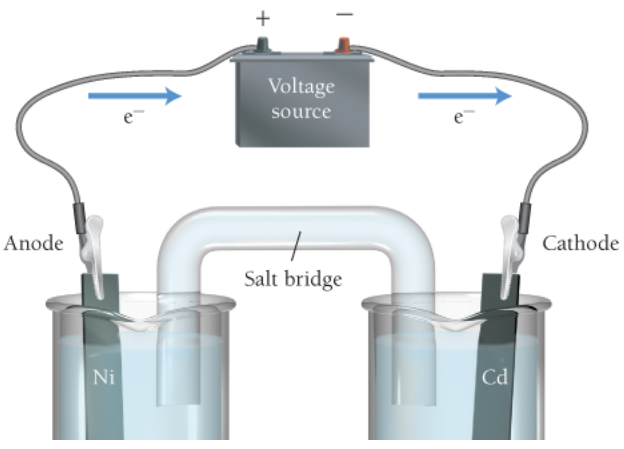
77. [Sn2+](ox)[Sn2+](red)=4.2×10−4

79. 0.3762

81. 1.038 V

83. **a, c** would prevent the corrosion of iron

85.



minimum voltage=0.17 V

87.

oxidation:2 Br−(l)→Br2(g)+2 e−oxidation:K+(l)+e−→K(l)

89.

oxidation:2 Br−(l)→Br2(g)+2 e−oxidation:K+(l)+e−→K(l)

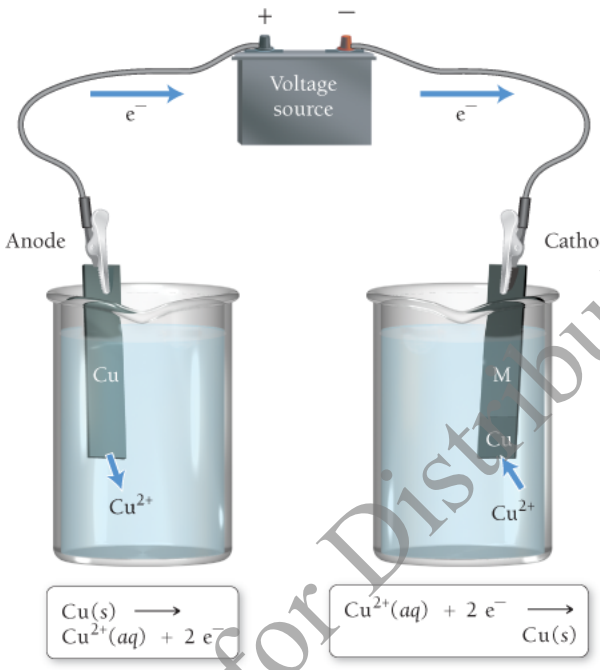
91.

a. anode:2 Br−→Br2(l)+2 e−cathode:2 H2O(l)+2 e−→H2(g)+2 OH−(aq)

b. anode:2 I−(aq)→I2(s)+2 e−cathode:Pb2+(aq)+2 e−→Pb(s)

c. anode:2 H2O(l)→O2(g)+4 H+(aq)+4 e−cathode:2 H2O(l)+2 e−→H2(g)+2 OH−(aq)

93.



95. 1.8×102 s

97. 1.2×103 A

99.

2 MnO4−(aq)+5 Zn(s)+16 H+(aq)→2 Mn2+(aq)+5 Zn2+(aq)+8 H2O(l) 34.9 mL

101. The drawing should show that several Al atoms dissolve into solution as Al3+ions and that several Cu2+ions are deposited on the Al surface as solid Cu.

103.

a. 68.3 mL

b. cannot be dissolved

c. cannot be dissolved

105. 0.25

107. Ecell°=0.0726 V;K=284

$[B^{2+}]$	$[A^{2+}]$	Q	E_{cell}	ΔG_{rxn}
1.00	1.00	1.00	0.0726 V	−14.0 kJ
1.00	1.00×10^{-4}	1.00×10^{-4}	0.191	−36.8 kJ

1.00×10^{-4}	1.00	1.00×10^{4}	−0.0458	8.82 kJ
3.52×10^{-3}	1.00	284	0	0

109. There are no paired reactions that produce more than about 5 or 6 V.

111.

