Chapter 13.2-4 & 15 Review Sheet: Solids, Liquids & Solutions

Chapter 13 Chapter Assessment pp. 414-415 #37, 38, 39, 41, 44, 49, 51, 52, 53, 58, 60

37. Why are dispersion forces weaker than dipole-dipole forces?
Dispersion forces are between temporary dipoles while dipole-dipole forces are between permanent dipoles.

38. Explain why hydrogen bonds are stronger than most dipole-dipole forces.
A hydrogen bond involves a large difference in electronegativity between the hydrogen atom and the atom it is attached to (N, O, or F), making the bond extremely polar.

39. Use relative differences in electronegativity to label the ends of the polar molecules listed as partially positive or partially negative.

a. $\overset{\delta+}{H}–\overset{\delta-}{F}$ c. $\overset{\delta+}{H}–\overset{\delta-}{Br}$

b. $\overset{\delta+}{N}–\overset{\delta-}{O}$ d. $\overset{\delta+}{C}–\overset{\delta-}{O}$

41. Decide which of the substances listed can form hydrogen bonds.

a. H_2O c. NaF e. H_2O_2 g. H_2
b. HF d. NO f. NH_3 h. CH_4

a, b, e, f can form hydrogen bonds.

44. Explain why the surface of water in a graduated cylinder is curved.
Adhesion between water and glass is greater than cohesion between water molecules.

49. What is an amorphous solid? Under what conditions is such a solid likely to form?
One that lacks a regularly repeating structure; it can form when a liquid solidifies too quickly for crystal formation to occur.

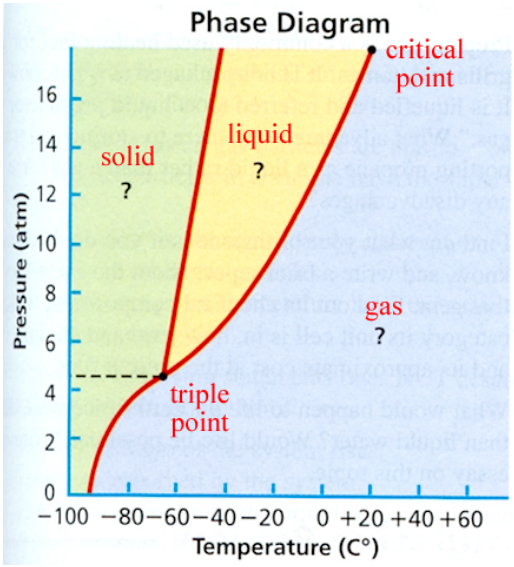
51. How does the strength of a liquid's intermolecular forces affect its viscosity?
Stronger intermolecular forces result in a higher viscosity because the forces hold the particles together too tightly for them to flow easily.

52. Explain why water has a higher surface tension than benzene, whose molecules are nonpolar.
Surface tension increases with the strength of intermolecular forces. The hydrogen bonds between water molecules are stronger than the dispersion forces between benzene molecules.

53. How does sublimation differ from deposition?
They are opposites: sublimation is a solid becoming a vapor, while deposition is a vapor becoming a solid.

58. Label the solid, liquid, and gas phases, triple point, and critical point on the phase diagram shown.
See image at right.

60. Why does a pile of snow slowly shrink even on days when the temperature never rises above the freezing point of water?
Because the snow sublimes.



Chapter 15 Chapter Assessment pp. 484-485 #48, 49, 50, 57, 58, 60, 61, 62, 63, 76(a,c), 77(a,c), 78(a,c), 79(a,c), 80, 81, 83a, 86

48. What is the difference between solute and solvent?
A solute is the substance being dissolved. The solvent is the substance in which the solute dissolves.

49. What determines whether a solute will be soluble in a given solvent?
The polarity of the solute and solvent, temperature, and pressure.

50. Explain the difference between saturated and unsaturated solutions.
A saturated solution contains the maximum amount of solute in a given solvent at a specific temperature and pressure. An unsaturated solution contains less than the maximum amount.

57. How does a solute affect the boiling point of a solution?

Since a liquid boils when its vapor pressure equals atmospheric pressure, and the solute increases the amount of energy needed to evaporate the solvent, the boiling point increases.

58. How does a solute affect the freezing point of a solution?

The solute interferes with the attractive forces between the solvent particles, so the freezing point is lowered.

60. What is a colligative property?

A colligative property is a property of a solution that depends on the concentration but not the identity of the solute particles.

61. What is a suspension and how does it differ from a colloid?

A suspension is a heterogeneous mixture that settles out if left undisturbed. The particles dispersed in a colloid a much smaller than those in a suspension and do not settle out.

