Chemistry 112-2013, Vining NAME: ______________________

Exam #2 Questions 1-17 = 3.5 points each; 18-23 = 6 or 7 points each

1. As salt is added to water, what happens to the freezing point?

a) increases b) decreases c) does not change

2. Of the following compounds, which are expected to be highly soluble in water?

CF_4 CH_3OH SH_2 CH_3CH_3

a) only CF_4 b) CH_3OH and SH_2 c) only CH_3CH_3 d) CF_4 and CH_3CH_3

3. You have two salt solutions. Solution #1 has a higher boiling point than Solution #2. Which has the higher melting point?

a) Solution #1 b) Solution #2 c) You need to know the salt concentrations to answer this

4. Soap is composed of surfactant molecules. Surfactant molecules are:

a) hydrophilic b) hydrophobic c) both hydrophilic and hydrophobic

5. What is the primary reason water and oil do not mix?

a) if they did, many strong hydrogen bonds would need to be broken

b) in order to do so, the water would need to first be vaporized, which requires too much energy

c) if they did, the entropy of water would decrease markedly

d) the intermolecular forces between the nonpolar molecules are too strong

6. Which of the following is not control the freezing point of a solution of an ionic compound dissolved in water?

(a) the mass of water
(b) the mass of solute
(c) the molar mass of solute
(d) the number of ions the salt produces when dissolved
(e) the density of the solution

7. Which of the following best favors a reaction having a fast rate?

(a) low activation energy

(b) high activation energy

(c) low activation energy and high temperature

(d) high activation energy and high temperature

(e) high activation energy and low temperature

(f) low activation energy, high temperature, and positive ΔH

8. For a reaction with the rate law: Rate = $k[A]$:

(a) a plot of ln[A] vs. time gives a straight line.

(b) a plot of 1/[A] vs. 1/time gives a straight line.

(c) a plot of [A] vs. time gives a straight line.

(d) a plot of 1/[A] vs. time gives a straight line.

(e) a plot of log $\frac{[A]_0}{[A]}$ vs. 1/time gives a straight line.

9. The gas phase reaction $C_2H_4 + Cl_2 \rightarrow C_2H_4Cl_2$ follows the rate law: Rate = $k[C_2H_4]\,[Cl_2]^2$. If the concentration of C_2H_4 is doubled while the concentration of Cl_2 remains constant, the initial rate of the reaction:

(a) increases by a factor of 4.
(b) decreases by a factor of 2.
(c) increases by a factor of 2.
(d) increases by a factor of 1.5.
(e) remains constant.

10. What is a *half-life*?

(a) It is a special case when the rate constant equals one-half. (i.e. $k = 0.5$)

(b) A period of time required for the concentration of a reactant to reduce to one-half its original value.

(c) It is a rate law that is one-half order: (ie. Rate = $k[A]^{1/2}$)

(d) One half the time it takes for the reaction to go to completion.

(e) A period representing the amount of time required for an initial concentration of a reactant to reduce to 0.5 M.

11. When the reversible reaction, $N_2 + O_2 \rightleftarrows 2\ NO$, has reached a state of dynamic equilibrium, which statement below is true?

(a) Both the forward and reverse reactions stop completely and no more NO, N_2 or O_2 are produced.

(b) The rate of the forward reaction equals the rate of the reverse reaction.

(c) The rate constant of the forward reaction equals the rate constant of the reverse reaction.

12. Consider the system, $2\ CH_2Cl_2(g) \rightleftarrows CH_4(g) + CCl_4(g)$, which has an equilibrium constant of K = 2.4. If a system has:

$[CH_2Cl_2] = 0.22$ M
$[CH_4] = 1.64$ M
$[CCl_4] = 0.58$ M

then, (a) the system is at equilibrium
(b) the system is not at equilibrium and will react to form more CH_2Cl_2
(c) the system is not at equilibrium and will react to form more CH_4 and CCl_4

13. The following system is at equilibrium $CH_4(g) + CCl_4(g) \rightleftarrows 2\ CH_2Cl_2(g)$.

If CCl_4 is removed from the sample, what will then happen to the concentrations of CH_4 and of CH_2Cl_2?

(a) both $[CH_4]$ and $[CH_2Cl_2]$ will increase
(b) both $[CH_4]$ and $[CH_2Cl_2]$ will decrease
(c) $[CH_4]$ will decrease and $[CH_2Cl_2]$ will increase
(d) $[CH_4]$ will increase and $[CH_2Cl_2]$ will decrease
(e) $[CH_4]$ will remain constant and $[CH_2Cl_2]$ will increase

14. A highly toxic pesticide decomposes in the soil via a *first order rate law*. The rate constant for the decomposition is 0.0995 $days^{-1}$. How long will it take for it to decompose to 10% of its original concentration? In days.

(a) 0.0529 days *(b)* 6.55 days *(c)* 9.08 days *(d)* 18.9 days *(e)* 23.1 days

15. For the reaction 2 $SO_2Cl_2(g) \rightleftarrows 2 SO_2(g) + Cl_2(g)$, the expression for K_{eq} is

(a) $K_{eq} = \frac{[SO_2]^2[Cl_2]^2}{[SO_2Cl_2]^2}$

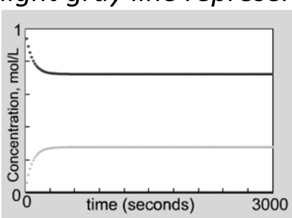
(d) $K_{eq} = \frac{[SO_2]^2[Cl_2]}{[SO_2Cl_2]}$

(b) $K_{eq} = \frac{[SO_2]^2[Cl_2]}{[SO_2Cl_2]^2}$

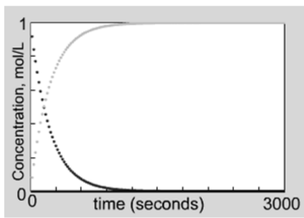
(e) $K_{eq} = \frac{[SO_2Cl_2]^2}{[SO_2]^2[Cl_2]}$

(c) $K_{eq} = \frac{2[SO_2]^2[Cl_2]}{2[SO_2Cl_2]^2}$

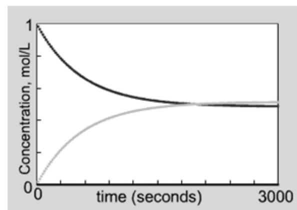
Questions 16-17 use the following concentration-time plots. The black line represents reactants and the light gray line represents products. Answer with the correct letter.