a. 2.83 V

b. 2.71 V

c. 16 hr

113. 176 h

115. 0.71 V

117.

a. $\Delta G°=461$ kJ,$K=1.4\times10-81$

b. $\Delta G°=2.7\times102$ kJ,$K=2.0\times10-48$

119. MCl4

121. 51.3%

123. pH=0.85

125. 0.83 M

127. 4.1×105 L

129. 435 s

131. 8.39% U

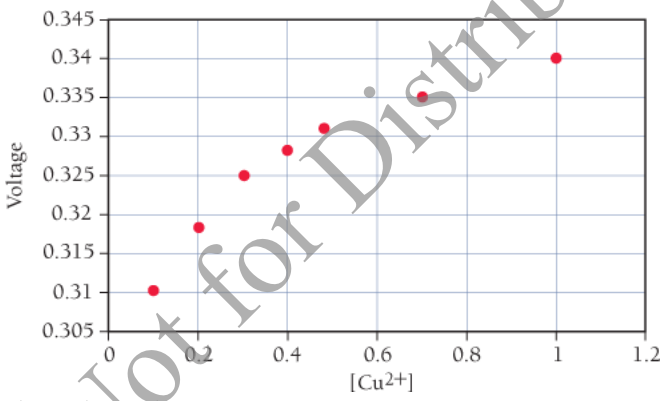
133. The overall cell reaction for both cells is $2\ Cu+(aq)\rightarrow Cu2+(aq)+Cu(s)$. The difference in $E°$ is because $n=1$for the first cell and $n=2$for the second cell. For both cells, $\Delta G°=-35.1$ kJ.

135. **a**

137. $\Delta Grxn°$is positive and $Ecell°$is negative.

143.

a.



The graph is not linear.

c. Slope=0.0298; intercept=0.340; yes the slope should be 0.0592/n and the intercept should be $Ecell°$.

Chapter 20

31.

a. U092234→He24+Th090230

b. Th090230→He24+Ra088226

c. Pb082214→e−10.0+Bi083214

d. N0713→e+10.0+C0613

e. Cr2451+e+10.0→V2351

33.

Th090232→He24+Ra088228Ra088228→e−1.00+Ac089228Ac089228→e−1.00+Th090228Th090228→He24+Ra088224

35.

a. Fr087221

b. e−10.0

c. e+10.0

d. e−10.0

37.

a. stable, *N*/*Z* ratio is close to 1, acceptable for low *Z* atoms

b. not stable, *N*/*Z* ratio much too high for low *Z* atom

c. not stable, *N*/*Z* ratio is less than 1, much too low

d. stable, *N*/*Z* ratio is acceptable for this *Z*

39. Sc, V, and Mn, each have odd numbers of protons. Atoms with an odd number of protons typically have less stable isotopes than those with an even number of protons.

41.

a. beta decay

b. positron emission

c. positron emission

d. positron emission

43.

a. Cs-125

b. Fe-62

45. 2.34×109 yr

47. 0.57 g

49. 10.8 hr

51. 2.66×103 yr

53. 2.4×104 yr

55. 2.7×109 yr

57. U092235+n01→Xe054144+Sr3890+2 n01

59. H12+H12→He23+n01

61.

U092238+n01→U093239U092239→Np093239+e−1030Np093239→Pu094239+e−1030

63. Cf098249+C0612→Rf104257+4 n01

65. 9.0×1013 J

67.

a. mass defect=0.13701 amubinding energy=7.976 MeV/nucleon

b. mass defect=0.54369 amubinding energy=8.732 MeV/nucleon

c. mass defect=1.16754 amubinding energy=8.431 MeV/nucleon

69. 7.228×1010 J/g U-235

71. 7.84×1010 J/g H-2

73. radiation: 25 J, fall: 370 J

75. 68 mi

77.

a. p11+Be49→Li36+He241.03×1011 J/mol

b. Bi083209+Ni2864→Rg111272+n011.141×1013 J/mol

c. W074179+e−10.0→Ta0731797.59×1010 J/mol

79.

a. Ru044114→e−10.0+Rh045114

b. Ra088216→e+10.0+Fr087216

c. Zn3058→e+10.0+Cu2958

d. $^{1031}_{10}\text{Ne} \rightarrow {}^{0}_{-1}\text{e} + {}^{1131}_{10.0}\text{Na}$

81. 2.9×10^{21} beta emissions, 3700 Ci

83. 1.6×10^{-5} L

85. 4.94×10^{7} kJ/mol

87. 7.72 MeV

89. N 14

91. 0.15%

93. 1.24×10^{21} atoms

95. 2.42×10^{-12}m

97. –0.7 MeV, there is no coulombic barrier for collision with a neutron.