62. Name a colloid formed from a gas dispersed in a liquid.

Whipped cream; beaten egg whites (chiffon), milk foam, etc.

63. How can the Tyndall effect be used to distinguish between a colloid and a solution? Why?

A beam of light is visible in a colloid but not in a solution. Dispersed colloid particles are large enough to scatter light.

64. The solubility of a gas in water is 0.22 g/L at 20.0 kPa of pressure. What is the solubility when the pressure is increased to 115 kPa?

$$\frac{S_1}{P_1}=\frac{S_2}{P_2};\ S_2=\frac{S_1P_2}{P_1}=\frac{(0.22\text{ g/L})(115\text{ kPa})}{(20.0\text{ kPa})}=1.3\text{ g/L}$$

67. The solubility of a gas is 4.5 g/Lat a pressure of 1.0 atm. At what pressure will there be 45 g of gas in 1.0 L of solution?

$$\frac{S_1}{P_1}=\frac{S_2}{P_2};\ P_2=\frac{S_2P_1}{S_1}=\frac{(45\text{ g/L})(1.0\text{ atm})}{(4.5\text{ g/L})}=10.\text{ atm}$$

68. The partial pressure of CO_2 inside a bottle of soft drink is 4.0 atm at 25°C. The solubility of CO_2 is 0.12 mol/L. When the bottle is opened, the partial pressure drops to 3.0×10^{-4} atm. What is the solubility of CO_2 in the open drink? Express your answer in grams per liter.

$$\frac{S_1}{P_1}=\frac{S_2}{P_2};\ S_2=\frac{S_1P_2}{P_1}=\frac{(0.12\text{ mol/L})(3\times10^{-4}\text{ atm})}{(4.0\text{ atm})}=9.0\times10^{-6}\text{ mol/L}$$

$$9.0\times10^{-6}\text{ mol/L}\times44.01\text{ g/mol}=4.0\times10^{-6}\text{ g/L}$$

76. What is the molarity of the following solutions?

a. 2.5 mol KCl in 1.0 L of solution

c. 0.875 mol of ammonia in 155 ml of solution

a. $M=\frac{2.5\text{ mol solute}}{1.0\text{ L solution}}=2.5\text{ M}$

c. $M=\frac{0.875\text{ mol solute}}{0.155\text{ L solution}}=5.64\text{ M}$

77. What is the molarity of the following solutions?

a. 0.96 g $MgCl_2$ in 500 mL of solution

c. 2.48 g CaF_2 in 375 mL of solution

a. moles solute $=\frac{0.96\text{ g }MgCl_2}{95.21\text{ g/mol}}=0.0101$ mole; $M=\frac{0.0101\text{ mol solute}}{0.500\text{ L solution}}=.0202\text{ M}$

c. moles solute $=\frac{2.48\text{ g }CaF_2}{78.08\text{ g/mol}}=0.0318$ mole; $M=\frac{0.0318\text{ mol solute}}{0.375\text{ L solution}}=.0847\text{ M}$

78. How many moles of solute are contained in the following solutions?

a. 15.25 mL 2.10 M $CaCl_2$

c. 53.1 mL 12.2 M HCl

a. moles solute = 0.01525 L × 2.10 M = 0.0320 moles

c. moles solute = 0.0531 L × 12.2 M = 0.648 moles

79. How many grams of solute are contained in the following solutions?

a. 64.3 mL 0.0238 M KOH

c. 750.0 mL 0.225 M NH_4OH

a. mol KOH = 0.0643 L × 0.0238 M = 0.00153 mol;

mass KOH = 0.00153 mol × 56.108 g/mol = 0.0589 g KOH

c. mol NH_4OH = 0.750 L × 0.225 M = 0.169 mol;

mass NH_4OH = 0.169 mol × 35.05 g/mol = 5.92 g NH_4OH

80. How many milliliters of 2.55 M NaOH is needed to make 125 ml 0.75 M NaOH solution?

$$(2.55\ \text{M})\cdot V_1 = (0.75\ \text{M})(125\ \text{mL});\ V_1 = \frac{(0.75\ \text{M})(125\ \text{mL})}{2.55\ \text{M}} = 36.8\ \text{mL}$$

81. How many milliliters of 0.400 M HBr solution can be made from 50.0 mL of 8.00 M HBr solution?

$$(8.00\ \text{M})(50.0\ \text{mL}) = (0.400\ \text{M})\cdot V_2;\ V_2 = \frac{(8.00\ \text{M})(50.0\ \text{mL})}{0.400\ \text{M}} = 1.00\times10^3\ \text{mL}$$

