13.1 Multiple Choice and Bimodal Questions

1) The process of solute particles being surrounded by solvent particles is known as _____.

A) salutation
B) agglomeration
C) solvation
D) agglutination
E) dehydration

2) Pairs of liquids that will mix in all proportions are called _____ liquids.

A) miscible
B) unsaturated
C) polar liquids
D) saturated
E) supersaturated

3) The solubility of oxygen gas in water at 25 °C and 1.0 atm pressure of oxygen is
0.041 g/L. The solubility of oxygen in water at 3.0 atm and 25 °C is _____ g/L.

A) 0.041
B) 0.014
C) 0.31
D) 0.12
E) 3.0

4) The solubility of nitrogen gas in water at 25 °C and a nitrogen pressure of 1.0 atm is 6.9×10^{-4} M. The solubility of nitrogen in water at a nitrogen pressure of 0.80 atm is _____ M.

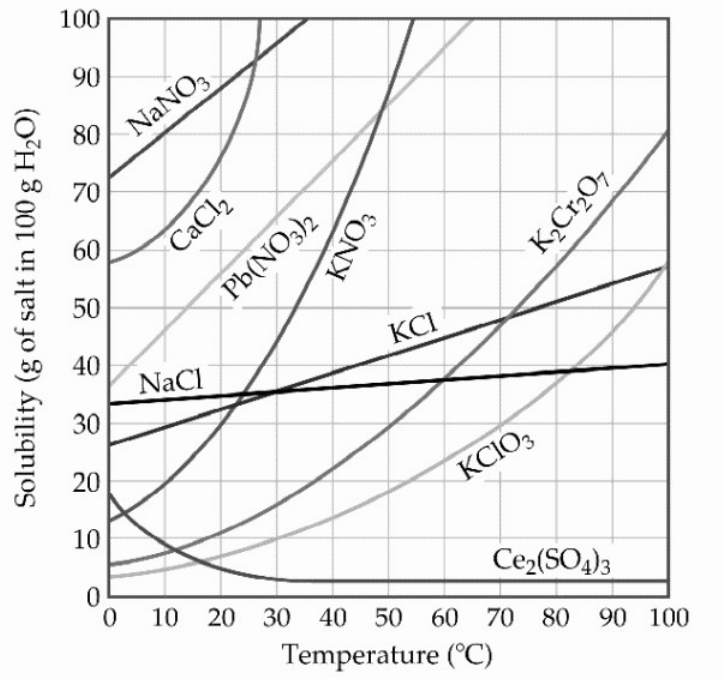
A) 5.5×10^{-4}
B) 8.6×10^{-4}
C) 1.2×10^{3}
D) 3.7×10^{-3}
E) 0.80

6) On a clear day at sea level, with a temperature of 25 °C, the partial pressure of N_2 in air is 0.78 atm and the concentration of nitrogen in water is 5.3×10^{-4} M. When the partial pressure of N_2 is _____ atm, the concentration in water is 1.1×10^{-3} M.

A) 0.63 atm
B) 0.78 atm
C) 1.0 atm
D) 2.1 atm
E) 1.6 atm

7) Which one of the following vitamins is water soluble?

A) A
B) B
C) K
D) D
E) E



8) A sample of potassium nitrate (49.0 g) is dissolved in 101 g of water at 100 °C, with precautions taken to avoid evaporation of any water. The solution is cooled to 30.0 °C and no precipitate is observed. This solution is _____.

A) hydrated
B) placated
C) saturated
D) unsaturated
E) supersaturated

9) A sample of potassium chlorate (15.0 g) is dissolved in 201 g of water at 70 °C with precautions taken to avoid evaporation of any water. The solution is cooled to 30.0 °C and no precipitate is observed. This solution is _____.

A) hydrated
B) miscible
C) saturated
D) unsaturated
E) supersaturated

10) A sample of potassium nitrate (49.0 g) is dissolved in 101 g of water at 100 °C with precautions taken to avoid evaporation of any water. The solution is cooled to 30.0 °C and a small amount of precipitate is observed. This solution is _____.

A) hydrated
B) placated
C) saturated
D) unsaturated
E) supersaturated

11) The solubility of $MnSO_4$ monohydrate in water at 20 °C is 70.0 g per 100.0 mL of water. A solution at 20 °C that is 4.22 *M* in $MnSO_4$ monohydrate is best described as a(n) _____ solution. The formula weight of $MnSO_4$ monohydrate is 168.97 g/mol.

