CH302 Spring 2009 Practice Exam 1 (a fairly easy exam to test basic concepts)

1) Complete the following statement:
We can expect _____ vapor pressure when the molecules of a liquid are held together by _____ intermolecular forces in the liquid and _____ vapor pressure when the intermolecular forces are strong.

    A. high; weak; low

    B. low; strong; high

    C. low; weak; high

    D. high; strong; low

**Answer:** A

2) A plot of ln(vapor pressure) versus 1/T for benzene gives a straight line with slope -3.70×10^3 K. The enthalpy of vaporization of benzene is

    A. 2.25 kJ mol^{-1}.

    B. Not enough information is given to permit the calculation.

    C. 3.70 kJ mol^{-1}.

    D. 30.8 kJ mol^{-1}.

    E. 445 J mol^{-1}.

Answer: D

3) The phase diagram for a pure substance is given below.
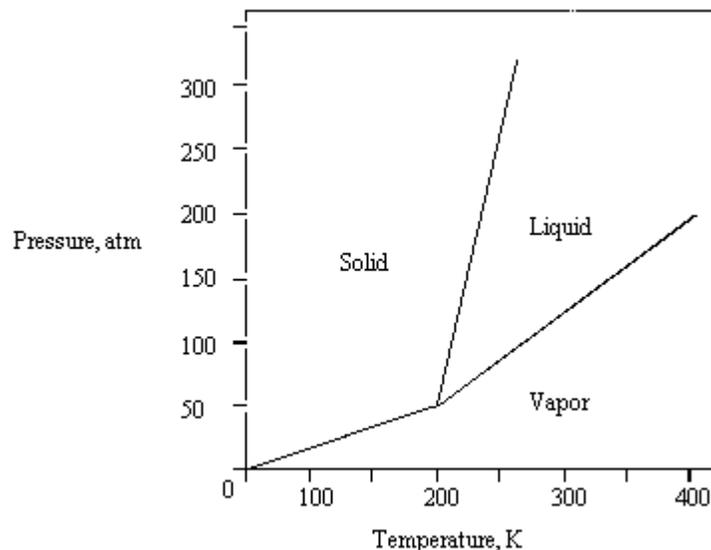
The substance is stored in a container at 150 atm at 25°C. Describe what happens if the container is opened at 25°C.

- A. The liquid in the container freezes.

- B. The solid in the container sublimes.

- C. The solid in the container melts.

- D. The vapor in the container escapes.

- E. The liquid in the container vaporizes.

Answer: E

4) Consider the phase diagrams for water and carbon dioxide given in the text on page 315. Explain the following observations: A thin wire with weights attached is draped over a block of "dry ice," a second wire with weights is draped over a block of ice. The wire cuts through the ice but not through the "dry ice."
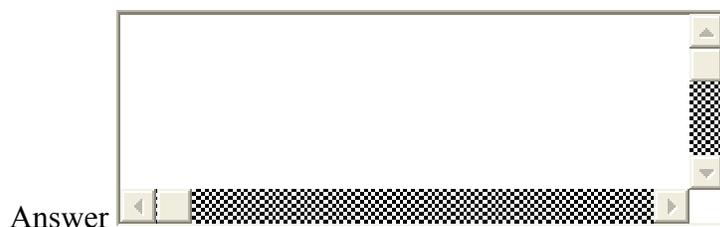
Answer

Answer: For water, increased pressure reduces the melting point, whereas for carbon dioxide the opposite is true. Remember, ice is less stable at high pressures.

5) For $CaCl_2$, the enthalpies of hydration and solution are –2337 and –81 kJ mol^{-1}, respectively, at 25°C. Calculate the lattice enthalpy of calcium chloride.

Answer

Answer: +2256 kJ mol^{-1}

6) Calculate the vapor pressure at 25°C of a mixture of benzene and toluene in which the mole fraction of benzene is 0.650. The vapor pressure at 25°C of benzene is 94.6 Torr and that of toluene is 29.1 Torr.

   A. 84.4 Torr

   B. 124 Torr

   C. 51.3 Torr

   D. 71.7 Torr

   E. 61.5 Torr

Answer: D

7) Of the following, which would likely dissolve in toluene?

   A. Na_2CO_3

   B. $NaCl$

   C. $C_6H_{12}O_6$

   D. $Ca(HCO_3)_2$

   E. Cl_2CCCl_2

Answer: E

8) True or false: the van't Hoff i of HBr, HCl, and HF should all be the same?

Answer

Answer: False

9) The addition of 58 g of acetone to 10.0 kg of water lowers the water freezing point by 0.186°C. What is the molar mass of acetone? Give your answer to 2 significant figures.

10) An animal cell assumes its normal volume when it is placed in a solution with a total solute molarity of 0.3 M. If the cell is placed in a solution with a total solute molarity of 0.1 M,

    ○ A. water enters the cell, causing expansion.

    ○ B. water leaves the cell, causing contraction.

    ○ C. the escaping tendency of water in the cell increases.

    ○ D. no movement of water takes place.

