

## Answers

- (a) Butane is nonpolar; chloroethane is polar. Intermolecular forces of attraction in liquid chloroethane are larger due to dipole-dipole attraction; thus a higher boiling point for chloroethane.  
(b) Both chloroethane and acetone are polar. However, acetone forms hydrogen bonds to water much more effectively than chloroethane does, resulting in greater solubility of acetone in water.  
(c) Butane is non-polar and cannot form hydrogen bonds; 1-propanol is polar and can form hydrogen bonds. 1-propanol can interact with water by both dipole-dipole forces and hydrogen bonds. Butane can interact with water by neither means. Thus, 1-propanol is much more soluble.  
(d) Acetone molecules are attracted to each other by van der Waals attraction and dipole-dipole attraction. 1-propanol molecules show these two types of attraction. However, 1-propanol can also undergo hydrogen bonding. This distinguishing feature results in the higher boiling point of 1-propanol.

- (a)  $H_2$  and  $C_3H_8$  have low melting points because the forces involved were the weak van der Waals (or London) forces.

HF has a higher melting point because intermolecular hydrogen bonding is important.

CsI and LiF have still higher melting points because ionic lattice forces must be overcome to break up the crystals, and the ionic forces are stronger than van der Waals forces and hydrogen bonds.

SiC is an example of a macromolecular substance where each atom is held to its neighbors by very strong covalent bonds.

- (b)  $C_3H_8$  and  $H_2$ : There are more interactions per molecule in  $C_3H_8$  than in  $H_2$ . **OR**  $C_3H_8$  is weakly polar and  $H_2$  is nonpolar.

LiF and CsI: The smaller ions in LiF result in a higher lattice energy than CsI has. Lattice energy  $U$  is proportional to  $\frac{1}{r^+ + r^-}$ .

- (a) Xe and Ne are monatomic elements held together by London dispersion (van der Waals) forces. The magnitude of such forces is determined by the number of electrons in the atom. A Xe atom has more electrons than a neon atom has. (Size of the atom was accepted but mass was not.)  
(b) The electrical conductivity of copper metal is based on mobile valence electrons (partially filled bands). Copper chloride is a rigid ionic solid with the valence electrons of copper localized in individual copper(II) ions.  
(c)  $SiO_2$  is a covalent network solid. There are strong bonds, many of which must be broken simultaneously to volatilize  $SiO_2$ .  $CO_2$  is composed of discrete, nonpolar  $CO_2$  molecules so that the only forces holding the molecules together are the weak London dispersion (van der Waals) forces.  
(d) In  $NF_3$  a lone pair of electrons on the central atom results in a pyramidal shape. The dipoles don't cancel, thus the molecule is polar.  
While in  $BF_3$  there is no lone pair on the central atom so the molecule has a trigonal planar shape in which the dipoles cancel, thus the molecule is nonpolar.

4.  $NH_3$  exhibits hydrogen bonding (H attached to nitrogen, attracted to N in adjacent molecule) between molecules which creates a larger IMF than  $CH_4$  which doesn't exhibit H-bonding, only weak London dispersion forces). More energy is required to overcome this higher IMF in  $NH_3$  and, therefore, has a higher boiling point.  
(b) Both ethane's and hexane's IMF consist mainly of weak London dispersion forces. The greater number of electrons in hexane (50 vs. ethane's 18) creates a greater IMF, enough to make it a liquid at  $25^\circ C$  but for ethane, the fewer electrons make a smaller IMF and that is not strong enough to cause ethane to condense.  
(c) Si forms strong network covalent bonds (4 per atom) to create a high melting solid. The non-polar molecules of  $Cl_2$  (covalent bond, Cl-Cl) do not form strong IMF, only weak London dispersion forces and that makes it easy to melt at a low temperature.

- (d) Magnesium oxide is a  $\text{Mg}^{2+}\text{O}^{2-}$  ionic compound while sodium fluoride is a  $\text{Na}^+\text{F}^-$  ionic compound. The larger ionic charge creates a stronger Coulombic attraction between the anion and cation in  $\text{MgO}$  and a higher temperature is required to overcome it and melt it.