Chem 101B Study Questions Name: _____
Chapters 10 (partial), 11 & 12 (partial)
Review Tuesday 2/7/2012
Due on Exam Thursday 2/9/2012 (Exam 1 date)
This is a homework assignment. Please show your work for full credit. If you do work on separate paper, attach the work to these.

$$\ln\left(\frac{\mathcal{P}_{vap1}}{\mathcal{P}_{vap2}}\right)=\frac{\Delta\mathcal{H}_{vap}}{\mathcal{R}}\left(\frac{1}{\mathcal{T}_2}-\frac{1}{\mathcal{T}_1}\right)$$

R = 8.314 J/K·mol
R = 0.082057 L·atm/K·mol

$P_{solution} = \chi_{solvent} P^o_{solvent}$

$P_{solution} = \chi_A P^o_A + \chi_B P^o_B$

$\Delta T_f = k_b m_{solute}$

$\Delta T_b = k_f m_{solute}$

$\Pi = MRT$

1. Which of the following would you expect to have the highest boiling point?
   A) F_2
   B) Cl_2
   C) Br_2
   D) I_2
   E) All of the above have the same boiling point.

2. Which of the species below would you expect to show the least hydrogen bonding?
   A) NH_3
   B) H_2O
   C) HF
   D) CH_4
   E) all the same

3. Hydrogen bonding is a type of London dispersion force.
   A) True
   B) False

4. Liquids with large intermolecular forces tend to have high surface tension.
   A) True
   B) False

5. Given below are the temperatures at which two different liquid compounds with the same empirical formula have a vapor pressure of 400 torr.

Compound	**T (°C)**
dimethyl ether, $CH_3–O–CH_3$	–37.8
ethanol, CH_3CH_2OH	63.5

Hint: *sketch each vapor pressure / temperature curve on one set of axes!*

Which of the following statements (a–d) is *false*?

A) Increasing the temperature will increase the vapor pressure of both liquids.
B) Intermolecular attractive forces are stronger in (liquid) ethanol than in (liquid) dimethyl ether.
C) The normal boiling point of dimethyl ether will be higher than the normal boiling point of ethanol.
D) The reason that the temperature at which the vapor pressure is 400 torr is higher for ethanol (than for dimethyl ether) is that there is strong hydrogen bonding in ethanol.
E) None of these is false.

6. A liquid placed in a closed container will evaporate until equilibrium is reached. At equilibrium, which of the statements (A-D) is *false?*

A) The partial pressure exerted by the vapor molecules is called the vapor pressure of the liquid.
B) Liquid molecules are still evaporating.
C) The number of vapor molecules remains essentially constant.
D) The boundary (meniscus) between liquid and vapor disappears.
E) All of these are true.

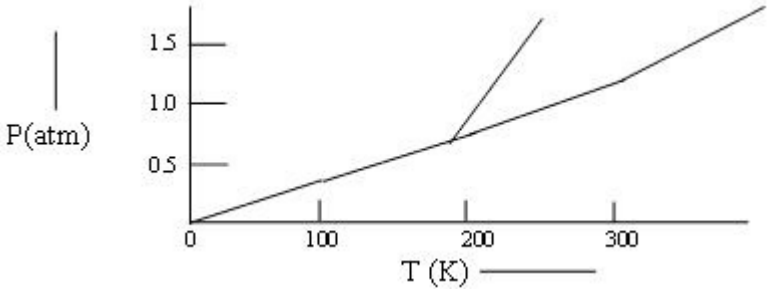
7. The vapor pressure of water at 100.0°C is

A) 85 torr
B) 760 torr
C) 175 torr
D) 1 torr
E) More information is needed.

8. Given ΔH_{vap} for water is 40.7 kJ/mol, calculate P_{vap} of water at 35°C. *hint: see #7*

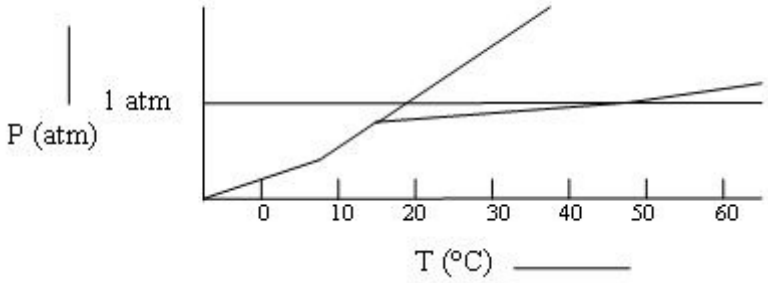
A) 16.0 torr
B) 274 torr
C) 15.9 torr
D) 758 torr
E) 47.6 torr

