Chem. 1A Final Exam Review Problems From ch. 11, 12 & 13

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Multiple Choice

Identify the choice that best completes the statement or answers the question.

____ 1. Place the following cations in order from lowest to highest hydration enthalpy.
a. $Na^+ < Rb^+ < H^+$ b. $Rb^+ < H^+ < Na^+$ c. $Rb^+ < Na^+ < H^+$ d. $H^+ < Na^+ < Rb^+$ e. $H^+ < Rb^+ < Na^+$

____ 2. Which one of the following molecules will exhibit dipole-dipole intermolecular forces as a pure liquid?
a. C_2H_2 b. SO_3 c. CO_2 d. F_2 e. NO_2

____ 3. Hydrogen bonding is present in all of the following molecular solids EXCEPT ____.
a. H_2SO_4 b. NH_3 c. PH_3 d. HF e. H_2O_2

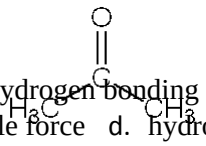
____ 4. As pure molecular solids, which of the following exhibits dipole-dipole intermolecular forces: HCl, Cl_2, SCl_2, and CCl_4?
a. HCl only b. HCl and Cl_2 c. HCl and SCl_2 d. Cl_2 and CCl_4 e. SCl_2 and CCl_4

____ 5. Arrange H_2O, H_2S, and H_2Se in order from lowest to highest boiling point.
a. $H_2O < H_2S < H_2Se$ b. $H_2O < H_2Se < H_2S$ c. $H_2Se < H_2O < H_2S$ d. $H_2Se < H_2S < H_2O$ e. $H_2S < H_2Se < H_2O$

____ 6. As pure molecular solids, which of the following exhibit only induced dipole/induced dipole forces: O_2, CH_2Cl_2, and SO_2?
a. O_2 only b. CH_2Cl_2 only c. SO_2 only d. O_2 and CH_2Cl_2 e. O_2 and SO_2

____ 7. Which one of the following molecules has the lowest boiling point?
a. CH_4 b. $CHCl_3$ c. CH_2Cl_2 d. CH_3Cl e. CCl_4

____ 8. List all the intermolecular forces present in pure acetone.



a. hydrogen bonding only b. dipole-dipole force only c. dipole-dipole force and induced dipole/induced dipole force d. hydrogen bonding and induced dipole/induced dipole force e. hydrogen bonding, dipole-dipole force, and induced dipole/induced dipole force

____ 9. Which of the following liquids has the smallest enthalpy of vaporization?
a. C_5H_{12} b. C_4H_{10} c. C_3H_8 d. C_2H_6 e. C_6H_{14}

____ 10. At its boiling point of –34.0 °C, 6.33 kJ of heat is required to vaporize 22.0 g of chlorine (Cl_2). What is the molar enthalpy of vaporization of chlorine?
a. 0.0893 kJ/mol b. 0.286 kJ/mol c. 1.96 kJ/mol d. 20.4 kJ/mol e. 139 kJ/mol

____ 11. A linear relationship exists between the natural logarithm of the vapor pressure of a gas and the reciprocal of its temperature (in kelvin). What is the slope of the line?

a. $-\dfrac{RT}{\Delta_{vap}H}$ b. $-R \times \Delta_{vap}H$ c. T d. $-\Delta_{vap}H$ e. $-\dfrac{\Delta_{vap}H}{R}$

____ 12. Which of the following properties of water can be attributed to hydrogen bonding?

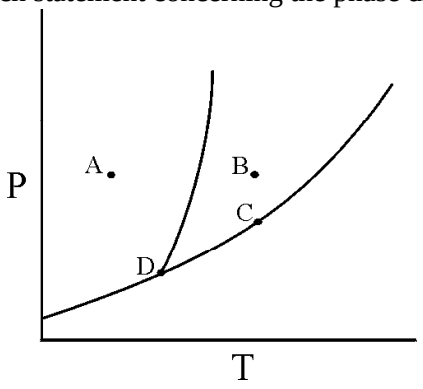
1. high melting point
2. high heat of vaporization
3. low vapor pressure
4. high surface tension