Answer: A

11) When a certain solid dissolves, the disorder of a system increases ($\Delta S > 0$). Which of the following is concluded?

    ○ A. This solid is more soluble at higher temperatures.

    ○ B. This solid is less soluble at higher temperatures.

    ○ C. The change in Gibbs free energy becomes more positive at higher temperatures.

   ○ D. There is no change in Gibbs free energy at higher temperatures.

Answer: A

12) You observe that the solubility of an inert gas increases as the temperature of the solution decreases. Which of the following statements explains this observation?

    ○ A. The dissolution of the gas in water is an exothermic process.

    ○ B. The dissolution of the gas in water is driven by an increase in system entropy

    ○ C. The dissolution of the gas in water is an endothermic process.

    ○ D. The dissolution of the gas in water is driven by a decrease in system entropy

    ○ E. More than one of these statements explains the observation.

Answer: A

13) According to the given heat curve, which of the following statements is wrong?

Heat supplied (kJ/mol)
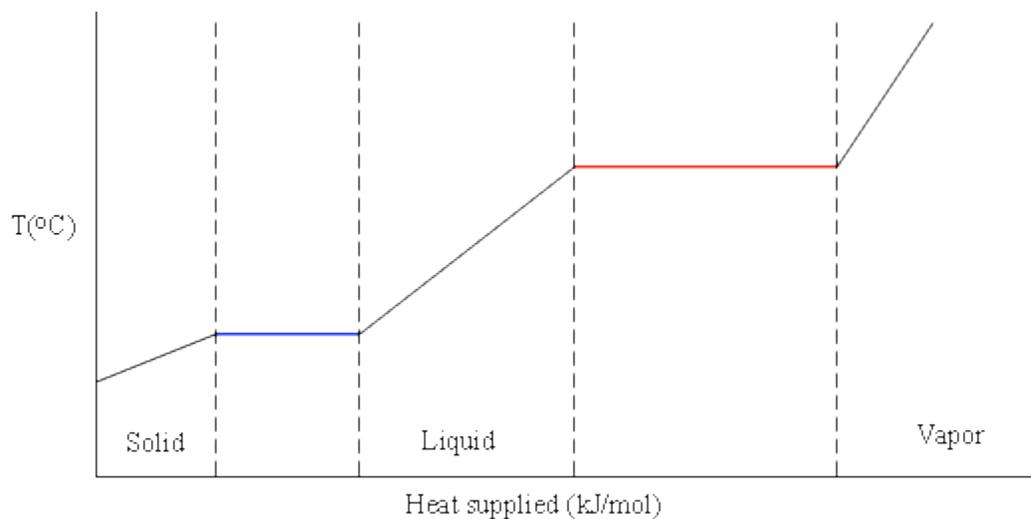
- A. $\Delta H_{vap} > \Delta H_{fus}$
- B. C (s) > C (l)
- C. C (l) > C (g)
- D. None of the above

Answer: D

14) Which of the following is the expression for the equilibrium constant for the reaction 4 $NH_3(g) + 5\ O_2(g) \rightleftharpoons 4\ NO(g) + 6\ H_2O(g)$?

- A. $K = [\ (P_{NO})^4 \times (P_{H2O})^{12}\ ] / [\ (P_{NH3})^{12} \times (P_{O2})^{10}\ ]$
- B. $K = [\ 6(P_{H2O}) \times 4(P_{NO})\ ] / [\ 5(P_{O2}) \times 4(P_{NH3})\ ]$
- C. $K = [\ (P_{NH3})^4 \times (P_{O2})^5\ ] / [\ (P_{NO})^4 \times (P_{H2O})^6\ ]$
- D. $K = [\ (P_{H2O})^6 \times (P_{NO})^4\ ] / [\ (P_{O2})^5 \times (P_{NH3})^4\ ]$

Answer: D

15) The standard Gibbs free energy of reaction for $2\ O_3(g) \rightarrow 3\ O_2(g)$ is $\Delta G_r^\circ = -326.4$ kJ × mol^{-1} at 298 K. Calculate the equilibrium constant for this reaction.

- A. 1.63×10^{57}
- B. 11.7×10^6
- C. 1.14

D. 6.14×10^{-58}

Answer: A

16) For the reaction

$$NH_3(g) + H_2S(g) \rightleftharpoons NH_4HS(s)$$
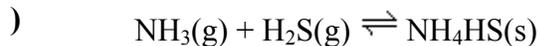
$K_c = 9.7$ at 900 K. If the initial concentrations of $NH_3(g)$ and $H_2S(g)$ are 2.0 M, what is the equilibrium concentration of $H_2S(g)$?

A. 1.9 M

B. 0.20 M

C. 1.7 M

D. 0.10 M

E. 0.32 M

Answer: E

17) The equilibrium constant K for the dissociation of $N_2O_4(g)$ to $NO_2(g)$ is 1700 at 500 K. Predict its value at 300 K. For this reaction, $\Delta H°$ is 56.8 kJ mol^{-1}.

