Practice Test Chapter 11
Liquids and IM Forces

Directions: *Circle the letter of the best answer(s).*

Target 1: I can describe the various types of intermolecular attractive forces, and the state the kinds of intermolecular forces expected for a substance given its molecular structure.

1. In which of the following are the intermolecular forces listed from the weakest to the strongest?

    a. dipole-dipole > London > hydrogen bonds
    b. London < dipole-dipole < hydrogen bonds
    c. hydrogen bonds < dipole-dipole < London
    d. London > hydrogen bonds > dipole-dipole
    e. London < hydrogen bonds < dipole-dipole

2. Which substance has the weakest dispersion forces? ~~Smallest~~
    a. He   b. Ne   c. Ar   d. Kr   e. Xe

3. Which pair is mismatched?
    a. polarizability : dispersion forces
    b. N-H or O-H bonds : hydrogen bonds
    c. polarity : dipole moment
    d. dipole moment : dipole-dipole forces
    e. polar molecules : low boiling point

4. Circle all of the FALSE statements.
    a. London dispersion forces are present in all molecular substances.
    b. The greater the dipole moment, the stronger the dipole-dipole forces.
    c. The polarizability of elongated molecules is greater than that of compact, more spherical molecules.
    d. Polar molecules always have higher boiling points than nonpolar molecules.
    e. Hydrogen bonding is the strongest type of van der Waals force.

5. Carbon dioxide sublimes. Which physical transformation occurs in sublimation?
    a. gas to liquid
    b. gas to solid
    c. solid to liquid to gas
    d. solid to gas
    e. solid to liquid

6. Which element is expected to have the greatest polarizability? *biggest*
   a. Fe   (b) Ca   c. Ne   d. S   e. Al

7. Which of the following compounds will NOT hydrogen bond?
   (a) CF_4 b. CH_3OH c. $H_2NCH_2CH_2CH_3$ d. $HOCH_2CH_2OH$ e. HClO

8. $C_{30}H_{62}$ is a nonpolar compound which has London dispersion forces as its only IM forces. $C_{30}H_{62}$ is a solid at room temperature. Water has hydrogen bonding and dispersion forces, yet is a liquid room temperature. The reason that $C_{30}H_{62}$ is a solid and water is a liquid at room temerature is that . . .
   a. water molecules are very light.
   b. water molecules ionize easily.
   (c.) the 62 hydrogen atoms in $C_{30}H_{62}$ allow for many instantaneous dipoles.
   d. $C_{30}H_{62}$ is so large that it cannot melt.
   e. $C_{30}H_{62}$ has a lower melting point if dissolved in nonpolar hexane.

Target 2: I can explain the meaning of the terms viscosity, surface tension, critical temperature, and critical pressure, and account for the variations in these properties in terms of intermolecular forces and temperature.

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9. A liquid substance that exhibits low intermolecular attractions is expected to have _____ .
   (a) low viscosity, low boiling point, and low heat of vaporization
   b. high viscosity, low boiling point, and low heat of vaporization
   c. low viscosity, high boiling point, and low heat of vaporization
   d. low viscosity, low boiling point, and high heat of vaporization
   e. high viscosity, high boiling point, and high heat of vaporization

10. When the following compounds are kept at the same temperature, the compound expected to evaporate most quickly is:
    a. C_8H_{18} b. $C_8H_{17}OH$ c. $C_8H_{17}NH_2$ (d) C_6H_{14} e. $C_7H_{15}COOH$

11. Which one of the following properties does not generally increase with increasing strengths of IM forces?
    a. boiling point
    (b) vapor pressure *decreases*
    c. surface tension
    d. ΔH_{vap}
    e. deviation from ideal gas law

12. When water rises in a small-diameter glass tube, it is due to _____ .
    a. vaporization
    b. viscosity
    c. cohesive forces
    d. dishwashing detergent
    (e.) capillary action

13. The reason that some insects can walk on water is due to _____ .
    a. vaporization
    b. viscosity
    (c.) cohesive forces
    d. dishwashing detergent
    e. capillary action

14. Critical temperature and critical pressure is the combination of temperature and pressure which . . . (Pick 2 answers!)
    (a.) represent the critical point of a given substance.
    b. is the state of a substance at 1 atmosphere of pressure.
    c. is the point where all 3 states of matter can exist at the same time.
    d. below this point a supercritical fluid exists.
    (e.) represents the highest temperature at which a liquid can exist.