A) hydrated
B) solvated
C) saturated
D) unsaturated
E) supersaturated

12) A solution is prepared by dissolving 23.7 g of $CaCl_2$ in 375 g of water. The density of the resulting solution is 1.05 g/mL. The concentration of $CaCl_2$ is _____% by mass.

A) 5.94
B) 6.32
C) 0.0632
D) 0.0594
E) 6.24

13) The concentration of urea in a solution prepared by dissolving 16 g of urea in 39 g of H_2O is _____% by mass. The molar mass of urea is 60.0 g/mol.

A) 29
B) 41
C) 0.29
D) 0.41
E) 0.48

14) The concentration of nitrate ion in a solution that contains 0.900 M aluminum nitrate is _____ M.

A) 0.900
B) 0.450
C) 0.300
D) 2.70
E) 1.80

15) 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) 2.07×10^{-5}
E) 0.0186

16) The concentration of lead nitrate $(Pb(NO_3)_2)$ in a 0.726 M solution is _____ molal. The density of the solution is 1.202 g/mL.

A) 0.476
B) 1.928
C) 0.755
D) 0.819
E) 0.650

17) The concentration of a benzene solution prepared by mixing 12.0 g C_6H_6 with 38.0 g CCl_4 is _____ molal.

A) 4.04
B) 0.240
C) 0.622
D) 0.316
E) 0.508

18) A solution is prepared by dissolving 15.0 g of NH_3 in 250.0 g of water. The density of the resulting solution is 0.974 g/mL. The mole fraction of NH_3 in the solution is _____.

A) 0.0640
B) 0.0597
C) 0.940
D) 0.922
E) 16.8

19) A solution is prepared by dissolving 15.0 g of NH_3 in 250.0 g of water. The density of the resulting solution is 0.974 g/mL. The molarity of NH_3 in the solution is _____.

A) 0.00353
B) 0.882
C) 60.0
D) 3.24
E) 3.53

20) A solution is prepared by dissolving 23.7 g of $CaCl_2$ in 375 g of water. The density of the resulting solution is 1.05 g/mL. The concentration of Cl^- in this solution is _____ M.

A) 0.214
B) 0.562
C) 1.12
D) 1.20
E) 6.64×10^{-2}

21) A solution is prepared by dissolving 23.7 g of $CaCl_2$ in 375 g of water. The density of the resulting solution is 1.05 g/mL. The concentration of $CaCl_2$ in this solution is _____ molal.

A) 0.214
B) 0.569
C) 5.70
D) 63.2
E) 1.76

22) The concentration of HCl in a solution that is prepared by dissolving 5.5 g of HCl in 200 g of C_2H_6O is _____ molal.

A) 27.5
B) 7.5×10^{-4}
C) 3.3×10^{-2}
D) 0.75
E) 1.3

23) The concentration (M) of HCl in a solution prepared by dissolving 5.5 g of HCl in 200 g of C_2H_6O is _____ M. The density of the solution is 0.79 g/mL.

A) 21
B) 0.93
C) 0.58
D) 6.0×10^{-4}
E) 1.72

24) The mole fraction of He in a gaseous solution prepared from 4.0 g of He, 6.5 g of Ar, and 10.0 g of Ne is _____.

A) 0.60
B) 1.5
C) 0.20

D) 0.11
E) 0.86

25) The mole fraction of urea (MW = 60.0 g/mol) in a solution prepared by dissolving 16 g of urea in 39 g of H_2O is _____.

A) 0.58
B) 0.37
C) 0.13
D) 0.11
E) 9.1

26) The concentration of urea (MW = 60.0 g/mol) in a solution prepared by dissolving 16 g of urea in 39 g of H_2O is _____ molal.

A) 96
B) 6.8
C) 0.68
D) 6.3
E) 0.11

27) The molarity of urea in a solution prepared by dissolving 16 g of urea (MW = 60.0 g/mol) in 39 g of H_2O is _____ M. The density of the solution is 1.3 g/mL.

A) 0.11
B) 3.7
C) 6.8
D) 6.3
E) 0.16

28) What is the molarity of sodium chloride in solution that is 13.0% by mass sodium chloride and that has a density of 1.10 g/mL?