9. Below is a phase diagram for compound *Q*. You wish to purify a sample of *Q* that was collected at *P* = 1.0 atm and *T* = 100 K by subliming it. In order to sublime the sample, you should:



A) Increase *P* to 1.5 atm and then increase *T* to 300 K.
B) Increase *T* to 300 K, keeping *P* = 1.0 atm.
C) Lower *P* to 0.5 atm and then increase *T* to 200 K.
D) Increase *T* to 300 K and then lower *P* to 0.5 atm.
E) Abandon the attempt to sublime *Q*.

10. Below is a phase diagram for compound *Y*. The normal freezing point of *Y* is most likely:



A) 47°C
B) 21°C
C) 63°C
D) 18°C
E) 0°C

11. The resistance of a liquid to an increase in its surface area is the _____ of the liquid.

12. For an acid-base reaction, 1 *M* $Al(OH)_3$ has a normality of 3 *N*. This is <u>best</u> explained because:
    A) The equivalent mass is three times the molar mass.
    B) Each mole contains 3 moles of hydroxide ions that can react with 3 moles of hydrated protons.
    C) The mole fraction is equal to 3 when aluminum hydroxide is mixed with water.
    D) The normality is *always* three times stronger than the concentration of a solution.
    E) At least two of the above statements are correct.

13. 2.39 L of an aqueous solution containing 25.00 g of KCl dissolved in pure water is prepared. The molarity of the solution is:
    A) 0.140 *M*
    B) 10.5 *M*
    C) 7.13 *M*
    D) 0.281 *M*
    E) 0.0702 *M*

14. Calculate the mole fraction of NaCl in a solution prepared by dissolving 117 g NaCl in 1.45 kg H_2O.
    A) 9.88×10^{-1}
    B) 1.01×10^{-2}
    C) 4.85×10^{-2}
    D) 1.21×10^{-2}
    E) 2.43×10^{-2}

15. Find the mass percent of $CaCl_2$ in a solution whose molarity is 1.50 *M* and whose density is 1.12 g/mL.
    A) 14.8%
    B) 17.4%
    C) 85.2%
    D) 16.6%
    E) none of these

16. The vapor pressure of water at 25.0°C is 23.8 torr. Determine the mass of glucose (molar mass = 180 g/mol) needed to add to 500.0 g of water to change the vapor pressure to 23.0 torr.
    A) 17.4 g
    B) 174 g
    C) 144 g
    D) 6.27 kg
    E) 186 g

17. An ideal solution is formed from a mixture of the nonvolatile solute urea, $CO(NH_2)_2$, and methanol, CH_3OH. The vapor pressure of pure methanol at 20°C is 89 mmHg. If 4.4 g of urea is mixed with 35.4 g of methanol, calculate the vapor pressure of the methanol solution.
    A) 5.5 mmHg
    B) 79 mmHg
    C) 72 mmHg
    D) 17 mmHg
    E) 83 mmHg

18. At a given temperature, you have a mixture of benzene (vapor pressure of pure benzene = 745 torr) and toluene (vapor pressure of pure toluene = 290 torr). The mole fraction of benzene *in the vapor* above the solution is 0.590. Assuming ideal behavior, calculate the mole fraction of toluene *in the solution*.
    A) 0.213
    B) 0.778
    C) 0.641
    D) 0.359
    E) 0.590

Use the following to answer questions 19-20:

Solutions of benzene and toluene obey Raoult's law. The vapor pressures at 20°C are: benzene, 76 torr; toluene, 21 torr.

19. What is the mole fraction of benzene in a benzene-toluene solution whose vapor pressure is 53 torr at 20°C?
    A) 0.24
    B) 0.42
    C) 0.58
    D) 0.70
    E) 0.76

20. If the mole fraction of benzene in a particular benzene-toluene solution is 0.73, what is the mole fraction of benzene in the vapor phase in equilibrium with that solution?
    A) 0.25
    B) 0.57
    C) 0.73
    D) 0.78
    E) 0.91

21. The freezing point (T_f) for t-butanol is 25.50°C and K_f is 9.1°C/*m*. Usually t-butanol absorbs water on exposure to the air. If the freezing point of a 16.6-g sample of t-butanol is measured as 24.59°C, how many grams of water are present in the sample?
    A) 0.10 g
    B) 0.030 g
    C) 10. g
    D) 3.0 g
    E) 30. g