Target 3: I can explain the way in which the vapor pressure of a substance changes with intermolecular forces and temperature.

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15. A student observed that a small amount of acetone sprayed on the back of the hand felt very cool compared to a similar amount of water. Your explanation of this phenomena should be that:

    a. All organic compounds do this.
    b. Acetone has a lower viscosity and transfers heat quanta better.
    c. Water has a higher heat capacity than acetone, therefore retaining more heat.
    (d.) The higher vapor pressure of acetone results in more rapid evaporation and heat loss due to liquid turning to a vapor.
    e. The observed effect is not real and is only imagined.

16. When a pot of water boils on the stove small bubbles form at the bottom of the pan and rise to the surface. What is inside these bubbles?
    (a.) steam
    b. hydrogen gas
    c. oxygen gas
    d. a vacuum
    e. air

17. Substances with a high vapor pressure tend to have . . .
    a. large IM forces and low boiling points.
    b. large IM forces and high boiling points.
    (c.) small IM forces and low boiling points.
    d. small IM forces and high boiling points.
    e. structures not stable and vary with intramolecular covalent and ionic bonds with delocalized pi and sigma bonding.

18. Which of the following liquids has the highest vapor pressure? Assume all liquids are at the same temperature.
    (a) CH_4 b. NH_3 c. H_2O d C_5H_{12} e. NaCl(aq)

19. Assume that you have a closed container which contains a liquid and its vapor. Which one statement is false regarding this closed system?
    a. The vapor exerts a pressure called vapor pressure.
    b. Increasing the temperature of the liquid would lead to a greater vapor pressure.
    (c.) Evapoartion and condensation will eventually cease after a constant pressure has been attained.
    d. Decreasing the volume of the container at constant temperature would cause increased condensation until the pressure of the vapor was once again the same as it had been.
    e. The rate of evaporation is equal to the rate of condensation.

Target 4: I can describe the relationship between the pressure on the surface of a liquid and the boiling point of the liquid.

20. The greater the pressure on the surface of a liquid, the greater the _____ of the liquid.
    a. mass   b. volume   c. density   d. molar mass   (e) boiling point

21. The reason that water boils at a lower temperature in Denver than in Lincolnshire is that _____ .
    a. the average temperature in Denver is lower
    b. the mean free path of particles is greater in Lincolnshire
    c. humidity level in Lincolnshire is lower.
    d. Lincolnshire has an atmosphere with a greater percentage of oxygen.
    (e) the atmospheric pressure in Lincolnshire is ~~lower~~ than in Denver
        higher

22. Which statement(s) below is/are false?
    (a) Volatile liquids tend to have high boiling points.
    b. The boiling point of a liquid is the temperature at which its vapor pressure is equal to the external pressure. T
    c. The stronger the IM forces, the higher the boiling point. T
    d. The equilibrium vapor pressure above a liquid is independent of the volume of the liquid present. T
    e. The vapor pressure above a liquid increases with increasing temperature. T

23. How much heat, in kJ, is released when 15.8 grams of CH_3OH is condensed at 25°C? ($\Delta H_{vap} = 38.0$ kJ/mol)

    a. 18.8   b. 600.   c. 77.0   d. 1,400   e. 1.00

$$15.8g \times \frac{1 mol}{32g} \times \frac{38 kJ}{mol} = 18.7$$

$$\frac{16}{32} = \frac{1}{2} \qquad \frac{38}{2} = 19$$

24. Consider the following data for a ficticous substance "X":

    molar mass ....   25.0 g/mol
    boiling point ...   25°C
    freezing point ..   -25°C
    ΔH_{vap} ....   25.0 kJ/mol
    ΔH_{fusion} ....   2.50 kJ/mol
    C_p (solid) ......   1.00 J/g•°C
    C_p (liquid) ......   2.00 J/g•°C
    C_p (gas) ....   3.00 J/g•°C

Assume you had 50.0 grams of liquid X at 15.0°C. How much heat would it take to covert this liquid to a gas at 125°C?

a. 66 kJ   b. 525 kJ   c. 525,000 kJ   d. 6.6×10^9 kJ   e. 5.25×10^{19} kJ

$$50g \times \frac{1}{25g} = 2 mol$$

15 → 25 ; $\Delta T = 10$ (MCΔT)

@ 25 phase Δ (ΔH_{vap})

25 → 125 ; $\Delta T = 100$ (MCΔT)

$$q = (50)(2)(10) = 1,000 J$$

$$q = (2)(25) = 50 kJ$$

$$q = (50)(3)(100) = 15,000 J$$

$$\begin{array}{r} 1 \\ 50 \\ 15 \\ \hline 66 kJ \end{array}$$

Target 6: I can draw a phase diagram of a substance given appropriate data. I can use
a phase diagram to predict which phases are present at any given temperature and
pressure.