A) 143
B) 2.45
C) 2.56
D) 2.23
E) 1.43×10^{-2}

29) The concentration of sodium chloride in an aqueous solution that is 2.23 M and that has a density of 1.01 g/mL is _____% by mass.

A) 2.21
B) 7.83
C) 45.3
D) 12.9
E) 10.1

30) The vapor pressure of pure ethanol at 60 °C is 0.459 atm. Raoult's Law predicts that a solution prepared by dissolving 10.0 mmol naphthalene (nonvolatile) in 90.0 mmol ethanol will have a vapor pressure of _____ atm.

A) 0.498
B) 0.413
C) 0.790
D) 0.367
E) 0.0918

31) The vapor pressure of pure water at 25 °C is 23.8 torr. What is the vapor pressure (torr) of water above a solution prepared by dissolving 18.0 g of glucose (a nonelectrolyte, MW = 180.0 g/mol) in 95.0 g of water?

A) 24.3
B) 23.4
C) 0.451
D) 0.443
E) 23.8

32) The vapor pressure of pure water at 25 °C is 23.8 torr. Determine the vapor pressure (torr) of water at 25 °C above a solution prepared by dissolving 35 g of urea
(a nonvolatile, non-electrolyte, MW = 60.0 g/mol)in 75 g of water.

A) 2.9
B) 3.3
C) 21
D) 27
E) 0.88

33) The freezing point of ethanol (C_2H_5OH) is -114.6 °C. The molal freezing point depression constant for ethanol is 2.00 °C/m. What is the freezing point (°C) of a solution prepared by dissolving 50.0 g of glycerin $(C_3H_8O_3$, a nonelectrolyte) in 200.0 g of ethanol?

A) -115
B) -5.42
C) -132.3
D) -120.0
E) -114.6

34) What is the freezing point (°C) of a solution prepared by dissolving 11.3 g of $Ca(NO_3)_2$ (formula weight = 164 g/mol) in 115 g of water? The molal freezing point depression constant for water is 1.86 °C/m.

A) -3.34
B) -1.11
C) 3.34
D) 1.11
E) 0.00

35) A solution containing 10.0 g of an unknown liquid and 90.0 g water has a freezing point of -3.33 °C. Given K_f = 1.86 °C/m for water, the molar mass of the unknown liquid is _____ g/mol.

A) 69.0
B) 333
C) 619
D) 161
E) 62.1

36) A solution is prepared by dissolving 0.60 g of nicotine (a nonelectrolyte) in water to make 12 mL of solution. The osmotic pressure of the solution is 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

37) 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 25.0 °C. What is the molecular weight (g/mol) of the unknown solute?

A) 16.4
B) 196
C) 110
D) 30.6
E) 5.12×10^{-3}

38) Calculate the freezing point (0 °C) of a 0.05500 m aqueous solution of glucose. The molal freezing-point-depression constant of water is 1.86 °C/m.

A) 0.0286
B) 0.106
C) -0.0562
D) -0.102
E) -0.204

39) Calculate the freezing point (0 °C) of a 0.05500 m aqueous solution of $NaNO_3$. The molal freezing-point-depression constant of water is 1.86 °C/m.

A) 0.0286
B) -0.106
C) 0.102
D) -0.0562
E) -0.205

40) An aqueous solution of a soluble compound (a nonelectrolyte) is prepared by dissolving 33.2 g of the compound in sufficient water to form 250mL of solution. The solution has an osmotic pressure of 1.2 atm at 25 °C. What is the molar mass (g/mL) of the compound?

A) 1.0×10^3

B) 2.7×10^3
C) 2.3×10^2
D) 6.8×10^2
E) 28

41) Determine the freezing point (°C) of a 0.015 molal aqueous solution of $MgSO_4$. Assume i = 2.0 for $MgSO_4$. The molal freezing-point-depression constant of water is 1.86 °C/m.

A) -0.056
B) -0.028
C) -0.17
D) -0.084
E) 0.000

42) 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 25.0 °C. What is the van't Hoff factor (i) for the unknown solute?

A) 0
B) 0.99
C) 1.98
D) 2.98
E) 0.630

43) George is making spaghetti for dinner. He places 4.01 kg of water in a pan and brings it to a boil. Before adding the pasta, he adds 58 g of table salt (NaCl) to the water and again brings it to a boil. The temperature of the salty, boiling water is _____ °C.

