Chapter 13 Homework

Part A multiple choice (select the one that is best in each case. 1point/question)

C 1. Which one of the following is incorrect?
A) Emulsifiers have the ability to keep substances in suspension as a colloid.
B) Coagulation is often induced by heating.
C) Hydrophobic colloids like to be associated with water.
D) The diameter of colloidal particles is usually in the range 5 − 1000 nm.
E) Colloids will not pass through semi-permeable membranes.

D 2. Indicate the main type of solute–solvent interaction HCl in acetonitrile (CH_3CN).
A) ion-ion forces B) ion-dipole C) London dispersion D) dipole-dipole
E) hydrogen bonding

B 3. 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

A 4. Pressure has an appreciable effect on the solubility of _____ in liquids.
A) gases
B) solids
C) liquids
D) salts
E) solids and liquids

D 5. The concentration of CO_2 in a soft drink bottled with a partial pressure of CO_2 of 6.5 atm over the liquid at 29 °C is 2.2×10^{-1} *M*. The Henry's law constant for CO_2 at this temperature is _____.
A) 2.2×10^{-1} mol/L-atm
B) 7.6×10^{-3} mol/L-atm
C) 5.6×10^{-3} mol/L-atm
D) 3.4×10^{-2} mol/L-atm

D 6. The process of a substance sticking to the surface of another is called _____.
A) absorption
B) diffusion
C) effusion
D) adsorption
E) coagulation

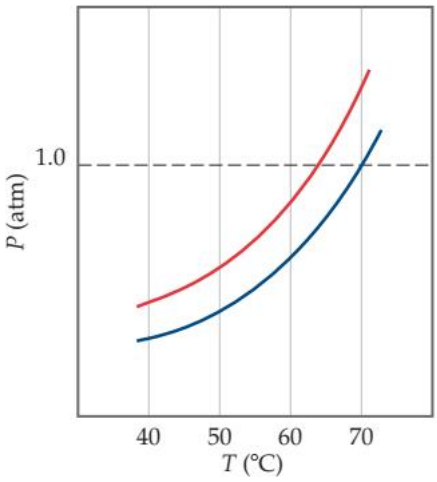
B 7. Seawater contains 3.4 g of salts for every liter of solution. Assuming that the solute consists entirely of NaCl (in fact, over 90% of the salt is indeed NaCl), calculate the osmotic pressure of seawater at 20 ℃. (R = 0.0821 L·atm·K^{-1}·mol^{-1})
A) 272 atm B) 2.8 atm C) 2.69 atm D) 20.4 atm E) 817 atm

D 8. Which of the following substances is more likely to dissolve in H_2O?
A) CCl_4
B) Ar
C) C_6H_6
D) CH_3OH

E) I_2

D

9. This portion of a phase diagram shows the vapor-pressure curves of a volatile solvent and of a solution of that solvent containing a nonvolatile solute. The_____ line represents the solution. And the normal boiling points of the solution is _____ .



A) red, 64℃ B) red, 70℃ C) blue, 64℃ D) blue, 70℃

C

10. Indicate which statement is false in the formation of a solution.
A) A solute will dissolve in a solvent if solute–solute interactions are smaller than solute-solvent interactions.
B) An increase in entropy favors mixing.
C) In making a solution, the enthalpy of mixing is always a positive number
D) NaCl dissolves in water but not in benzene because the water–ion interactions are stronger than benzene–ion interactions.

E

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 150.99 g/mol.
A) hydrated
B) solvated
C) saturated
D) supersaturated
E) unsaturated

D

12. What is/are the intermolecular attraction(s) that occur between a water molecule and a glycerol molecule ($CH_2(OH)CH(OH)CH_2OH$).
A) hydrogen bond
B) dispersion
C) dipole-dipole
D) all of the above

C

13. Which of the following cannot be a colloid?
A) an emulsion
B) an aerosol
C) a homogeneous mixture
D) a foam
E) All of the above are colloids.

B

14. Indicate whether each of the following is a hydrophilic or a hydrophobic colloid:

(i) butterfat in homogenized milk;
(ii) hemoglobin in blood;
(iii) vegetable oil in an oil and vinegar salad dressing
A) (i) hydrophilic (ii) hydrophilic (iii) hydrophilic
B) (i) hydrophobic (ii) hydrophilic (iii) hydrophobic
C) (i) hydrophilic (ii) hydrophobic (iii) hydrophobic
D) (i) hydrophilic (ii) hydrophobic (iii) hydrophilic
E) (i) hydrophobic (ii) hydrophobic (iii) hydrophobic

D 15. An "emulsifying agent" is a compound that helps stabilize a hydrophobic colloid in a hydrophilic solvent (or a hydrophilic colloid in a hydrophobic solvent). Which of the following choices is the best emulsifying agent?
A) CH_3COOH
B) $CH_3CH_2CH_2COOH$
C) $CH_3(CH_2)_{11}COOH$
D) $CH_3(CH_2)_{11}COONa$

Part B short questions--Write legibly and show all work for all steps in the problem. For mathematical relationships show both the equations used and substitution of values into the equation. Maintain correct units throughout your calculations and report your answers with the correct significant figures.（20 points）

16. The solubility of Xe in water at 1 atm pressure and 20 °C is approximately 5×10^{-3} *M*. (a) Compare this with the solubilities of Ar and Kr in water (in order of increase solubility). (b) What properties of the rare gas atoms account for the variation in solubility?

17. When ammonium chloride dissolves in water, the solution becomes colder. (**a**) Is the solution process exothermic or endothermic? (**b**) Why does the solution form?