Questions 25 - 28 refer to the phase diagram below.
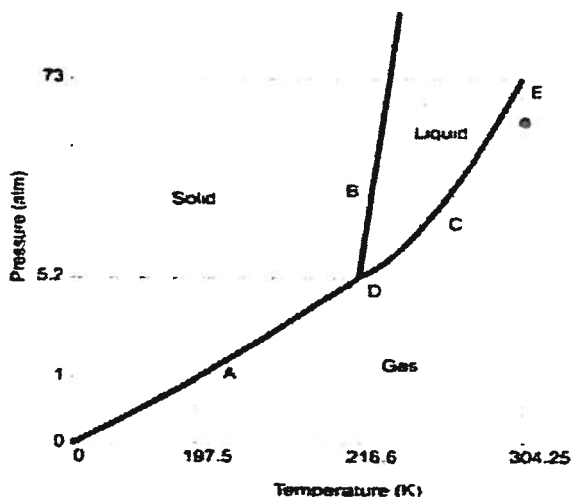
304.25

25. Assume the substance is at a temperature of 195 K and a pressure of 68 atm. [304.25]
    If the pressure remains constant and the temperature is decreased, what
    phase change will occur?
    a. boiling   (b.) condensing   c. subliming   d. melting   e. freezing

26. What is the normal sublimation point of this compound?

    a.   0 K
    (b.) 197.5 K
    c.   216.6 K
    d.   304.25 K
    e.   Any temperature greater than 304.25 K.

27. At 30°C and 1.0 atm of pressure this substance will be   273
                                                                  30
    a.   a liquid   ————
    b.   a solid   303
    (c.) a gas
    d.   a solid and liquid in equilibrium
    e.   a gas and liquid in equilibrium

28. What letter on the diagram represents all three phases in equilibrium at that
    temperature and pressure?
    a. A   b. B   c. C   (d.)D   e. E

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Practice Test Chapter 12
Solids

Part I: *Circle the letter of the best annswer(s).*

> Target 1: I can classify a solid as being either molecular, covalent network, ionic, or metallic. I list the forces holding each of these solids together. I can also list the general properties associated with each solid.

1. Which of the following statements is **NOT** consistent with the crystal properties of the substance?
    a. SiO_2 is a hard, crystalline substance.
    b. Tungsten can be drawn out into thin wires.
    c. $C_6H_{12}O_6$ has a relatively high melting point.
    d. Graphite is used to lubricate locks.
    e. MgF_2 shatters when dropped.

2. Which of the following consistently have the highest melting points?
    a. metals
    b. salts
    c. molecular crystals
    d. alkanes
    e. hydrogen-bonded compounds

3. Diamond is classified as _____ .
    a. a covalent-network solid.
    b. an ionic solid.
    c. an amorphous solid.
    d. a metallic solid with covalent bonds.
    e. a molecular solid with ionic characteristics.

4. The attractive forces holding the atoms together in a piece of steel are . . . (Choose 2 answers!)
    a. ionic bonds.
    b. covalent bonds.
    c. metallic bonds.
    d. the attractions between oppositely charged ions.
    e. the attractions between cations and delocalized electrons.

5. Which 2 statements are false?
    a. All ionic compounds are solids at room temperature.
    b. Covalent compounds can also be called molecular compounds.
    c. Covalent network solids are held together by IM forces.
    d. All ionic compounds are made of ions.
    e. All metals are hard.

6. Which of the following ionic solids are arranged in order of decreasing melting point?
   (a) CaS, $CaCl_2$, NaBr
   b. CaS, NaBr, $CaCl_2$
   c. $CaCl_2$, CaS, NaBr
   d. NaBr, CaS, $CaCl_2$
   e. NaBr, $CaCl_2$, CaS

Target 2: I can distinguish between crystalline and amorphous solids.

For #7-11, indicate whether it is most closely related to amorphous solids (A) or crystalline solids (C).