a. 1 and 3 b. 2 and 3 c. 2, 3, and 4 d. 1, 3, and 4 e. 1, 2, 3, and 4

____ 13. The toughness of the skin of a liquid is a measure of its ____.

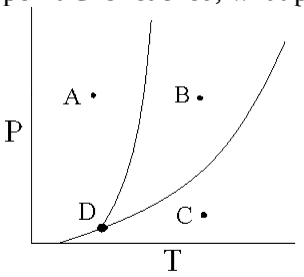
a. meniscus quality b. adhesive forces c. dispersion forces d. viscosity e. surface tension

____ 14. Which statement concerning the phase diagram below is INCORRECT?



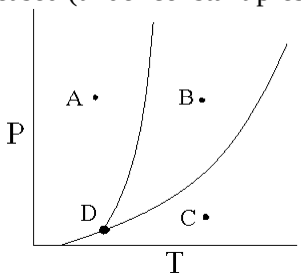
a. Only the solid phase exists at point A. b. At point D, the triple point, all three phases (gas, liquid, and solid) are in equilibrium. c. Moving from point A to B results in a phase transition from solid to liquid. d. At point C, the solid and liquid phases are in equilibrium. e. Only the liquid phase exists at point B.

____ 15. If a pure substance begins at point B on the phase diagram below and the pressure on the substance is reduced until point C is reached, what process occurs?



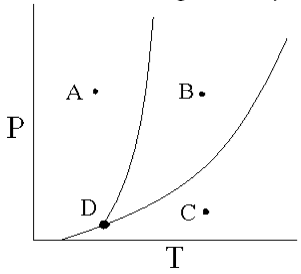
a. fusion b. vaporization c. condensation d. sublimation e. none of these

____ 16. What process occurs when a substance is at point B on the phase diagram below, and the temperature is decreased (under constant pressure) until the substance is at point A?



a. condensation b. vaporization c. sublimation d. melting e. freezing

____ 17. What process occurs when a substance is at point C on the phase diagram below, and the pressure is increased (under constant temperature) until the substance is at point B?



a. condensation b. vaporization c. sublimation d. melting e. freezing

____ 18. What is the definition of molality?

a. moles of solute per kg of solvent b. grams of solute per kg of solution c. grams of solute per liter of solution d. moles of solute per liter of solvent e. moles of solute per liter of solution

____ 19. If 355 g of ethanol (C_2H_5OH) is added to 645 g of water, what is the molality of the ethanol?

a. 0.550 *m* b. 7.71 *m* c. 11.9 *m* d. 21.7 *m* e. 55.0 *m*

____ 20. What is the mole fraction of water in a solution that is 37.9% by weight ethylene glycol? The molar mass of ethylene glycol, $HOCH_2CH_2OH$, is 62.07 g/mol.

a. 0.177 b. 0.379 c. 0.849 d. 0.901 e. 5.63

____ 21. Concentrated sodium hydroxide is 19.4 M and has a density of 1.54 g/mL. What is the molality of concentrated NaOH?

a. 12.6 *m* b. 19.8 *m* c. 25.4 *m* d. 29.9 *m* e. 50.4 *m*

____ 22. Which of the following statements is/are CORRECT?

1. Solubility is defined as the concentration of solute in equilibrium with undissolved solute in a saturated solution.
2. If two liquids mix to an appreciable extent to form a solution, they are miscible.
3. If two liquids mix completely in any proportion to form a solution, the resulting solution is supersaturated.

a. 1 only b. 2 only c. 3 only d. 1 and 2 e. 2 and 3

____ 23. In which solvent should Na^+ have the most negative enthalpy of solvation?
a. CCl_4 b. H_2O c. C_6H_6 d. CS_2 e. C_6H_{14}

____ 24. The vapor pressure of pure water at 55 °C is 118 mm Hg. What is the equilibrium vapor pressure of water above a mixture of 77.0 g ethanol (CH_3CH_2OH, molar mass = 46.07 g/mol) and 32.0 g water?
a. 2.72 mm Hg b. 34.6 mm Hg c. 49.0 mm Hg d. 57.2 mm Hg e. 60.8 mm Hg

