Answers to Chapter 14 Study Questions

1. In gases, the particles are far apart, move independently in the ideal case, take the shape of their container and can have a variety of volumes. In ideal gases, the particles are not attracted to each other at all. In liquids, the particles are close together giving them a constant volume although liquids take the shape of their container. The particles are mobile and attracted to each other. In solids, the particles are close together, fixed in position and strongly attracted to each other. Solids hold their own shape.

2. London dispersion forces < dipole forces < Hydrogen bonds

3. The heat of vaporization is endothermic because the bonds between particles in a liquid must be broken in order to separate the particles from each other. The breaking of bonds always requires energy.

4. The boiling point of a liquid is the temperature at which both liquid and gas exist in equilibrium; it is the temperature at which the equilibrium vapor pressure of the liquid is equal to external pressure.

5. a) C_8H_{18} (highest molar mass) b) HF (H bonds) c) $CH_3–CH_2–O–H$ (H bonds)
   d) MgO (ionic) e) $CH_3–O–CH_3$ (polar) f) Cs (metal)

6. a) Ionic solids are composed of positive and negative ions arranged so that each positive ion is surrounded by negative ions and vice versa. The are held together by the attractive force between the oppositely charged ions.
   b) Covalent (molecular) solids are made up of molecules. Covalent bonds hold together the atoms within the molecules. The forces between the molecules are London dispersion forces, dipole forces and hydrogen bonds.
   c) Metallic solids are made up of a regular crystalline array of metal atoms. Valence electrons are free to move within the solid and make up the "metallic bonding" that holds the metal together.
   d) Covalent network solids consist of atoms covalently bound together in a continuous 3-dimensional network. The solid is held together by covalent bonds.

7. In general, b) molecular < c) metallic < a) ionic < d) network covalent

8. Only metallic substances conduct electricity as solids. Both metallic and ionic substances conduct electricity as liquids.

9. a) molecular b) network covalent c) ionic d) metallic e) molecular
   f) metallic g) ionic h) molecular

10. Order of *increasing* vapor pressure: $SiO_2 < TiO_2 < CO_2$ (lowest vapor pressure = strongest bonds)

11. Ethanol = C_2H_6O. Molar mass of ethanol = 2(12.0) + 6(1.0) + 16.0 = 46.0 g/mole.

$$1.31\ \text{kJ} \times \frac{1000\ J}{1\ kJ} \times \frac{1\ cal}{4.18\ J} \times \frac{1\ gram}{26.1\ cal} \times \frac{1\ mole}{46.0\ g} = \mathbf{0.261\ moles}$$