99.

a. 1.164×10^{10} kJ

b. 0.1299 g

101. U-235 forms Pb-207 in seven α-decays and four β-decays, and Th-232 forms Pb-208 in six α-decays and four β-decays.

103. 3.0×10^{2} K

105. $^{21}_{09}\text{F} \rightarrow {}^{21}_{10}\text{Ne} + {}^{0}_{-1}\text{e}$ 10.0

107. Nuclide A is more dangerous because the half-life is shorter (18.5 days) and so it decays faster.

109. Iodine is used by the thyroid gland to make hormones. Normally, we ingest iodine in foods, especially iodized salt. The thyroid gland cannot tell the difference between stable and radioactive iodine and will absorb both. KI tablets work by blocking radioactive iodine from entering the thyroid. When a person takes KI, the stable iodine in the tablet gets absorbed by the thyroid. Because KI contains so much stable iodine, the thyroid gland becomes "full" and cannot absorb any more iodine—either stable or radioactive—for the next 24 hours.

115.

a. 0.34 g at 200 minutes; 0.23 g at 400 minutes

b. 0.63 μg

Chapter 21

33.

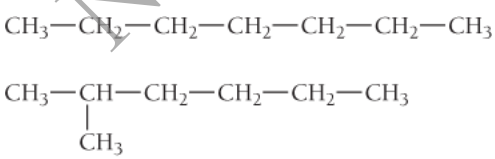
a. alkane

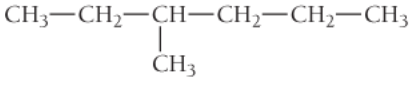
b. alkene

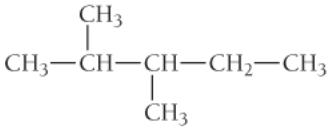
c. alkyne

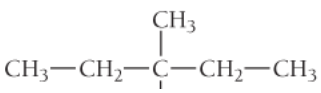
d. alkene

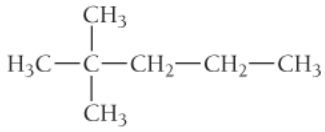
35.

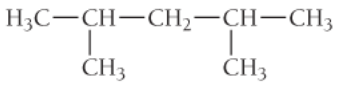


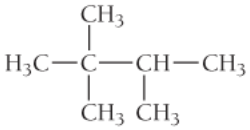


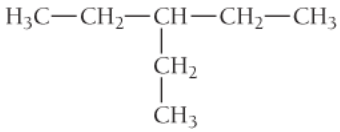












37.

a. no

b. yes

c. yes

d. no

39.

a. enantiomers

b. same

c. enantiomers

41.

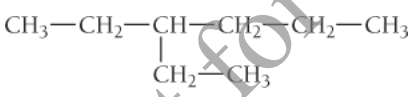
a. pentane

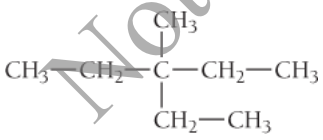
b. 2-methylbutane

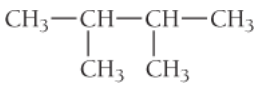
c. 4-isopropyl-2-methylheptane

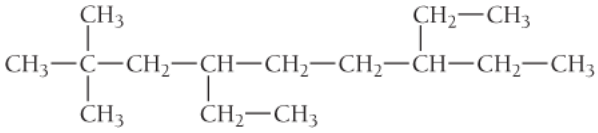
d. 4-ethyl-2-methylhexane

43.

a. 

b. 

c. 

d. 

45.

a. CH3CH2CH3+5 O2→3 CO2+4 CO2

b. CH3CH2CH3═CH+6 O2→4 CO2+4 H2O

c. 2 CH≡CH+5 O2→4 CO2+2 H2O

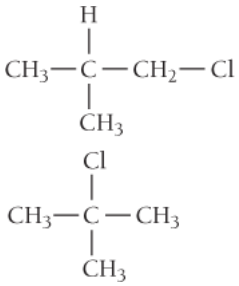
47.

a. CH3CH2Br

b. CH3CH2CH2Cl,CH3CHClCH3

c. CHCl2Br

d.