____ 25. Which of the following aqueous solutions should have the lowest freezing point?
a. pure H_2O b. 1 *m* $MgBr_2$ c. 1 *m* RbI d. 1 *m* NH_3 e. 1 *m* $C_6H_{12}O_6$

____ 26. Which of the following aqueous solutions should have the highest boiling point?
a. 0.50 *m* NaBr b. 0.50 *m* K_2SO_4 c. 0.50 *m* $CaBr_2$ d. 1.0 *m* KCl e. 1.5 *m* $C_6H_{12}O_6$

____ 27. What is the freezing point of a solution containing 3.10 grams benzene (molar mass = 78.11 g/mol) dissolved in 32.0 grams paradichlorobenzene? The freezing point of pure paradichlorobenzene is 53.0 °C and the freezing point depression constant, K_{fp}, is –7.10 °C/*m*.
a. 44.2 °C b. 51.8 °C c. 52.3 °C d. 54.2 °C e. 61.8 °C

____ 28. What is the molar mass of a nonpolar molecular compound if 3.42 grams dissolved in 41.8 grams benzene begins to freeze at 1.17 °C? The freezing point of pure benzene is 5.50 °C and the freezing point depression constant, K_{fp}, is –5.12 °C/*m*.
a. 2.89 g/mol b. 69.2 g/mol c. 96.7 g/mol d. 126 g/mol e. 358 g/mol

____ 29. What concentration unit is used in the calculation of osmotic pressure for a dilute solution?
a. molality b. weight percent c. mass fraction d. mole fraction e. molarity

____ 30. A solution is prepared by dissolving 4.78 g of an unknown nonelectrolyte in enough water to make 375 mL of solution. The osmotic pressure of the solution is 1.33 atm at 27 °C. What is the molar mass of the solute? (R = 0.08206 L·atm/mol·K)
a. 0.0203 g/mol b. 21.2 g/mol c. 49.4 g/mol d. 96.8 g/mol e. 236 g/mol

____ 31. Which relationship correctly compares the rates of the following reactants and products?

$$C_3H_8(g) + 5\ O_2(g) \rightarrow 3\ CO_2(g) + 4\ H_2O(\ell)$$

a. $\dfrac{\Delta[C_3H_8]}{\Delta t} = \dfrac{\Delta[O_2]}{\Delta t} = \dfrac{\Delta[CO_2]}{\Delta t} = \dfrac{\Delta[H_2O]}{\Delta t}$

b. $\dfrac{\Delta[C_3H_8]}{\Delta t} = \dfrac{\Delta[O_2]}{\Delta t} = -\dfrac{\Delta[CO_2]}{\Delta t} = -\dfrac{\Delta[H_2O]}{\Delta t}$

c. $-\dfrac{\Delta[C_3H_8]}{\Delta t} = -\dfrac{1}{5}\dfrac{\Delta[O_2]}{\Delta t} = \dfrac{1}{3}\dfrac{\Delta[CO_2]}{\Delta t} = \dfrac{1}{4}\dfrac{\Delta[H_2O]}{\Delta t}$

d. $\dfrac{\Delta[C_3H_8]}{\Delta t} = \dfrac{5\Delta[O_2]}{\Delta t} = -\dfrac{3\Delta[CO_2]}{\Delta t} = -\dfrac{4\Delta[H_2O]}{\Delta t}$

e. $\dfrac{\Delta[C_3H_8]}{\Delta t} = \dfrac{5\Delta[O_2]}{\Delta t} = \dfrac{3\Delta[CO_2]}{\Delta t} = \dfrac{4\Delta[H_2O]}{\Delta t}$

____ 32. An aqueous solution of hydrogen peroxide decomposes to oxygen and water according to the balanced chemical equation below.