22. A solution consisting of 0.250 mol of methylbenzene, $C_6H_5CH_3$, in 244 g of nitrobenzene, $C_6H_5NO_2$, freezes at –1.2°C. Pure nitrobenzene freezes at 6.0°C. What is the freezing-point depression constant of nitrobenzene?
    A) 4.7°C/*m*
    B) 3.5°C/*m*
    C) 29°C/*m*
    D) 7.0°C/*m*
    E) 14°C/*m*

23. Consider pure water separated from an aqueous sugar solution by a semipermeable membrane, which allows water to pass freely but not sugar. After some time has passed, the concentration of sugar solution:
    A) will have increased
    B) will have decreased
    C) will not have changed
    D) might have increased or decreased depending on other factors
    E) will be the same on both sides of the membrane

24. Calculate the osmotic pressure (in torr) of 6.00 L of an aqueous 0.836 *M* solution at 30.°C, if the solute concerned is totally ionized into three ions (e.g., it could be Na_2SO_4 or $MgCl_2$).
    A) 62.4 torr
    B) 4.74×10^4 torr
    C) 2.82×10^4 torr
    D) 1.58×10^4 torr
    E) 5.27×10^3 torr

25. What is reverse osmosis?
    A) the application, to a concentrated solution, of a pressure that is greater than the osmotic pressure, such that solvent flows from the concentrated solution to the dilute solution
    B) the application, to a dilute solution, of a pressure that is greater than the osmotic pressure, such that solvent flows from the concentrated solution to the dilute solution
    C) the application, to a concentrated solution, of a pressure that is greater than the osmotic pressure, such that solute flows from the concentrated solution to the dilute solution
    D) the application, to a dilute solution, of a pressure that is greater than the osmotic pressure, such that solute flows from the concentrated solution to the dilute solution
    E) the application, to a concentrated solution, of a pressure that is greater than the osmotic pressure, such that solvent flows from the dilute solution to the concentrated solution

26. What is the freezing point of an aqueous 1.60 *m* $CaCl_2$ solution? (water $k_f = 1.86°C/m$)
    A) –2.98°C
    B) 2.98°C
    C) –8.93°C
    D) 8.93°C
    E) 0.00°C

27. Consider the reaction $2H_2 + O_2 \rightarrow 2H_2O$
    What is the ratio of the initial rate of the appearance of water to the initial rate of disappearance of oxygen?
    A) 1 : 1
    B) 2 : 1
    C) 1 : 2
    D) 2 : 2
    E) 3 : 2

28. Consider the following rate law: Rate = $k[A]^n[B]^m$
    How are the exponents *n* and *m* determined?
    A) by using the balanced chemical equation
    B) by using the subscripts for the chemical formulas
    C) by using the coefficients of the chemical formulas
    D) by educated guess
    E) by experiment

29. Tabulated below are initial rate data for the reaction

$$2Fe(CN)_6^{3-} + 2I^- \rightarrow 2Fe(CN)_6^{4-} + I_2$$

Run	$[Fe(CN)_6^{3-}]_0$	$[I^-]_0$	$[Fe(CN)_6^{4-}]_0$	$[I_2]_0$	Initial Rate (M/s)
1	0.01	0.01	0.01	0.01	1×10^{-5}
2	0.01	0.02	0.01	0.01	2×10^{-5}
3	0.02	0.02	0.01	0.01	8×10^{-5}
4	0.02	0.02	0.02	0.01	8×10^{-5}
5	0.02	0.02	0.02	0.02	8×10^{-5}

The experimental rate law is:

A) $\frac{\Delta[I_2]}{\Delta t} = k[Fe(CN)_6^{3-}]^2[I^-]^2[Fe(CN)_6^{4-}]^2[I_2]$

B) $\frac{\Delta[I_2]}{\Delta t} = k[Fe(CN)_6^{3-}]^2[I^-][Fe(CN)_6^{4-}][I_2]$

C) $\frac{\Delta[I_2]}{\Delta t} = k[Fe(CN)_6^{3-})]^2[I^-]$

D) $\frac{\Delta[I_2]}{\Delta t} = k[Fe(CN)_6^{3-}][I^-]^2$

E) $\frac{\Delta[I_2]}{\Delta t} = k[Fe(CN)_6^{3-}][I^-]\ [Fe(CN)_6^{4-}]$

Use the following to answer questions 30-33:

A general reaction written as A + 2B $\rightarrow$ C + 2D is studied and yields the following data:

$[A]_0$	$[B]_0$	Initial $\Delta[C]/\Delta t$
0.150 M	0.150 M	8.00×10^{-3} mol/L·s
0.150 M	0.300 M	1.60×10^{-2} mol/L·s
0.300 M	0.150 M	3.20×10^{-2} mol/L·s

30. What is the order of the reaction with respect to B?

A) 0
B) 1
C) 2
D) 3
E) 4

31. What is the order of the reaction with respect to A?
    A) 0
    B) 1
    C) 2
    D) 3
    E) 4

32. What is the overall order of the reaction?
    A) 0
    B) 1
    C) 2
    D) 3
    E) 4

33. What is the numerical value of the rate constant?
    A) 0.053
    B) 1.19
    C) 2.37
    D) 5.63
    E) none of these (A-D)

Use the following to answer questions 34-35:

The reaction $H_2SeO_3(aq)$ $6I^-(aq) + 4H^+(aq) \rightarrow 2I_3^-(aq) + 3H_2O(l) + Se(s)$ was studied at 0°C by the method of initial rates:

$[H_2SeO_3]_0$	$[H^+]_0$	$[I^-]_0$	Rate (mol/L s)
1.0×10^{-4}	2.0×10^{-2}	2.0×10^{-2}	1.66×10^{-7}
2.0×10^{-4}	2.0×10^{-2}	2.0×10^{-2}	3.33×10^{-7}
3.0×10^{-4}	2.0×10^{-2}	2.0×10^{-2}	4.99×10^{-7}
1.0×10^{-4}	4.0×10^{-2}	2.0×10^{-2}	6.66×10^{-7}
1.0×10^{-4}	1.0×10^{-2}	2.0×10^{-2}	0.41×10^{-7}
1.0×10^{-4}	2.0×10^{-2}	4.0×10^{-2}	13.4×10^{-7}
1.0×10^{-4}	4.0×10^{-2}	4.0×10^{-2}	5.33×10^{-6}

34. The rate law is
    A) Rate = $k[H_2SeO_3][H^+][I^-]$
    B) Rate = $k[H_2SeO_3][H^+]^2[I^-]$
    C) Rate = $k[H_2SeO_3][H^+][I^-]^2$
    D) Rate = $k[H_2SeO_3]^2[H^+][I^-]$
    E) Rate = $k[H_2SeO_3][H^+]^2[I^-]^3$

35. The numerical value of the rate constant is
    A) 5.2×10^5
    B) 2.1×10^2
    C) 4.2
    D) 1.9×10^{-6}
    E) none of these

Use the following to answer questions 36-39:

The following questions refer to the reaction shown below:

$3A + B \rightarrow C$

Experiment	Initial [A] (mol/L)	Initial [B] (mol/L)	Initial Rate of Disappearance of A (mol/L·s)
1	0.16	0.15	0.08
2	0.16	0.30	0.30
3	0.08	0.30	0.08

36. What is the rate law for this reaction?
    A) Rate = $k[A][B]$
    B) Rate = $k[A]^2[B]$
    C) Rate = $k[A][B]^2$
    D) Rate = $k[A]^2[B]^2$
    E) Rate = $k[B]$

37. What is the magnitude of the rate constant for the reaction?
    A) 140
    B) 79
    C) 119
    D) 164
    E) 21

38. What are the units for the rate constant for this reaction?
    A) L/mol·s
    B) $L^2/mol^2 \cdot s$
    C) mol/L·s
    D) $L^3/mol^3 \cdot s$
    E) mol^3/L

39. What is the order of this reaction?
    A) 4
    B) 3
    C) 2
    D) 1
    E) 0

40. The reaction 2A + 5B → products is third order in A and fourth order in B. What is the rate law for this reaction?
    A) rate = $k[A]^2[B]^5$
    B) rate = $k[A]^4[B]^3$
    C) rate = $k[A]^3[B]^4$
    D) rate = $k[A]^5[B]^2$
    E) rate = $k[A]^{2/7}[B]^{5/7}$

Answer Key

1. D
2. D
3. B
4. A
5. C
6. D
7. B
8. E
9. C
10. B
11. surface tension
12. B
13. A
14. E
15. A
16. B
17. E
18. C
19. C
20. E
21. B
22. D
23. B
24. B
25. A
26. C
27. B
28. E
29. C
30. B
31. C
32. D
33. C
34. E
35. A
36. D
37. A
38. D
39. A
40. C