Assume a pressure of 1.00 atm and negligible evaporation of water. K_b for water is 0.52 °C/*m*

A) 99.87
B) 100.26
C) 100.13
D) 99.74
E) 100.00

13.2 Multiple-Choice Questions

1) The dissolution of water in octane (C_8H_{18}) is prevented by _____.

A) London dispersion forces between octane molecules
B) hydrogen bonding between water molecules
C) dipole-dipole attraction between octane molecules
D) ion-dipole attraction between water and octane molecules
E) repulsion between like-charged water and octane molecules

2) When argon is placed in a container of neon, the argon spontaneously disperses throughout the neon because _____.

A) of the large attractive forces between argon and neon atoms
B) of hydrogen bonding
C) a decrease in energy occurs when the two mix
D) the dispersion of argon atoms produces an increase in disorder
E) of solvent-solute interactions

3) Hydration is a specific example of the phenomenon known generally as _____.

A) salutation
B) disordering
C) solvation
D) condensation
E) dilution

4) The dissolution of gases in water is virtually always exothermic because _____.

A) one of the two endothermic steps (separation of solute particles) in the solution-formation process is unnecessary
B) the exothermic step in the solution-formation process is unnecessary

C) gases react exothermically with water
D) neither of the two endothermic steps in the solution-formation process is necessary
E) all three steps in the solution-formation process are exothermic

5) Formation of solutions where the process is endothermic can be spontaneous provided that _____.

A) they are accompanied by another process that 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

6) The phrase "like dissolves like" refers to the fact that _____.

A) gases can only dissolve other gases
B) polar solvents dissolve polar solutes and nonpolar solvents dissolve nonpolar solutes
C) solvents can only dissolve solutes of similar molar mass
D) condensed phases can only dissolve other condensed phases
E) polar solvents dissolve nonpolar solutes and vice versa

7) Ammonium nitrate (NH_4NO_3) dissolves readily in water even though the dissolution is endothermic by 26.4 kJ/mol. The solution process is spontaneous because _____.

A) the vapor pressure of the water decreases upon addition of the solute
B) osmotic properties predict this behavior
C) of the decrease in enthalpy upon addition of the solute
D) of the increase in enthalpy upon dissolution of this strong electrolyte
E) of the increase in disorder upon dissolution of this strong electrolyte

8) When solutions of strong electrolytes in water are formed, the ions are surrounded by water molecules. These interactions are described as a case of _____.

A) hydration
B) supersaturation
C) crystallization
D) dehydration
E) saturation

9) When two nonpolar organic liquids are mixed, a solution forms and the enthalpy of solution is quite small. Label the two organic liquids as *A* (solvent) and *B* (solute). The formation of solution is favored by _____.

A) hydration of the solute, *B*
B) the equal enthalpy of the solvent and solute
C) the highly negative enthalpy of the solution process
D) solvation of the solvent, *A*
E) an increase in disorder, since A-A, B-B, and A-B interactions are similar

10) A saturated solution _____.

A) contains as much solvent as it can hold
B) contains no double bonds
C) contains dissolved solute in equilibrium with undissolved solute
D) will rapidly precipitate if a seed crystal is added
E) cannot be attained

11) In a saturated solution of a salt in water, _____.

A) the rate of crystallization > the rate of dissolution
B) the rate of dissolution > the rate of crystallization
C) seed crystal addition may cause massive crystallization
D) the rate of crystallization = the rate of dissolution
E) addition of more water causes massive crystallization

12) Compounds composed of a salt and water combined in definite proportions are known as

A) clathrates
B) homogenates
C) ionic solids
D) molecular solids
E) hydrates

13) An unsaturated solution is one that _____.

A) has no double bonds
B) contains the maximum concentration of solute possible, and is in equilibrium with undissolved solute
C) has a concentration lower than the solubility
D) contains more dissolved solute than the solubility allows
E) contains no solute

14) A solution with a concentration higher than the solubility is _____.

A) is not possible
B) is unsaturated
C) is supercritical
D) is saturated
E) is supersaturated

15) A supersaturated solution _____.