Ch. 15 Extra Review Problems

1. What is the solubility of SO_2 at 15.8 atm if the solubility of SO_2 is 0.25 g/L at 1.50 atm?

$$\frac{S_1}{P_1} = \frac{S_2}{P_2};\ \frac{0.25\ \text{g/L}}{1.50\ \text{atm}} = \frac{S_2}{15.8\ \text{atm}};\ S_2 = \frac{(0.25\ \text{g/L})(15.8\ \text{atm})}{1.50\ \text{atm}} = \boxed{2.63\ \text{g/L}}$$

2. At what pressure will the solubility of a gas be 0.98 g/L if the solubility at 0.85 atm is 0.14 g/L?

$$\frac{S_1}{P_1} = \frac{S_2}{P_2};\ \frac{0.14\ \text{g/L}}{0.85\ \text{atm}} = \frac{0.98\ \text{g/L}}{P_2};\ P_2 = \frac{(0.98\ \text{g/L})(0.85\ \text{atm})}{0.14\ \text{g/L}} = \boxed{5.95\ \text{atm}}$$

3. What is the molarity of a solution containing 73.8 g $SrBr_2$ in a volume of 250 mL?

$$\text{mol} = \frac{73.8\ \text{g SrBr}_2}{1}\times\frac{1\ \text{mol SrBr}_2}{247.42\ \text{g SrBr}_2} = 0.298\ \text{mol SrBr}_2;\ V = \frac{250.\ \text{mL}}{1}\times\frac{1\ \text{L}}{1000\ \text{mL}} = 0.250\ \text{L}$$

$$M = \frac{0.298\ \text{mol}}{0.250\ \text{L}} = \boxed{1.19\ \text{M}}$$

4. How many grams of NaF are in 300. mL of a 0.350 M solution?

$$\text{mol} = M\times V = 0.350\ \text{M}\times 300.\ \text{mL}\times\frac{1\ \text{L}}{1000\ \text{mL}} = 0.105\ \text{mol}$$

$$0.105\ \text{mol}\times\frac{41.99\ \text{g}}{1\ \text{mol}} = \boxed{4.41\ \text{g NaF}}$$

5. How many L of a 2.53 M solution of RbCl contains 8.29 g of RbCl?

$$\text{mol} = \frac{8.29\ \text{g}}{1}\times\frac{1\ \text{mol}}{120.92\ \text{g}} = 0.0686\ \text{mol}$$

$$2.53\ \text{M} = \frac{0.0686\ \text{mol}}{V};\ V = \frac{0.0686\ \text{mol}}{2.53\ \text{M}} = \boxed{0.0271\ \text{L}\ (27.1\ \text{mL})}$$

6. What is the final concentration of a solution when 75.0 mL of 8.50 M HCl is diluted to 500.0 mL?

$$M_1V_1 = M_2V_2;\ (8.50\ \text{M})(75.0\ \text{mL}) = M_2(500.0\ \text{mL})$$

$$M_2 = \frac{(8.50\ \text{M})(75.0\ \text{mL})}{500.0\ \text{mL}} = \boxed{1.28\ \text{M}}$$

7. How many mL of 16.0 M H_2SO_4 stock solution must be used to make 250 mL of 0.600 M solution?

$$M_1V_1 = M_2V_2;\ (16.0\ \text{M})V_1 = (0.600\ \text{M})(250.\ \text{mL})$$

$$V_1 = \frac{(0.600\ \text{M})(250.\ \text{mL})}{16.0\ \text{M}} = \boxed{9.38\ \text{mL}}$$

8. How many mL of 0.58 M $BaCl_2$ are needed to completely react with 10.0 mL of 0.58 M $Al_2(SO_4)_3$? The balanced reaction is:

$$3\ BaCl_2(aq) + Al_2(SO_4)_3(aq) \rightarrow 3\ BaSO_4(s) + 2\ AlCl_3(aq)$$

$$?\ mL\ BaCl_2 = \underbrace{10.0\ mL\ Al_2(SO_4)_3 \times \frac{0.58\ mol\ Al_2(SO_4)_3}{1000\ ml\ Al_2(SO_4)_3}}_{0.0058\ mol\ Al_2(SO_4)_3} \times \underbrace{\frac{3\ mol\ BaCl_2}{1\ mol\ Al_2(SO_4)_3}}_{0.0174\ mol\ BaCl_2} \times \frac{1000\ mL\ BaCl_2}{0.58\ mol\ BaCl_2} = \boxed{30.0\ mL\ BaCl_2}$$