A. 1.32×10^{-6}

B. 1.11×10^{-4}

C. 15.5

D. 0.188

E. 1.54×10^{7}

Answer: D

18) Consider the gas-phase reaction, $N_2(g) + 3 H_2(g) <=> 2 NH_2 (g)$, for which $K_p = 43$ at 400 K. If the mixture is analyzed and found to contain 0.18 bar of N_2, 0.36 bar of H_2 and 0.62 bar of NH_3, describe the situation:

A. Q < K and more reactants will be made to reach equilibrium.

B. Q < K and more products will be made to reach equilibrium.

C. Q > K and more reactants will be made to reach equilibrium.

D. Q > K and more products will be made to reach equilibrium.

○ E. Within 1 decimal place, Q = K and the reaction is at equilibrium

Answer: C

19) Consider the reaction $H_2(g) + Cl_2(g) \Longleftrightarrow 2\ HCl(g)$, which is exothermic as written. What would be the effect on the equilibrium position of decreasing the temperature?

○ A. Reaction would go to the right, making more "products"

○ B. Reaction would go to the left, making more "reactants"

○ C. Reaction would go to the left, making more "products"

○ D. Reaction would go to the right, making more "reactants"

○ E. No change on the equilibrium position

Answer: A

20) For each of the following equilibria, state whether reactants or products will be favored by an increase in the total pressure resulting from compression.

I. $CaC_2(s) + 2\ H_2O(l) \rightleftharpoons Ca(OH)_2(s) + C_2H_2(g)$
II. $Ni(s) + 4\ CO(g) \rightleftharpoons Ni(CO)_4(g)$

○ A. I – Reactants will be favored; II – products will be favored.

○ B. I – products will be favored; II – Reactants will be favored.

○ C. I, II – Reactants will be favored.

○ D. I, II – products will be favored.

Answer: A

21) You watch a really exciting explosion occur in class as part of a demonstration designed to keep you at least moderately enthusiastic about chemistry. Which of the following is most likely the value of equilibrium constant's exponent for the reverse reaction?

○ A. 27

○ B. -27

○ C. 2

○ D. -2

Answer: B

22) In a solution labeled "0.0018 M barium hydroxide" what is the molarity of OH⁻?

    A. 0.0018 M

    B. 0.00090 M

    C. 0.0036 M

    D. 0.0072 M

    E. None of the above.

Answer: C

23) The boxes below contain a series of 0.1 M aqueous solutions of increasing pH where A is the solution of lowest pH and E is the solution of highest pH.

A	B	C	D	E

Match each box with the correct compound.

    phenol, $pK_a = 9.89$

    cyanide ion, $pK_b = 4.69$

    pyridine, $pK_b = 8.75$

    hydrogen sulfate ion, $pK_a = 1.92$

    sodium nitrate

Answer: phenol, $pK_a = 9.89$ (B)
cyanide ion, $pK_b = 4.69$ (E)
pyridine, $pK_b = 8.75$ (D)
hydrogen sulfate ion $pK_a = 1.92$ (A)
sodium nitrate (C)

24) Which of the following statements about the autoprotolysis of water is not correct?

    A. Neutral solutions of water always have an equal number of protons and hydroxides.

    B. The concentration of water in water, in molarity units, is about equal to the speed limit on highways during the Carter presidency.

    C. The autoprotolysis of water produces hydrogen and oxygen gas.

    D. The dissociation constant associated with the dissociation of water suggests a free energy of reaction that is a positive number.

    E. The pH always equals the pOH in a pure water solution.

Answer: C

25) You have learned in class that as the temperature of a water solution increases, the value of

Kw increases and the pH of solution decreases. What does this say about the enthalpy of water dissociation?

   A. It is endothermic

   B. It is exothermic

   C. Kw is less than 1 so it is neither endothermic or exothermic.

Answer: A

26) What are the values for OH-, pH and pOH, respectively, if a aqueous solution is found to have a proton concentration of 10M?

   A. This cannot happen because pH cannot be less than 0.

   B. 10e-7, 7, 7

   C. 10e-15, -1, 15

   D. 10e-15, 15, -1

   E. 10, 10e-15, 15

Answer: C

27) Confronted by a collection of salts, each of which has an identical solubility product constant, which one would have the lowest molar solubility?

   A. A salt of the form AB

   B. A salt of the form A_2B

   C. A salt of the form AB_2

   D. A salt of the form AB_3

   E. A salt of the form A_2B_3

Answer: A

28) What is the pH of a 0.01 M weak acid solution with a K_a value of 10e-4? (Please don't use a calculator to work this problem.)

   A. 2

   B. 3

   C. 4

   D. 5

E. 6

Answer: B

29) What is the pH of a 0.01 M solution of ammonia solution with a pK_b of 4.6? (Again, using a calculator would be kind of sad.)

   A. 7.4

   B. 6.6

   C. 10.7

   D. 3.3

   E. 11

Answer: C

30) What is the molar solubility of MgF_2 which has a K_{sp} of 4 x 10e-12? (And again, using a calculator would be kind of sad.)

   A. 4 x 10e-12

   B. 4 x 10e-4

   C. 2 x 10e-6

   D. 1 x 10e-4

Answer: D