A) is one with more than one solute
B) is one that has been heated
C) is one with a higher concentration than the solubility
D) must be in contact with undissolved solid
E) exists only in theory and cannot actually be prepared

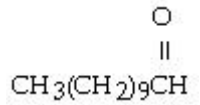
16) The principal reason for the extremely low solubility of NaCl in benzene (C_6H_6) is the _____.

A) strong solvent-solvent interactions
B) hydrogen bonding in (C_6H_6)
C) strength of the covalent bond in NaCl
D) weak solvation of Na^+ and Cl^- by (C_6H_6)
E) increased disorder due to mixing of solute and solvent

17) Which one of the following substances would be the most soluble in CCl_4?

A) CH_3CH_2OH
B) H_2O
C) NH_3
D) $C_{10}H_{22}$
E) NaCl

18) Which of the following substances is more likely to dissolve in water?

A) $HOCH_2CH_2OH$
B) $CHCl_3$
C) 
D) $CH_3(CH_2)_8CH_2OH$
E) CCl_4

19) Which of the following substances is more likely to dissolve in CH_3OH?

A) CCl_4
B) Kr
C) N_2
D) CH_3CH_2OH
E) H_2

20) Which one of the following substances is more likely to dissolve in CCl_4?

A) CBr_4
B) HBr
C) HCl

D) CH_3CH_2OH
E) NaCl

21) Which one of the following substances is more likely to dissolve in benzene (C_6H_6)?

A) CH_3CH_2OH
B) NH_3
C) NaCl
D) CCl_4
E) HBr

22) Which one of the following is most soluble in water?

A) CH_3OH
B) $CH_3CH_2CH_2OH$
C) CH_3CH_2OH
D) $CH_3CH_2CH_2CH_2OH$
E) $CH_3CH_2CH_2CH_2CH_2OH$

23) Which one of the following is most soluble in hexane (C_6H_{14})?

A) CH_3OH
B) $CH_3CH_2CH_2OH$
C) CH_3CH_2OH
D) $CH_3CH_2CH_2CH_2OH$
E) $CH_3CH_2CH_2CH_2CH_2OH$

24) The largest value of the Henry's Law constant for the liquid solvent H_2O will be obtained with _____ gas as the solute and a temperature of _____ °C.

A) C_2H_4, 45
B) Ar, 11
C) HCl, 49
D) CO_2, 32
E) N_2, 15

25) The solubility of nitrogen gas at 25 °C and 1 atm is 6.8×10^{-4} mol / L . If the partial pressure of nitrogen gas in air is 0.76 atm, what is the concentration (molarity) of dissolved nitrogen?

A) 6.8×10^{-4} M
B) 5.2×10^{-4} M
C) 4.9×10^{-4} M
D) 3.8×10^{-4} M
E) 1.1×10^{-5} M

26) The concentration of CO_2 in a soft drink bottled with a partial pressure of CO_2 of 4.0 atm over the liquid at 25 °C is 1.2×10^{-1} M . The Henry's law constant for CO_2 at this temperature is _____.

A) 3.0×10^{-2} mol/L-atm
B) 4.5×10^{-3} mol/L-atm
C) 5.6×10^{-3} mol/L-atm
D) 2.3×10^{-2} mol/L-atm
E) More information is needed to solve the problem.

27) Pressure has an appreciable effect on the solubility of _____ in liquids.

A) gases
B) solids
C) liquids
D) salts
E) solids and liquids

28) Which of the following statements is false?

A) Nonpolar liquids tend to be insoluble in polar liquids.
B) The weaker the attraction between the solute and solvent molecules, the greater the solubility.
C) Substances with similar intermolecular attractive 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 temperature.

9) Which of the following choices has the compounds correctly 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) $CH_3OH < Cl_4 < CHCl_3$

30) The Procter & Gamble Company product called olestra™ is formed by combining a sugar molecule with _____.

A) alcohols
B) vitamin A
C) fatty acids
D) protein
E) cholesterol

31) Which component of air is the primary problem in a condition known as "the bends"?

A) O_2
B) CO_2
C) He
D) N_2
E) CO

32) If the partial pressure of oxygen in the air a diver breathes is too great, _____.

A) respiratory tissue is damaged by oxidation
B) hyperventilation results
C) the urge to breathe is increased and excessive CO_2 is removed from the body
D) the urge to breathe is reduced and not enough CO_2 is removed from the body
E) No problems result from this situation.