_C_ 7. Solids which usually have flat surfaces or cleavage planes.

_C_ 8. NaCl

_A_ 9. Obsidean (volcanic glass).

_A_ 10. Rubber

_C_ 11. Orderly, repeating pattern.

Target 3: I can determine the net contents in a unit cubic cell, given a drawing or verbal description of the cell. Using this information, together with the atomic weights of the atoms in the cell and the cell dimensions, I can calculate the density of the substance.

12. Complete the following tables regarding unit cells.

Fraction of an atom that occupies various positions of a unit cell

Position in unit cell	Center	Face	Edge	Corner
Fraction of sphere in unit cell	1	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$

Number of Spheres per Unit Cell

Unit cell type	Primitive	Body centered	Face centered
# of net spheres	1	2	4

Equations relating edge length to radius of a sphere

Cell Type	Equation
Primitive	$\ell = 2r$
FCC	$\ell = 2r\sqrt{2}$
BCC	$r = \ell\sqrt{3}/4$

13. Tin crystallizes in a FCC arrangement. The atomic radius of a tin atom is 141 pm. What is the volume of a unit cell (in cm³) of tin?

$$141 \, pm \times \frac{1m}{1\times10^{12}pm} \times \frac{1\times10^2 cm}{1m} = 1.41\times10^{-8} \, cm$$

$$l = 2r\sqrt{2} = (2)(1.41\times10^{-8})(\sqrt{2}) = 3.99\times10^{-8} \, cm$$

$$V = l^3 = (3.99\times10^{-8} \, cm)^3 = 6.34\times10^{-23} \, cm^3$$

14. Metallic potassium has a body-centered cubic structure. If the edge length of unit cell is 533 pm, calculate the radius (in pm) of a potassium atom.

$$r = \frac{l\sqrt{3}}{4} = \frac{533\sqrt{3}}{4} = 231 \, pm$$

15. You are given a small bar of an unknown metal. You experimentally determine its density to be 10.5 g/cm³ and x-ray diffraction identifies the structure as a face centered cubic crystal with a unit cell edge length of 4.09 Ångstroms. Determine the identity of the unknown metal.

$$\frac{10.5g}{cm^3} \times \frac{(4.09\times10^{-8} cm)^3}{4 \, atoms} \times \frac{6.02\times10^{23} \, atoms}{mol} =$$

$$108 \, g/mol = \boxed{Ag}$$

Practice Test Chapter 13
Solutions

Target 1: I can describe the energy changes that occur in the solution process in terms of the solute-solute, solvent-solvent, and solute-solvent attractive forces.

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1. Formation of solutions where the process is endothermic can be spontaneous provided that _____ .
   a. they are accompanied by another process which is exothermic
   b. they are accompanied by an increase in order
   c. they are accompanied by an increase in disorder
   d. the solvent is a gas and the solute is a solid
   e. the solvent is water and the solute is a gas

2. Circle all of the true statements regarding the process of making a solution.
   a. Separating the solute particles from one another is always an endothermic process.
   b. Separating the solvent particles from one another is always an endothermic process.
   c. The process of the solute particles being attracted to the solvent particles is always an exothermic process.
   d. The formation of a solution can be either exothermic or endothermic.
   e. Exothermic processes tend to occur spontaneously.

Target 2: I can rationalize the solubilities of substances in various solvents in terms of their molecular structures and intermolecular forces.

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3. Which one of the following substances is most soluble in CCl_4?
   a. CH_3CH_2OH b. H_2O c. NH_3 d. $C_{10}H_{22}$ e. NaCl

4. Which one of the following alcohols is least soluble in H_2O?
   a. CH_3OH
   b. CH_3CH_2OH
   c. $CH_3CH_2CH_2OH$
   d. $CH_3CH_2CH_2CH_2OH$
   e. $CH_3CH_2CH_2CH_2CH_2CH_2OH$

5. Which of the following liquids would make the best solvent for iodine, I_2?
   a. HCl   b. H_2O c. CH_3OH d. NH_3 e. CS_2

6. Which ONE of the following choices has the compounds arranged in order of increasing solubility in water? (least soluble to most soluble)
   a. CCl_4 < $CHCl_3$ < $NaNO_3$
   b. CH_3OH < CH_4 < LiF
   c. CH_4 < $NaNO_3$ < $CHCl_3$
   d. LiF < $NaNO_3$ < $CHCl_3$
   e. CH_3OH < CH_2Cl_2 < CH_4