49.

CH2=CH–CH2–CH2–CH2–CH3CH3–CH=CH–CH2–CH2–CH3CH3–CH2–CH=CH–CH2–CH3

51.

a. 1-butene

b. 3,4-dimethyl-2-pentene

c. 3-isopropyl-1-hexene

d. 2,4-dimethyl-3-hexene

53.

a. 2-butyne

b. 4,4-dimethyl-2-hexyne

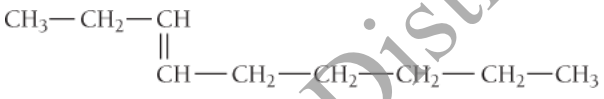
c. 3-isopropyl-1-hexyne

d. 3,6-dimethyl-4-nonyne

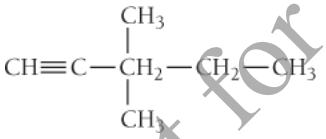
55.

a. CH3–CH2–CH–C≡C–CH2–CH2–CH3

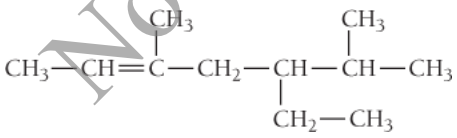
b.



c.

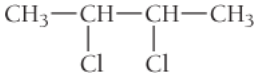


d.

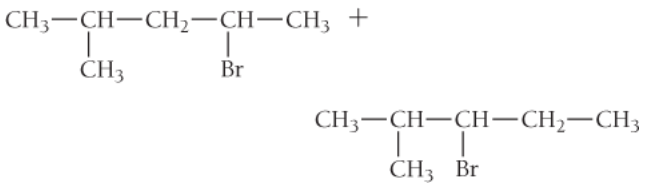


57.

a.

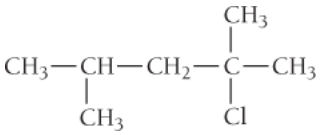


b.



c.

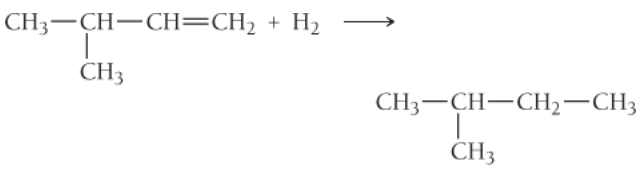
d.



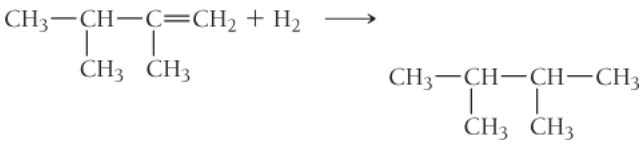
59.

a. CH2=CH–CH3+H2→CH3–CH2–CH3

b.



c.



61.

a. methylbenzene or toluene

b. bromobenzene

c. chlorobenzene

63.

a. 3,5-dimethyl-7-phenylnonane

b. 2-phenyl-3-octene

c. 4,5-dimethyl-6-phenyl-2-octyne

65.

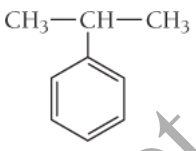
a. 1,4-dibromobenzene or *p*-dibromobenzene

b. 1,3-diethylbenzene or *m*-diethylbenzene

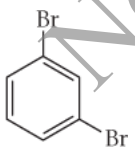
c. 1-chloro-2-fluorobenzene or *o*-chlorofluorobenzene

67.

a.



b.



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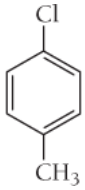
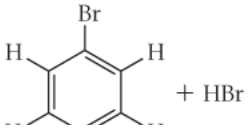
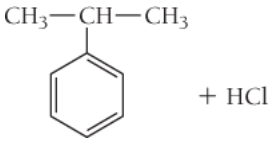


69.



a. 

b. 