$2\ H_2O_2(aq) \rightarrow O_2(g) + 2\ H_2O(\ell)$

If the rate of disappearance of hydrogen peroxide is $-3.8\ 10^{-5}$ M/s, what is the rate of formation of oxygen?

a. -3.8×10^{-5} M/s b. 1.9×10^{-5} M/s c. 3.8×10^{-5} M/s d. 6.2×10^{-3} M/s e. 7.6×10^{-5} M/s

____ 33. What is the name given to a substance that increases the rate of a chemical reaction but is not itself consumed?

a. catalyst b. reactant c. intermediate d. product e. rate constant

____ 34. What is the overall order of the reaction below

$2\ NO(g) + O_2(g) \rightarrow 2\ NO_2(g)$

if it proceeds via the following rate expression?

$$-\frac{\Delta[NO]}{\Delta t} = k[NO]^2[O_2]$$

a. zero-order b. first-order c. second-order d. third-order e. fourth-order

____ 35. Given the initial rate data for the reaction $2A + B \rightarrow C$, determine the rate expression for the reaction.

[A], M	[B], M	$\Delta[C]/\Delta t$ (initial) M/s
0.180	0.250	1.36×10^{-3}
0.180	0.500	2.72×10^{-3}
0.720	0.500	1.09×10^{-2}

a. $\frac{\Delta[C]}{\Delta t} = 1.21 \times 10^{-1}\ M^{-2}s^{-1}[A][B]^2$ b. $\frac{\Delta[C]}{\Delta t} = 3.02 \times 10^{-2}\ M^{-2}s^{-1}[A]^2[B]$

c. $\frac{\Delta[C]}{\Delta t} = 1.68 \times 10^{-1}\ M^{-2}s^{-1}[A]^2[B]$ d. $\frac{\Delta[C]}{\Delta t} = 1.36 \times 10^{-3}\ M^{-1}s^{-1}[A][B]$

e. $\frac{\Delta[C]}{\Delta t} = 3.02 \times 10^{-2}\ M^{-1}s^{-1}[A][B]$

____ 36. For the reaction $A + 2B \rightarrow C$, the rate law is

$$\frac{\Delta[C]}{\Delta t} = k[A][B].$$

What are the units of the rate constant where time is measured in seconds?

a. $\frac{1}{M \cdot s}$ b. $\frac{1}{M^2 \cdot s}$ c. $\frac{1}{s}$ d. $\frac{M^2}{s}$ e. $\frac{M}{s}$

____ 37. The reaction of NO and O_2 produces NO_2.

$2\ NO(g) + O_2(g) \rightarrow 2\ NO_2(g)$

The reaction is second-order with respect to NO(g) and first-order with respect to $O_2(g)$. At a given temperature, the rate constant, k, equals $7.4 \times 10^2\ M^{-2}s^{-1}$. What is the rate of reaction when the initial concentrations of NO and O_2 are 0.030 M and 0.025 M, respectively?

a. 1.7×10^{-2} M/s b. 0.56 M/s c. 1.1 M/s d. 4.9×10^5 M/s e. 3.3×10^7 M/s

____ 38. How are the exponents in a rate law determined?
a. They are equal to one for gas phase reactants and zero for solid phase reactants. b. They are determined by experimentation. c. They are equal to the coefficients in the overall balanced chemical equation. d. They are equal to the reactant concentrations. e. They are equal to one for gas phase reactions and two for aqueous reactions.

____ 39. For a second-order decomposition reaction,

$2A \rightarrow B$ rate = $k[A]^2$

which of the following functions can be plotted versus time to give a straight line?
a. [A] b. $\frac{k}{[A]^2}$ c. $\ln\frac{1}{[A]}$ d. ln[A] e. $\frac{1}{[A]}$

____ 40. For a reaction, A → B + C, which of the following equations corresponds to the integrated expression for a first-order decomposition reaction?
a. $[A]_t = -kt + [A]_0$ b. $\ln\frac{[A]_t}{[A]_0} = -kt$ c. $\ln[A]_t = \ln[-kt] + \ln[A]_0$ d. $\frac{[A]_t}{[A]_0} = -kt$
e. $\frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$