33) 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

34) Calculate the molality of a 25.4% (by mass) aqueous solution of phosphoric acid (H_3PO_4).

A) 2.59 m
B) 3.47 m
C) 4.45 m
D) 25.4 m
E) The density of the solution is needed to solve the problem.

35) Calculate the molarity of a 25.4% (by mass) aqueous solution of phosphoric acid (H_3PO_4).

A) 2.59 m
B) 3.47 m
C) 4.45 m
D) 25.4 m
E) The density of the solution is needed to solve the problem.

36) Calculate the mole fraction of phosphoric acid (H_3PO_4) in a 25.4% (by mass) aqueous solution.

A) 0.0589
B) 0.0626
C) 0.259
D) 1.00
E) 4.14

37) Calculate the molality of a 10.0% (by mass) aqueous solution of hydrochloric acid.

A) 0.274 m

B) 2.74 m
C) 3.05 m
D) 4.33 m
E) The density of the solution is needed to solve the problem.

38) Calculate the molarity of a 10.0% (by mass) aqueous solution of hydrochloric acid.

A) 0.274 m
B) 2.74 m
C) 3.04 m
D) 4.33 m
E) The density of the solution is needed to solve the problem.

39) Calculate the mole fraction of HCl in a 10.0% (by mass) aqueous solution.

A) 0.00111
B) 0.0344
C) 0.0520
D) 0.0548
E) 0.122

40) A solution is prepared by dissolving calcium chloride in water and diluting to 500.0 mL. If this solution contains 44 ppm chloride ions, the concentration of calcium ions is _____ ppm.

A) 44
B) 88
C) 22
D) 11
E) 500

41) Molality is defined as the _____.

A) moles solute/moles solvent
B) moles solute/Liters solution
C) moles solute/kg solution
D) moles solute/kg solvent
E) none (dimensionless)

42) Which one of the following concentration units varies with temperature?

A) molarity
B) mass percent
C) mole fraction
D) molality
E) all of the above

43) Of the concentration units below, only _____ is temperature dependent.

A) mass %
B) ppm
C) ppb
D) molarity
E) molality

44) A solution contains 11% by mass of sodium chloride. This means that _____.

A) there are 11 g of sodium chloride in in 1.0 mL of this solution
B) 100 g of the solution contains 11 g of sodium chloride
C) 100 mL of the solution contains 11 g of sodium chloride
D) the density of the solution is 11 g/mL
E) the molality of the solution is 11

45) A solution contains 15 ppm of benzene. The density of the solution is 1.00 g/mL. This means that _____.

A) there are 15 mg of benzene in 1.0 L of this solution
B) 100 g of the solution contains 15 g of benzene
C) 100 g of the solution contains 15 mg of benzene
D) the solution is 15% by mass of benzene
E) the molarity of the solution is 15

46) A solution contains 15 ppm of benzene. The density of the solution is 1.00 g/mL. This means that _____.

A) there are 15 mg of benzene in 1.0 g of this solution
B) 100 g of the solution contains 15 g of benzene

C) 1.0 g of the solution contains 15×10^{-6} g of benzene
D) 1.0 L of the solution contains 15 g of benzene
E) the solution is 15% by mass of benzene

47) A 0.100 m solution of which one of the following solutes will have the lowest vapor pressure?

A) $KClO_4$
B) $Ca(ClO_4)_2$
C) $Al(ClO_4)_3$
D) sucrose
E) NaCl

48) The magnitudes of K_f and of K_b depend on the identity of the _____.

A) solute
B) solvent
C) solution
D) solvent and on temperature
E) solute and solvent

49) 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

50) Which of the following liquids will have the lowest freezing point?

A) pure H_2O
B) aqueous glucose (0.60 m)
C) aqueous sucrose (0.60 m)
D) aqueous FeI_3 (0.24 m)
E) aqueous KF (0.50 m)

51) Which of the following liquids will have the lowest freezing point?

A) pure H_2O
B) aqueous glucose (0.050 m)
C) aqueous CoI_2 (0.030 m)
D) aqueous FeI_3 (0.030 m)
E) aqueous NaI (0.030 m)

52) A 1.35 m aqueous solution of compound X had a boiling point of 101.4 °C. Which one of the following could be compound X? The boiling point elevation constant for water is 0.52 °C/m.