9. How many mL of 1.08 M $Fe_2(SO_4)_3$ are needed to fully react with 50.0 mL of 0.298 M KOH according to the following balanced reaction?

$$Fe_2(SO_4)_3(aq) + 6\ KOH(aq) \rightarrow 3\ K_2SO_4(aq) + 2\ Fe(OH)_3(s)$$

$$?\ mL\ Fe_2(SO_4)_3 = \underbrace{50.0\ mL\ KOH \times \frac{0.298\ mol}{1000\ mL}}_{0.0149\ mol\ KOH} \times \underbrace{\frac{1\ mol\ Fe_2(SO_4)_3}{6\ mol\ KOH}}_{0.00248\ mol\ Fe_2(SO_4)_3} \times \frac{1000\ mL}{1.08\ M} = \boxed{2.30\ mL\ Fe_2(SO_4)_3}$$

10. How many mL of 0.682 M HF would be needed to form 29.8 g SiF_4 with excess SiO_2 by the following balanced reaction?

$$SiO_2(s) + 4\ HF(aq) \rightarrow SiF_4(s) + 2\ H_2O(l)$$

$$?\ mL\ HF = \underbrace{29.8\ g\ SiF_4 \times \frac{1\ mol\ SiF_4}{104.1\ g\ SiF_4}}_{0.2863\ mol\ SiF_4} \times \underbrace{\frac{4\ mol\ HF}{1\ mol\ SiF_4}}_{1.145\ mol\ HF} \times \frac{1000\ mL\ HF}{0.682\ mol\ HF} = \boxed{1{,}680\ mL\ HF}$$

11. How many grams of $Al(OH)_3$ are required for complete reaction with the HBr in 615 mL of a 0.375 M HBr solution? The balanced equation for the reaction is:

$$Al(OH)_3(s) + 3\ HBr(aq) \rightarrow AlBr_3(aq) + 3\ H_2O(l)$$

$$?\ g\ Al(OH)_3 = \underbrace{615\ mL\ HBr \times \frac{0.375\ mol\ HBr}{1000\ mL}}_{0.231\ mol\ HBr} \times \underbrace{\frac{1\ mol\ Al(OH)_3}{3\ mol\ HBr}}_{0.0769\ mol\ Al(OH)_3} \times \frac{78.00\ g\ Al(OH)_3}{1\ mol\ Al(OH)_3} = \boxed{6.00\ g\ Al(OH)_3}$$

12. What is the concentration of $FeCl_2$ in 15.00 mL of a solution that reacts with 12.83 mL of 0.105 M $KMnO_4$ according to the following balanced equation?

$$8\ HCl\ (aq) + KMnO_4\ (aq) + 5\ FeCl_2\ (aq) \rightarrow 4\ H_2O\ (l) + MnCl_2\ (aq) + 5\ FeCl_3\ (aq) + KCl\ (aq)$$

a. How many *moles* of $FeCl_2$ reacted?

$$?\ mol\ FeCl_2 = \underbrace{12.83\ mL\ KMnO_4 \times \frac{0.105\ mol\ KMnO_4}{1000\ mL\ KMnO_4}}_{0.001347\ mol\ KMnO_4} \times \frac{5\ mol\ FeCl_2}{1\ mol\ KMnO_4} = \boxed{0.00674\ mol\ FeCl_2}$$

b. What is the concentration of the $FeCl_2$ solution?

$$M = \frac{0.00674\ mol\ FeCl_2}{15.00\ mL} \times \frac{1\ mL}{1\times10^{-3}\ L} = \boxed{0.449\ M\ FeCl_2}$$

13. (g-M) What is the concentration of NaI solution if 25.00 mL reacts with excess $Pb(NO_3)_2$ to produce 2.78 g PbI_2 according to the following balanced equation?

$$Pb(NO_3)_2\ (aq) + 2\ NaI\ (aq) \rightarrow PbI_2\ (s) + 2\ NaNO_3\ (aq)$$

a. How many *moles* of NaI reacted?

$$?\ mol\ NaI = \underbrace{2.78\ g\ PbI_2 \times \frac{1\ mol\ PbI_2}{461.0\ g\ PbI_2}}_{0.00603\ mol\ PbI_2} \times \frac{2\ mol\ NaI}{1\ mol\ PbI_2} = \boxed{0.0121\ mol\ NaI}$$

b. What is the concentration of the NaI solution?

$$M = \frac{0.0121\ mol\ NaI}{25.00\ mL} \times \frac{1\ mL}{1\times10^{-3}\ L} = \boxed{0.484\ M\ NaI}$$