7. A saturated solution is a solution which _____ .
   a. contains as much solvent as it can hold
   b. contains no double bonds
   ⓒ holds as much solute as possible at a given temperature
   d. will rapidly precipitate if a seed crystal is added
   e. cannot be attained

8. Which **one** of the following statements is false?
   a. Nonpolar liquids tend to be insoluble in polar liquids.
   ⓑ The weaker the attraction between the solute and the solvent molecules, the greater the solubility.
   c. Substances with similar IM forces tend to be soluble in one another.
   d. The solubility of a gas increases in direct proportion to its partial pressure above the solution.
   e. The solubility of gases in water decreases with increasing temperatures.

9. Consider the following solubility curve regarding an aqueous solution. The curve represents the solubility of a solute in 100 g of water at various temperatures.
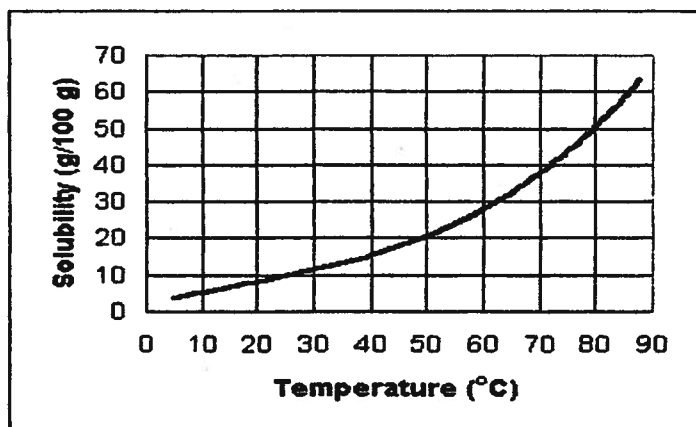
Assume you had 50 mL of a saturated solution at 80°C. Approximately how much precipitate would form if the solution is cooled to 30°C?
   a. 50 g   b. 40 g   c. 30 g   ⓓ 20 g   e. 5 g

10. The solubility of nitrogen gas at 25°C is 4.7 X 10⁻⁴ mol/L. If the pressure of the nitrogen at this temperature is 522 mmHg, what is the value of Henry's Law constant?
   ⓐ 6.8 X 10⁻⁴ mol/L•atm
   b. 4.7 X 10⁻⁵ mol/L•atm
   c. 3.2 X 10⁻⁶ mol/L•atm
   d. 9.0 X 10³ mol/L•atm
   e. 1.5 X 10⁷ mol/L•atm

$$P =$$

$$C_g = k P_g$$

$$\frac{522}{760} = .687 \, atm$$

$$k = \frac{C_g}{P_g} = \frac{4.7 \times 10^{-4}}{.687}$$

$$k = 6.8 \times 10^{-4}$$

Target 4: I can define mass percentage, parts per million, mole fraction, molarity, molality, and calculate concentrations in any of these concentration units.

11. Which one of the following concentration units varies with temperature?
   a. molarity
   b. mass percent
   c. mole fraction
   d. molality
   e. all of these

12. The concentration of KBr in a solution prepared by dissolving 2.21 g of KBr in 897 g of water is _____ molal.
   a. 2.46
   b. 0.0167
   c. 0.0207
   d. 2.07 x 10-5
   e. 0.0186

$$\frac{2.21}{39.1+79.9} = .0186 \, mol \, KBr \div .897 kg = .0207$$

13. A solution was prepared by dissolving 23.7 g of $CaCl_2$ in 375 g of water. The density of the resulting solution was 1.05 g/mL. The concentration of Cl^- in this solution is _____ M.
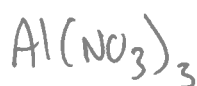   a. 0.214
   b. 0.562
   c. 1.12
   d. 1.14
   e. 6.64 x 10-2

$$\frac{23.7g}{110.98} = .214 \, mol \, CaCl_2$$

$$M = \frac{.214}{.380} = .563$$

$$\frac{375}{\underset{398.7 \, g \, solution}{23.7}} \times \frac{mL}{1.05g} \times \frac{1L}{1000mL} = .380 \, L$$