A) CH_3CH_2OH
B) $C_6H_{12}O_6$
C) Na_3PO_4
D) KCl
E) $CaCl_2$

53) Which produces the greatest number of ions when one mole dissolves in water?

A) NaCl
B) NH_4NO_3
C) NH_4Cl
D) Na_2SO_4
E) sucrose

54) Of the following, a 0.1 M aqueous solution of _____ will have the lowest freezing point.

A) NaCl
B) $Al(NO_3)_3$
C) K_2CrO_4
D) Na_2SO_4
E) sucrose

55) Of the following, a 0.2 M aqueous solution of _____ will have the highest freezing point.

A) $(NH_4)_3PO_4$
B) $Pb(NO_3)_2$
C) Na_3PO_4
D) $Mg(NO_3)_2$
E) NaCl

56) Which of the following aqueous solutions will have the highest boiling point?

A) 0.10 m Na_2SO_4
B) 0.20 m glucose
C) 0.25 m sucrose
D) 0.10 m NaCl
E) 0.10 m $SrSO_4$

57) The most likely van't Hoff factor for an 0.01 m CaI_2 solution is _____.

A) 1.00
B) 3.00
C) 1.27
D) 2.69
E) 3.29

58) Which one of the following solutes has a limiting van't Hoff factor (i) of 3 when dissolved in water?

A) KNO_3
B) CH_3OH
C) CCl_4
D) Na_2SO_4
E) sucrose

59) The ratio of the actual value of a colligative property to the value calculated, assuming the substance to be a nonelectrolyte, is referred to as _____.

A) Henry's law
B) vapor pressure lowering
C) the van't Hoff factor
D) freezing point depression
E) osmotic pressure

60) The ideal value of i (van't Hoff factor) for $(NH_4)_3PO_4$.

A) 1
B) 2
C) 3
D) 4
E) 5

61) Colligative properties of solutions include all of the following except _____.

A) depression of vapor pressure upon addition of a solute to a solvent
B) elevation of the boiling point of a solution upon addition of a solute to a solvent
C) depression of the freezing point of a solution upon addition of a solute to a solvent
D) an increase in the osmotic pressure of a solution upon the addition of more solute
E) the increase of reaction rates with increase in temperature

62) Calculate the vapor pressure of a solution made by dissolving 109 grams of glucose (molar mass = 180.2 g/mol) in 920.0 ml of water at 25 °C. The vapor pressure of pure water at 25 °C is 23.76 mm Hg. Assume the density of the solution is 1.00 g/ml.

A) 0.278 mm Hg
B) 0.605 mm Hg
C) 22.98 mm Hg
D) 23.48 mm Hg
E) 23.76 mm Hg

63) The process of a substance sticking to the surface of another is called

A) absorption
B) diffusion
C) effusion
D) adsorption
E) coagulation

64) Which of the following cannot be a colloid?

A) an emulsion
B) an aerosol
C) a homogenous mixture
D) a foam
E) All of the above are colloids.

65) Hydrophobic colloids _____.

A) are those that contain water
B) can be stabilized by adsorption of ions
C) are those that do not contain water
D) can be stabilized by coagulation
E) will separate into two phases if they are stabilized

13.3 Short Answer Questions.

1) The formula weight of $FeCl_3 \cdot 6H_2O$ is _____.

2) Water (H_2O) and the alcohol methanol (CH_3OH) are infinitely soluble in each other. The primary intermolecular force responsible for this is _____.

3) For a dilute aqueous solution, a concentration of 1 ppm also corresponds to a concentration of 1 _____ per liter of solution.

4) For a dilute aqueous solution, a concentration of 1 ppb also corresponds to a concentration of 1 _____ per liter of solution.

5) What is the osmotic pressure (in atm) of a 0.040 M solution of a non-electrolyte at 30.0 °C ?

6) Physical properties of a solution that depend on the quantity of the solute particles present, but not the kind or identity of the particles, are termed _____ properties.

7) A solution contains 150.8 grams of NaCl in 678.3 grams of water. Calculate the vapor pressure lowering (in torr) of the solution at 25.0 °C. (Note: The vapor pressure of pure water at 25.0 °C is 23.76 torr.)