71.

a. 1-propanol

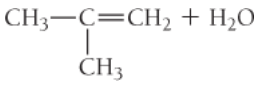
b. 4-methyl-2-hexanol

c. 2,6-dimethyl-4-heptanol

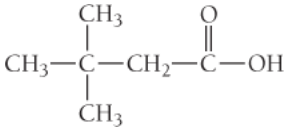
d. 3-methyl-3-pentanol

73.

a. CH3CH2CH2Br+H2O

b. 

c. CH3CH2ONa+12H2

d. 

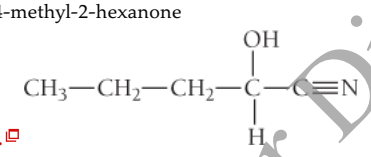
75.

a. butanone

b. pentanal

c. 3,5,5-trimethylhexanal

d. 4-methyl-2-hexanone



77.

79.

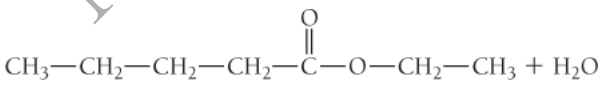
a. methylbutanoate

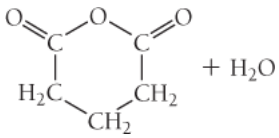
b. propanoic acid

c. 5-methylhexanoic acid

d. ethylpentanoate

81.

a. 

b. 

83.

a. ethyl propyl ether

b. ethyl pentyl ether

c. dipropyl ether

d. butyl ethyl ether

85.

a. diethylamine

b. methylpropylamine

c. butylmethylpropylamine

87.

a. acid–base, $(CH3)2NH2+(aq)+Cl+(aq)$

b. condensation, $CH3CH2CONHCH2CH3(aq)+H2O$

c. acid–base, $CH3NH3+(aq)+HSO4–(aq)$

89.

a. ester, methyl 3-methylbutanoate

b. ether, ethyl 2-methylbutyl ether

c. aromatic, 1-ethyl-3-methylbenzene or *m*-ethylmethylbenzene

d. alkyne, 5-ethyl-4-methyl-2-heptyne

e. aldehyde, butanal

f. alcohol, 2-methyl-1-propanol

91.

a. 5-isobutyl-3-methylnonane

b. 5-methyl-3-hexanone

c. 3-methyl-2-butanol

d. 4-ethyl-3,5-dimethyl-1-hexyne

93.

a. isomers

b. isomers

c. same

95. 558 g

97.

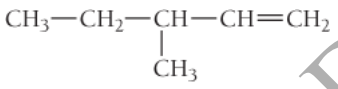
a. combustion

b. alkane substitution

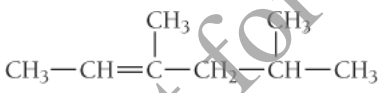
c. alcohol elimination

d. aromatic substitution

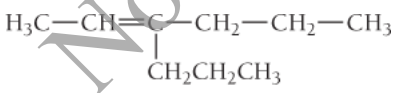
99.



a. Can exist as a stereoisomer

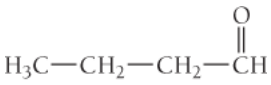


b. Can exist as a stereoisomer

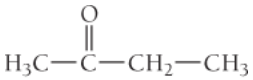


c. Can exist as a stereoisomer

101.