____ 41. The rate constant of a first-order decomposition reaction is 0.0456 hrs^{-1}. If the initial concentration of reactant is 0.072 M, what is the concentration of reactant after 27.0 hours?
a. 0.0033 M b. 0.021 M c. 0.071 M d. 0.58 M e. 0.25 M

____ 42. For a reaction, A → B + C, which of the following equations corresponds to the integrated expression for a zero-order decomposition reaction?
a. $[A]_t = -kt + [A]_0$ b. $\ln[A]_t = -kt + \ln[A]_0$ c. $\frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$ d. $\frac{[A]_t}{[A]_0} = -kt$ e. $\ln\frac{[A]_t}{[A]_0} = -kt$

____ 43. The reaction A → B follows first-order kinetics with a half-life of 14.3 days. If the concentration of A is 0.024 M after 3.25 days, what is the initial concentration of A?
a. 0.11 M b. 0.021 M c. 0.028 M d. 0.030 M e. 0.041 M

____ 44. The decomposition of phosphine, PH_3, follows first-order kinetics.

$4\ PH_3(g) \rightarrow P_4(g) + 6\ H_2(g)$

The half-life for the reaction at 550 °C is 81.3 seconds. What percentage of phosphine remains after 275 seconds?
a. 2.3% b. 9.6% c. 26% d. 30% e. 74%

____ 45. The Arrhenius equation, $k = Ae^{-E_a/RT}$, relates the rate constant of reaction and temperature. A plot of ln(k) versus 1/T will yield a straight line with a slope of ____.
a. $-E_a/R$ b. $-E_a$ c. A d. $e^{-E_a/R}$ e. $1/RT$

____ 46. Calculate the activation energy, E_a, for

$N_2O_5(g) \rightarrow 2\ NO_2(g) + 1/2\ O_2(g)$

given k (at 45.0 °C) = $5.79 \times 10^{-4}\ s^{-1}$ and k (at 60.0 °C) = $3.83 \times 10^{-3}\ s^{-1}$. ($R$ = 8.314 J/K·mol)

a. 0.256 kJ/mol b. 2.83 kJ/mol c. 31.1 kJ/mol d. 111 kJ/mol e. 389 kJ/mol

____ 47. The effect of adding a catalyst to a reaction is to

a. increase the number of collisions between reactants. b. lower the activation energy of a reaction. c. increase the equilibrium constant of a reaction. d. decrease the yield of the products. e. increase the enthalpy change of a reaction.

____ 48. The elementary steps for the catalyzed decomposition of dinitrogen monoxide are shown below.

$N_2O(g) + NO(g) \rightarrow N_2(g) + NO_2(g)$

$2\ NO_2(g) \rightarrow 2\ NO(g) + O_2(g)$

Which of the following statements is/are CORRECT?

1. The overall balanced reaction is $2\ N_2O(g) \rightarrow 2\ N_2(g) + O_2(g)$.
2. NO(g) is a catalyst for the reaction.
3. $NO_2(g)$ is a reaction intermediate.

a. 1 only b. 2 only c. 3 only d. 1 and 3 e. 1, 2, and 3

Short Answer

49. _____ is a measure of the degree to which the electron cloud surrounding an atom or molecule can be distorted in an electric field.

50. Which ion, K^+ or Ca^{2+}, is expected to have the more negative enthalpy of hydration? Why?

51. The following equation is known as _____ law: $P_{\text{solvent}} = X_{\text{solvent}}\ P^{\circ}_{\text{solvent}}$.

52. A solution in which there is more dissolved solute than in a saturated solution is known as a(n) _____ solution.

53. If a catalyst is present in the same phase as the reactants and products, it is referred to as a(n) _____ catalyst.

54. Radioactive isotopes decay by _____-order kinetics.

55. Elementary steps in a reaction mechanism often include reaction _____. These (usually) short-lived species, which are at one point produced and then later consumed, do not appear in the overall chemical reaction.