8) A solution contains 150.8 grams of NaCl in 678.3 grams of water. Calculate the vapor pressure of water (in torr) over the solution at 25.0 °C. (Note: The vapor pressure of pure water at 25.0 °C is 23.76 torr.)

9) The phenomenon used to differentiate colloids and true solutions is called the _____ effect.

13.4 True/False Questions

1) A solution with a solute concentration greater than the solubility is called a supercritical solution.

2) Adding a nonvolatile solute to a solution decreases the vapor pressure of the solution.

3) After swimming in the ocean for several hours, swimmers noticed that their fingers appeared to be very wrinkled. This is an indication that seawater is supertonic relative to the fluid in cells.

4) The value of the boiling-point-elevation constant (K_b) depends on the identity of the solvent.

5) Emulsifying agents typically have a hydrophobic end and a hydrophilic end.

13.5 Algorithmic Questions

1) The Henry's law constant for helium gas in water at 30 °C is 3.70×10^{-4} M / atm . When the partial pressure of helium above a sample of water is 0.650 atm, the concentration of helium in the water is _____ M.

A) 5.69×10^{-4}
B) 1.76×10^{3}
C) 1.30
D) 2.41×10^{-4}

E) 3.70×10^{-4}

2) A solution is prepared by adding 1.43 mol of KCl to 889 g of water. The concentration of KCl is _____ molal.

A) 1.61×10^{-3}
B) 622
C) 0.622
D) 1.27×10^{3}
E) 1.61

3) A solution is prepared by dissolving 16.2 g of benzene (C_6H_6) in 282 g of carbon tetrachloride (CCl_4). The concentration of benzene in this solution is _____ molal. The molar masses of C_6H_6 and CCl_4 are 78.1 g/mol and 154 g/mol, respectively.

A) 7.36×10^{-4}
B) 0.736
C) 0.102
D) 0.0543
E) 5.43

4) At 20 °C, an aqueous solution that is 24.0% by mass in ammonium chloride has a density of 1.0674 g/mL. What is the molarity of ammonium chloride in the solution? The formula weight of NH_4Cl is 53.50 g/mol.

A) 5.90
B) 0.479
C) 4.79
D) 0.0445
E) 22.5

5) At 20 °C, a 2.32 M aqueous solution of ammonium chloride has a density of 1.0344 g/mL. What is the molality of ammonium chloride in the solution? The formula weight of NH_4Cl is 53.50 g/mol.

A) 2.55
B) 0.0449
C) 2.32
D) 0.446
E) 12.00

6) At 20 °C, a 0.376 M aqueous solution of ammonium chloride has a density of 1.0045 g/mL. What is the mass % of ammonium chloride in the solution? The formula weight of NH_4Cl is 53.50 g/mol.

A) 0.381
B) 0.705
C) 0.374
D) 2.68
E) 2.00

7) A solution is prepared by dissolving 7.00 g of glycerin $(C_3H_8O_3)$ in 201 g of ethanol (C_2H_5OH). The freezing point of the solution is _____ °C. The freezing point of pure ethanol is -114.6 °C at 1 atm. The molal-freezing-point-depression constant (K_f) for ethanol is 1.99 °C/*m*. The molar masses of glycerin and of ethanol are 92.1 g/mol and 46.1 g/mol, respectively.

A) -121.3
B) 0.752
C) -107.9
D) -113.8
E) -115.4

8) Calculate the freezing point of a solution containing 5.0 grams of KCl and 550.0 grams of water. The molal-freezing-point-depression constant (K_f) for water is .86 °C/*m*.

A) -0.45 °C
B) +0.45 °C
C) -0.23 °C
D) +0.23 °C
E) 1.23 °C

9) The osmotic pressure of a solution formed by

dissolving 25.0 mg of aspirin $(C_9H_8O_4)$ in 0.250 L of water at 25 °C is _____ atm.

A) 13.6
B) 1.14×10^{-3}
C) 0.0136
D) 2.45
E) 1.38

10) A solution is prepared by adding 30.00 g of lactose (milk sugar) to 110.0 g of water at 55 °C The partial pressure of water above the solution is _____ torr. The vapor pressure of pure water at 55 °C is 118.0 torr. The MW of lactose is 342.3 g/mol.

A) 1.670
B) 94.1
C) 169.4
D) 116.3
E) 92.7