a. Aldehyde



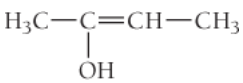
b. Ketone

c. $H3C–CH=CH–O–CH2$Alkene, ether

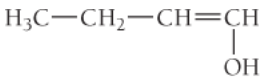
d. $H2C=CH–O–CH2–CH2$Alkene, ether

e. H2C=CH–CH2–O–CH3Alkene, ether

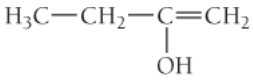
f. H3C–CH=CH–CH2–OHAlkene, alcohol



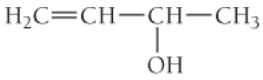
g. Alkene, alcohol



h. Alkene, alcohol



i. Alkene, alcohol

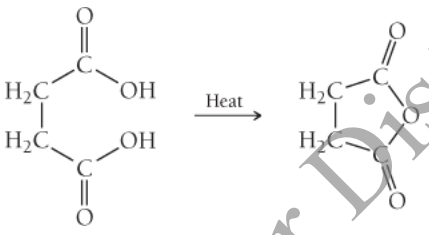


j. Alkene, alcohol

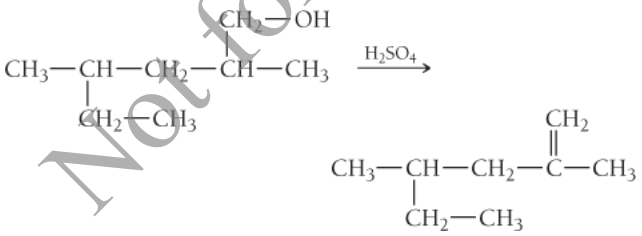
k. Alkene, alcohol

103. In the acid form of the carboxylic acid, electron withdrawal by the C=O enhances acidity. The conjugate base, the carboxylate anion, is stabilized by resonance, so the two O atoms are equivalent and bear the negative charge equally.

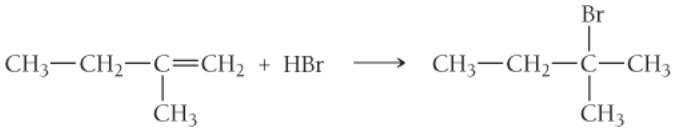
105.



a.



b.



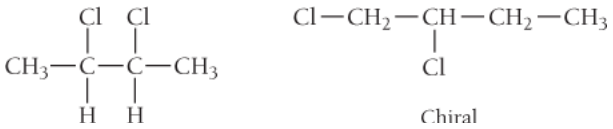
c.

107.

a. 3:1

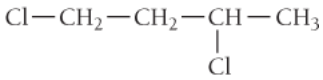
b. 2° hydrogen atoms are more reactive. The reactivity of 2° hydrogens to 1° hydrogens is 11:3.

109.



Chiral

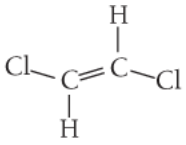
Chiral



Chiral

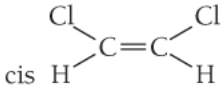
111. The first propagation step for F is very rapid and exothermic because of the strength of the H—F bond that forms. For I the first propagation step is endothermic and slow because the H—I bond that forms is relatively weak.

113.



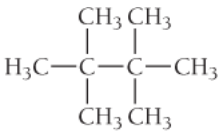
$Cl-C\equiv C-Cl$ trans No dipole moment

$ClCH_2-CH_2Cl$



cis Cl_2CHCH_3 Dipole moment

115.

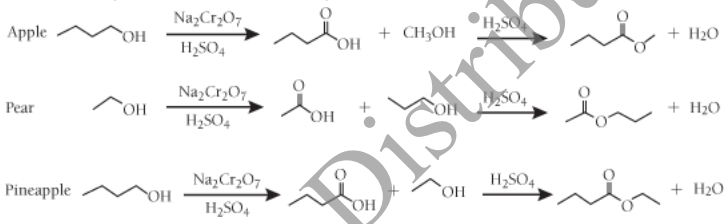


2,2,3,3-tetramethylbutane

121.

a. Apple: methyl butanoate; Pear: propyl ethanoate; Pineapple: ethyl butanoate

c.



Chapter 22

17.

a. [Ar] 4s23d8,[Ar] 3d8

b. [Ar] 4s23d5,[Ar] 3d3

c. [Kr] 5s24d1,[Kr] 5s14d1

d. [Xe] 6s24f145d3,[Xe] 4f145d3

19.

a. +5

b. +7

c. +4

21.

a. +3, 6

b. +2, 6

c. +2, 4

d. +1, 2

23.

a. hexaaquachromium(III)

b. tetracyanocuprate(II)

c. pentaaminebromoiron(III) sulfate

d. amminetetraaquahydroxycobalt(III) chloride

25.

a. [Cr(NH3)6]3+

b. K3[Fe(CN)6]

c. [Cu(en)(SCN)2]

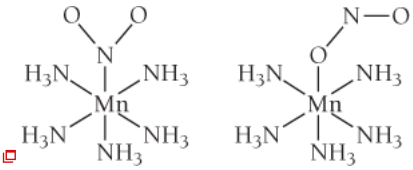
d. [Pt(H2O)4][PtCl6]

27.

a. [Co(NH3)3(CN)3], triamminetricyanocobalt(III)

b. [Cr(en)3]3+, tris(ethylenediamine)chromium(III)

29.