18. A solution is made containing 14.6 g of CH_3OH in 184 g of H_2O. Calculate (**a**) the mole fraction of CH_3OH, (**b**) the mass percent of CH_3OH, (**c**) the molality of CH_3OH.

19. (**a**) Calculate the vapor pressure of water above a solution prepared by dissolving 28.5 g of glycerin ($C_3H_8O_3$) in 125 g of water at 343 K. (The vapor pressure of water is 233.7 torr at 343 K.) (**b**) Calculate the mass of ethylene glycol ($C_2H_6O_2$) that must be added to 1.00 kg of ethanol (C_2H_5OH) to reduce its vapor pressure by 10.0 torr at 35 ℃. The vapor pressure of pure ethanol at 35 ℃ is 1.00×10^2 torr.

20. (**a**) Does a 0.10 *m* aqueous solution of NaCl have a higher boiling point, a lower boiling point, or the same boiling point as a 0.10 *m* aqueous solution of $C_6H_{12}O_6$? Explain. (**b**) The experimental boiling point of the NaCl solution is lower than that calculated assuming that NaCl is completely dissociated in solution. Why is this the case?

Chapter 13 Homework Answer Sheet

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Part A multiple choice (15 points)

1-5 CDBAD 6-10 DBDDC 11-15 EBCBD

Part B short question （20 points）

16. (4 points)

(a) Ar < Kr < Xe.

(b)The solubility of noble gases in water increases as the atomic mass and size increase.

17. (3 points)

(a) endothermic process.

(b) Even though the process is energetically unfavorable (endothermic), it occurs because of entropy (ΔS) ---- the dissolution of the solid crystal into ions significantly increases the disorder (randomness) of the system.

18. (6 points)

- **Moles:**
  - Moles CH_3OH = 14.6 g/32.04 g/mol = 0.4557 mol.
  - Moles H_2O = 184 g/18.02 g/mol = 10.211 mol.
- **(a) Mole Fraction of CH_3OH (X_{solute}):**

$$X_{solute} = \frac{\text{moles solute}}{\text{total moles}} = \frac{0.4557}{0.4557 + 10.211} = \frac{0.4557}{10.6667} = \mathbf{0.0427}$$

- **(b) Mass Percent of CH_3OH:**

$$\text{Mass } \% = \frac{\text{mass solute}}{\text{total mass}} \times 100 = \frac{14.6}{14.6 + 184} \times 100 = \frac{14.6}{198.6} \times 100 = \mathbf{7.35\%}$$

- **(c) Molality (m):**

$$m = \frac{\text{moles solute}}{\text{kg solvent}} = \frac{0.4557 \text{ mol}}{0.184 \text{ kg}} = \mathbf{2.48} \text{ m}$$

Chapter 13 Homework Answer Sheet

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19. (4 points)

(a) Vapor pressure of water over glycerin solution:

- Moles Glycerin ($C_3H_8O_3$, MM ≈ 92.09 g/mol): $28.5\ \text{g}/92.09\ \text{g/mol} = 0.3095$ mol.
- Moles Water (H_2O, MM ≈ 18.02 g/mol): $125\ \text{g}/18.02\ \text{g/mol} = 6.937$ mol.
- Mole Fraction Water ($X_{solvent}$):

$$X_{water} = \frac{6.937}{6.937 + 0.3095} = \frac{6.937}{7.2465} = 0.9573$$

- Calculate Vapor Pressure (Raoult's Law):

$$P_{solution} = X_{solvent} \cdot P^0_{solvent} = 0.9573 \times 233.7\ \text{torr} = \mathbf{223.7}\ \text{torr}$$

(b) Mass of ethylene glycol needed:

- Goal: Lower VP by 10.0 torr.
- $P^0_{ethanol} = 100$ torr. $\Delta P = 10.0$ torr.
- Formula: $\Delta P = X_{solute} \cdot P^0_{solvent}$.

$$10.0 = X_{solute} \times 100 \implies X_{solute} = 0.10$$

- Moles Ethanol (C_2H_5OH, MM ≈ 46.07 g/mol): $1000\ \text{g}/46.07\ \text{g/mol} = 21.71$ mol.
- Find moles of solute (n):

$$X_{solute} = \frac{n}{n + n_{solvent}} \implies 0.10 = \frac{n}{n + 21.71}$$

$$0.10(n + 21.71) = n$$

$$0.1n + 2.171 = n$$

$$0.9n = 2.171 \implies n = 2.412\ \text{mol}$$

- Mass Ethylene Glycol ($C_2H_6O_2$, MM ≈ 62.07 g/mol):

$$\text{Mass} = 2.412\ \text{mol} \times 62.07\ \text{g/mol} = \mathbf{150.}\ \text{g}\ (\text{or}\ 1.50 \times 10^2\ \text{g})$$

20.

(a) The 0.10 m NaCl solution has a higher boiling point.
Glucose ($C_6H_{12}O_6$) is a non-electrolyte ($i=1$), so 0.1 m glucose provides 0.1 m of particles. NaCl is an electrolyte ($i=2$), so 0.1 m NaCl provides approximately 0.2 m of particles. More particles result in a higher boiling point elevation.

(b)

1. The experimental boiling point is lower than calculated because of ion pairing. In solution, cations and anions are not perfectly independent; they occasionally cluster together or "pair up" for short periods. This reduces the effective number of independent particles in the solution, making the actual Van't Hoff factor (i) slightly less than the ideal value of 2.

2. Solid NaCl often contains impurity, which lowers the concentration of ions.