final_RP
Answer Section

MULTIPLE CHOICE

1. ANS: C TOP: 12.2 Intermolecular Forces Involving Polar Molecules
2. ANS: E TOP: 12.2 Intermolecular Forces Involving Polar Molecules
3. ANS: C TOP: 12.2 Intermolecular Forces Involving Polar Molecules
4. ANS: C TOP: 12.2 Intermolecular Forces Involving Polar Molecules
5. ANS: E TOP: 12.2 Intermolecular Forces Involving Polar Molecules
6. ANS: A TOP: 12.3 Interactions Involving Nonpolar Molecules
7. ANS: A TOP: 12.3 Interactions Involving Nonpolar Molecules
8. ANS: C TOP: 12.3 Interactions Involving Nonpolar Molecules
9. ANS: D TOP: 12.4 Properties of Liquids
10. ANS: D TOP: 12.4 Properties of Liquids
11. ANS: E TOP: 12.4 Properties of Liquids
12. ANS: E TOP: 12.4 Properties of Liquids
13. ANS: E TOP: 12.4 Properties of Liquids
14. ANS: D TOP: 13.6 Phase diagrams
15. ANS: B TOP: 13.6 Phase diagrams
16. ANS: E TOP: 13.6 Phase diagrams
17. ANS: A TOP: 13.6 Phase diagrams
18. ANS: A TOP: 14.1 Units of Concentration
19. ANS: C TOP: 14.1 Units of Concentration
20. ANS: C TOP: 14.1 Units of Concentration
21. ANS: C TOP: 14.1 Units of Concentration
22. ANS: D TOP: 14.2 The Solution Process
23. ANS: B TOP: 14.2 The Solution Process
24. ANS: E TOP: 14.4 Colligative Properties
25. ANS: B TOP: 14.4 Colligative Properties
26. ANS: D TOP: 14.4 Colligative Properties
27. ANS: A TOP: 14.4 Colligative Properties
28. ANS: C TOP: 14.4 Colligative Properties
29. ANS: E TOP: 14.4 Colligative Properties
30. ANS: E TOP: 14.4 Colligative Properties
31. ANS: C TOP: 15.1 Rates of Chemical Reactions
32. ANS: B TOP: 15.1 Rates of Chemical Reactions
33. ANS: A TOP: 15.2 Reaction Conditions and Rate
34. ANS: D TOP: 15.3 Effect of Concentration on Reaction Rate
35. ANS: E TOP: 15.3 Effect of Concentration on Reaction Rate
36. ANS: A TOP: 15.3 Effect of Concentration on Reaction Rate
37. ANS: A TOP: 15.3 Effect of Concentration on Reaction Rate
38. ANS: B TOP: 15.3 Effect of Concentration on Reaction Rate

39. ANS: E TOP: 15.4 Concentration-Time Relationships: Integrated Rate Laws
40. ANS: B TOP: 15.4 Concentration-Time Relationships: Integrated Rate Laws
41. ANS: B TOP: 15.4 Concentration-Time Relationships: Integrated Rate Laws
42. ANS: A TOP: 15.4 Concentration-Time Relationships: Integrated Rate Laws
43. ANS: C TOP: 15.4 Concentration-Time Relationships: Integrated Rate Laws
44. ANS: B TOP: 15.4 Concentration-Time Relationships: Integrated Rate Laws
45. ANS: A TOP: 15.5 A Microscopic View of Reaction Rates
46. ANS: D TOP: 15.5 A Microscopic View of Reaction Rates
47. ANS: B TOP: 15.5 A Microscopic View of Reaction Rates
48. ANS: E TOP: 15.6 Reaction Mechanisms

SHORT ANSWER

49. ANS:
Polarizability
50. ANS:
Ca^{2+} will have the more negative enthalpy of hydration. A calcium ion is smaller than a potassium ion. The smaller ion will bond more closely to water's dipole, allowing for a stronger ion-dipole interaction. In addition, the greater the charge on the ion, the greater the ion-dipole interaction.
51. ANS:
Raoult's
52. ANS:
supersaturated
53. ANS:
homogeneous
54. ANS:
first
55. ANS:
intermediates