14. The concentration (M) of nitrate ion in a solution that contains 0.900 M aluminum nitrate is _____.
   a. 0.900   b. 0.450   c. 0.300   d. 2.70   e. 1.80

$Al(NO_3)_3$ for every $Al(NO_3)_3$ that breaks up you get $3 \, NO_3^-$ ions so,

$$(3)(.9) = 2.70$$

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15. A solution contains 28% phosphoric acid by mass. This means that _____ .
    a. 1 mL of this solution contains 28 g of phosphoric acid
    b. 1 L of this solution has a mass of 28 g
    c. 100 g of this solution contains 28 g of phosphoric acid
    d. 1 L of this solution contains 28 mL of phosphoric acid
    e. the density of this solution is 2.8 g/mL

Target 5: I can define colligative property. I can solve problems associated with vapor pressure lowering, boiling point elevation, freezing point depression, and osmotic pressure. This includes molar mass determination.

16. As the concentration of a solute in a solution increases, the freezing point of the solution _____↓_____ and the vapor pressure of the solution _____↓_____ .
    a. increases, increases
    b. increases, decreases
    c. decreases, increases
    d. decreases, decreases
    e. decreases, is unaffected

17. Which liquid will have the lowest freezing point?
    a. pure H_2O
    b. aq. 0.60 m glucose $(1)(.6) = .6$ $\left(\Delta T = i\, k_f\, m \right)$
    c. aq. 0.60 m sucrose $(1)(.6) = .6$
    d. aq. 0.24 m FeI_3 $(4)(.24) = .96$
    e. aq. 0.50 m KF $(2)(.5) = 1$

18. A solution prepared by dissolving 0.60 g of nicotine (a nonelectrolyte) in water to make 12 mL of solution has an osmotic pressure of 7.55 atm at 25°C. The molecular weight of nicotine is _____ g/mol.
    a. 28   b. 43   c. 50   d. 160   e. 0.60

$$\Pi = MRT = \frac{nRT}{V} \qquad n = \frac{\Pi V}{RT} = \frac{(7.55)(.012)}{(.0821)(298)} = .0037\, m$$

$$MW = \frac{.6}{.0037} = 162$$

19. The vapor pressure of pure water at 25°C is 23.8 torr. Determine the vapor pressure (in torr) of water at 25°C above a solution containing 35 g of urea (a nonvolatile, non-electrolyte, MW = 60.0 g/mol) dissolved in 75 g of water.
    a. 2.9   b. 3.3   c. 21   d. 27   e. 0.88

$$P_{soln} = (X_{solv})(P^{\circ}_{solvent}) = \left(\frac{4.17}{4.17 + .583} \right)(23.5) = 21$$

could do this w/ out work. You know it is slightly less than 23.8 !!

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20. A solution is prepared by dissolving 6.00 g of an unknown nonelectrolyte in enough water to make 1.00 L of solution. The osmotic pressure of this solution is 0.750 atm at 25°C. What is the molecular weight (g/mol) of the unknown solute?

    a. 16.4   ⓑ 196   c. 110   d. 30.6   e. 5.12×10^{-3}

$$n = \frac{\pi V}{RT} = \frac{(.75)(1)}{(.0821)(298)} = .0307 \qquad \frac{6}{.0307} = 195$$

21. A solution is prepared by dissolving 2.60 g of a strong electrolyte (formula weight = 101 g/mol) in enough water to make 1.00 L of solution. The osmotic pressure of the solution is 1.25 atm at 25°C. What is the van't Hoff factor (i) for the unknown solute?

    a. 0
    b. 0.99
    ⓒ 1.99
    d. 2.98
    e. 0.630

$$\pi = iMRT$$
$$\pi = \frac{inRT}{V}$$
$$i = \frac{\pi V}{nRT} = \frac{(1.25)(1)}{(.026)(.0821)(298)} = 2$$

22. What is the freezing point of a solution made by dissolving 1.50 moles of glycerol in 250. grams of water?

$$\Delta T = i k_f m = (1)(1.86)\left(\frac{1.50}{.250}\right) = 11.16$$

$$-11.2\,°C$$

23. What mass of glucose ($C_6H_{12}O_6$) would need to be added to 50.0 grams of water to raise the boiling point to 100.45°C?

$$.45 = (1)(.51)\left(\frac{x}{.05kg}\right)$$

$$x = .0441\,mol \times \frac{180\,g}{1\,mol} = 7.9\,g$$