Chapter 12: 7, 9, 13, 15, 31, 41, 45, 71, 97, 111, 114, 127

7. \[ \text{Br} \quad \text{Br} : \quad \text{I} \quad \text{Cl} : \]

ICl is polar and Br\(_2\) is nonpolar. The dominate intermolecular force in ICl is dipole-dipole whereas in Br\(_2\) it is London. Dipole-dipole is the stronger of the two and therefore more difficult to break – the melting point is higher.

9. These are all nonpolar molecules:

\[
\begin{align*}
\text{H} & \quad \text{H} & \quad \text{H} & \quad \text{H} \\
\text{H} & \quad \text{C} & \quad \text{H} & \quad \text{H} \\
\text{H} & \quad \text{Si} & \quad \text{H} & \quad \text{H} \\
\text{H} & \quad \text{Ge} & \quad \text{H} & \quad \text{H} \\
\text{H} & \quad \text{Sn} & \quad \text{H} & \quad \text{H} \\
\text{H} & \quad \text{C} & \quad \text{H} & \quad \text{H} \\
\text{H} & \quad \text{Si} & \quad \text{H} & \quad \text{H} \\
\text{H} & \quad \text{Ge} & \quad \text{H} & \quad \text{H} \\
\text{H} & \quad \text{Sn} & \quad \text{H} & \quad \text{H}
\end{align*}
\]

\[10 \ e^- \quad 18 \ e^- \quad 36 \ e^- \quad 54 \ e^-\]

The dominate intermolecular force in all is London. The relative strength is determined by the total number of electrons.

13. RbF metal-nonmetal ionic ion-ion

CO\(_2\) nonmetal-nonmetal molecular

\[
\begin{align*}
\text{O} & \quad \text{C} & \quad \text{O} & \quad \text{O} & \quad \text{C} & \quad \text{O} \\
\text{H} & \quad \text{H} & \quad \text{H} & \quad \text{H} & \quad \text{H} & \quad \text{H}
\end{align*}
\]

nonpolar London

CH\(_3\)OH all nonmetals molecular

\[
\begin{align*}
\text{H} & \quad \text{H} & \quad \text{H} & \quad \text{H} \\
\text{H} & \quad \text{C} & \quad \text{O} & \quad \text{H} \\
\text{H} & \quad \text{O} & \quad \text{H} & \quad \text{H}
\end{align*}
\]

polar, O-H H-bond

CH\(_3\)Br all nonmetals molecular

\[
\begin{align*}
\text{H} & \quad \text{H} & \quad \text{H} & \quad \text{H} & \quad \text{H} \\
\text{H} & \quad \text{C} & \quad \text{Br} : & \quad \text{Br} \\
\text{H} & \quad \text{H} & \quad \text{H} & \quad \text{H} & \quad \text{H}
\end{align*}
\]

polar dipole-dipole

\[\text{CO}_2 \ < \ \text{CH}_3\text{Br} \ < \ \text{CH}_3\text{OH} \ < \ \text{RbF}\]
15.  a. \=[O\equiv O: N\equiv N:]

Both nonpolar, O\(_2\) has more electrons (16) than N\(_2\) (14), stronger London.

b. \=[\overset{\text{C}}{\overset{\text{O}}{\overset{\text{O}}{\text{O}}} \overset{\text{O}}{\text{O}} \xrightarrow{\text{C}} \overset{\text{C}}{\overset{\text{O}}{\text{O}}} \xrightarrow{\text{O}} \text{nonpolar London}}]

\=[\overset{\text{S}}{\overset{\text{O}}{\overset{\text{O}}{\text{O}}} \overset{\text{O}}{\text{O}}} \xrightarrow{\text{S}} \overset{\text{O}}{\text{O}} \xrightarrow{\text{O}} \text{polar dipole-dipole}}

SO\(_2\) has larger IMF

c. HF is polar with H attached to the electronegative element F, can H-bond. HI is just polar. Has more electrons (54 vs. 10), but H-bonding is more important.

31. Both are polar, but ethanol can form H-bonds (H attached to O). Dimethyl ether cannot. Surface tension is a function of IMF. The stronger force (H-bonding) has the greater surface tension.

41. Na\(_2\)O, MgO, and Al\(_2\)O\(_3\) are composed of a metal and a nonmetal. All three have high melting points. These are ionic solids. SiO\(_2\) is composed of a metalloid and a nonmetal. It has a high melting point, so we would classify it as a covalent solid. The final three compounds, P\(_4\)O\(_{10}\), SO\(_3\) and Cl\(_2\)O\(_7\), are molecular solids.

45. \[
\frac{7.87 \text{ g Fe}}{1 \text{ cm}^3 \text{ Fe}} \times \left(\frac{287 \text{ pm}}{\text{unit cell}}\right)^3 \times \left(\frac{1 \text{ m}}{10^{12} \text{ pm}}\right)^3 \times \left(\frac{10^2 \text{ cm}}{1 \text{ m}}\right)^3 \times \frac{1 \text{ mole Fe}}{55.847 \text{ g Fe}} \times \frac{6.022 \times 10^{23} \text{ atoms Fe}}{1 \text{ mole Fe}} = 2.006 \text{ atoms/unit cell} = 2 \text{ atoms/unit cell}
\]

71. \[
\frac{74.6 \text{ g H}_2\text{O}}{18.015 \text{ g H}_2\text{O}} \times \frac{1 \text{ mole H}_2\text{O}}{1 \text{ mole H}_2\text{O}} \times \frac{40.79 \text{ kJ}}{1 \text{ mole H}_2\text{O}} = 169 \text{ kJ}
\]

97. The vapor pressure of mercury (as well as all other substances) is 760 mmHg at its normal boiling point.

111. a. \(~2.4 \text{ K}\)
    b. \(~10 \text{ atm}\)
    c. \(~5 \text{ K}\)
    d. No, there is no solid-vapor boundary.
    e. 2
114. \[
\frac{39.948 \text{ g Ar}}{1 \text{ mole Ar}} \times \frac{1 \text{ mole Ar}}{6.022 \times 10^{23} \text{ atoms Ar}} \times \frac{4 \text{ atoms Ar}}{1 \text{ unit cell}} = 2.6535 \times 10^{-22} \text{ g/unit cell}
\]

\[r = \frac{a\sqrt{2}}{4}; \quad a = \frac{4r}{\sqrt{2}} = \frac{4(1.91 \times 10^{-8} \text{ cm})}{\sqrt{2}} = 5.4023 \times 10^{-8} \text{ cm}\]

\[V = a^3 = (5.4023 \times 10^{-8} \text{ cm})^3 = 1.5766 \times 10^{-22} \text{ cm}^3\]

\[\text{density} = \frac{\text{mass of unit cell}}{\text{volume of unit cell}} = \frac{2.6535 \times 10^{-22} \text{ g/unit cell}}{1.5766 \times 10^{-22} \text{ cm}^3/\text{unit cell}} = 1.68 \text{ g/cm}^3\]

127. The original diagram shows that as heat is supplied to the water, its temperature rises. At the bp (represented by the horizontal line), water is converted to water vapor. Beyond this point the temperature of the steam rises above 100°C.

(a) is eliminated because it shows no change from the original diagram even though the mass of water is doubled.

(b) is eliminated because the rate of heating is greater than that for the original system. Also, it shows water boiling at a higher temperature.

(c) is eliminated because it shows that water now boils at a temperature below 100°C.

(d) represents what actually happens. The heat supplied is enough to bring the water to its boiling point, but not raise the temperature of the steam.