31. [Fe(H2O)5Cl]Cl·H2O, pentaaquachloroiron(II) chloride monohydrate [Fe(H2O)4Cl2]·2 H2O, tetraaquadichloroiron(II) dihydrate

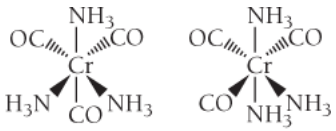
33. **b, c, e**

35.

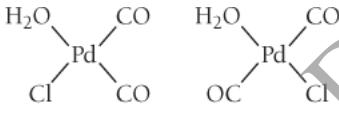
a. 3

b. No geometric isomers.

37.



a. Fac Mer



b. Cis Trans

39. cis isomer is optically active.

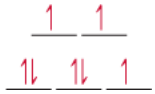
41.

a.

b.

c.

d.



43. 163 kJ/mol

45. [Co(CN)6]3−→290 nm, colorless

[Co(NH3)6]3+→440 nm, yellow

[CoF6]3−→770 nm, green

47. weak

49.

a. 4

b. 3

c. 1

51. 3

53. porphyrin

55. Water is a weak field ligand that forms a high-spin complex with hemoglobin. Because deoxyhemoglobin is a weak field, it absorbs large wavelength light and appears blue. Oxyhemoglobin is a low-spin complex and absorbs small wavelength light, so O2must be a strong field ligand.

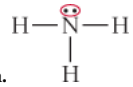
57.

a. [Ar] 4s13d5,[Ar] 3d5,[Ar] 3d4,[Ar] 3d3

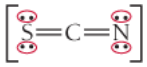
b. [Ar] 4s13d10,[Ar] 3d10,[Ar] 3d9

59.

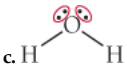
a.



b.



c.



61. [MA2B2C2]all cis; A trans and B and C cis; B trans and A and C cis; C trans and A and B cis; all trans.

[MA2B3C]will have fac–mer isomers.

[MAB2C3]will have fac–mer isomers.

[MAB3C2]will have fac–mer isomers.

[MA3B2C]will have fac–mer isomers.

[MA2BC3]will have fac–mer isomers.

[MA3BC2]will have fac–mer isomers.

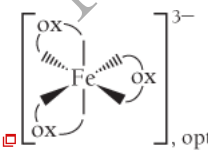
[MABC2]will have AB cis–trans isomers.

[MAB4C]will have AC cis–trans isomers.

[MA4BC]will have BC cis–trans isomers.

[MABC4]will have AB cis–trans isomers.

63.



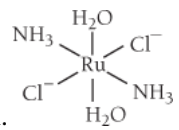
, optical isomers

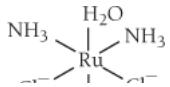
65.

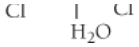
, paramagnetic

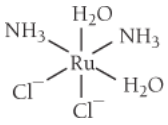
67.

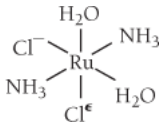
1.

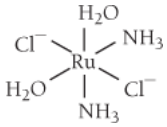




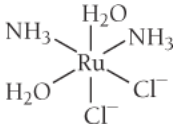
2. 

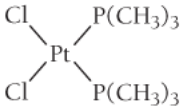
3. 

4. 

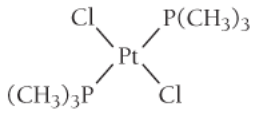
5. 

Only structure 3 is chiral. This is its mirror image.





cis-dichlorobis (trimethyl phosphine) platinum(II)



69. *trans*-dichlorobis (trimethyl phosphine) platinum(II)

71. ____ dz2

____ ____ dx2–y2and dxy

____ ____ dxzand dyz

73.

a. 2×10–8 M

b. 6.6×10–3 M

c. NiS will dissolve more easily in the ammonia solution because the formation of the complex ion is favorable, removing Ni2+ions from the solution allowing more NiS to dissolve.

75. Prepare a solution that contains both [MCl6]3–and [MBr6]3–and see if any complex ions that contain both Cl and Br form. If they do, it would demonstrate that these complexes are labile.

77. pH=10.1

79. Au

86.

a. Red

b. smaller (because it absorbs at longer wavelengths)

c. The crystal field-splitting energies of the two complexes must be similar because they are both the same color.