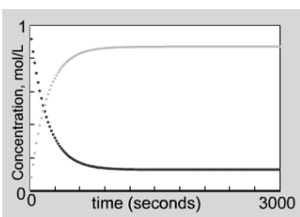
a.



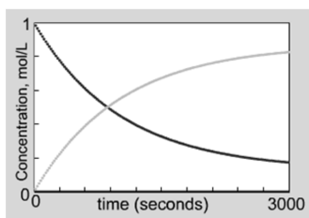
b.



c.



d.



e.

16. Which reaction goes to completion? _____

17. Which reaction has the smallest equilibrium constant? _____

For the rest of the questions, show all your work. **NAME: ______________________**

18. The vapor pressure of the solvent, benzene , C_6H_6, is 73.03 mm Hg at 25°C.
Exactly 16.13 grams of an unknown compound are dissolved in 1.920 mol of benzene, the vapor pressure of the solution is 70.85 mm Hg. The compound is nonvolatile and a non-electrolyte.

What is the molar mass of this compound?

19. Use the following information for the reaction: $2A + B \rightarrow C$. Initial rates were measured at different molar concentrations.

Experiment	[A]	[B]	Initial Rate (mol/L·s)
1	1.0×10^{-2}	1.0×10^{-2}	5.3×10^{-4}
2	2.0×10^{-2}	1.0×10^{-2}	1.06×10^{-3}
3	3.0×10^{-2}	2.0×10^{-2}	1.59×10^{-3}
4	2.0×10^{-2}	2.0×10^{-2}	1.06×10^{-3}

What is the order of this reaction with respect to reactants [A] and [B]?
What is the value of the rate constant?

20. Consider the two-step mechanism for ozone decomposition:

step 1: $H_2O_2 + I^- \longrightarrow H_2O + OI^-$

step 2: $H_2O_2 + OI^- \longrightarrow H_2O + O_2 + I^-$

⇦ overall reaction

a. Write the overall reaction under the two steps.

b. What is the molecularity of step 2? ____________________

c. If the first step is slow, what is the rate law: Rate = ______________________

d. Identify any catalysts (if none, write none): _________________________

e. Identify any intermediates (if none, write none): _________________________

21. The rate constant for a first order reaction at 773 K is 1.68 s^{-1}. The rate constant for this process at 873 K is 14.6 s^{-1}. What is the activation energy **(E_a)** for the reaction in kJ/mol? (R = 8.314 J/mol·K)

ANS = ________________

22. A student ran the following reaction in the laboratory at **450** K: **PCl_5**(g) ⇄ **PCl_3**(g) + **Cl_2**(g)
When she introduced **0.789** moles of **PCl_5**(g) into a 1.00 liter container, she found the equilibrium concentration of **Cl_2**(g) to be **0.0312** M. Calculate the equilibrium constant, K_c. You **must** use an ICE table.

K_c = ________

23. Butene isomerizes to form cyclobutane.

butene ⇄ cyclobutane K = 6.0

If a sample of 1.00 M butene is placed in a flask and allowed to react, what will [isobutene] be once equilibrium is established?

Show your work, the ICE method must be used and presented correctly.

Useful Information

PV = nRT R = 0.0821 L•atm/K•mol 760 mmHg = 1 atm

$P = \chi P^{o}$ $\Pi = MRT$

$[R]_0 - [R]_t = kt$ | $\ln \frac{[R]_t}{[R]_0} = -kt$ | $\frac{1}{[R]_t} - \frac{1}{[R]_0} = kt$ $[R]_t = [R]_o e^{-kt}$

$t_{1/2} = \frac{0.693}{k}$ $t_{1/2} = \frac{1}{k[R]_o}$

$k = Ae^{\frac{-Ea}{RT}}$ $\ln\frac{k_2}{k_1} = -\frac{Ea}{R}\left[\frac{1}{T_2} - \frac{1}{T_1}\right]$ $\Delta T_{fp} = K_{fp}mi$ $\Delta T_{bp} = K_{bp}mi$

$K_{fp}(H_2O) = -1.86\ ^{o}C/m$ $K_{bp}(H_2O) = 0.51\ ^{o}C/m$

	1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIIIB	9 VIIIB	10 VIIIB	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1 1.0079 H HYDROGEN																	2 4.0026 He HELIUM
2	3 6.941 Li LITHIUM	4 9.0122 Be BERYLLIUM											5 10.811 B BORON	6 12.011 C CARBON	7 14.007 N NITROGEN	8 15.999 O OXYGEN	9 18.998 F FLUORINE	10 20.180 Ne NEON
3	11 22.990 Na SODIUM	12 24.305 Mg MAGNESIUM											13 26.982 Al ALUMINIUM	14 28.086 Si SILICON	15 30.974 P PHOSPHORUS	16 32.065 S SULPHUR	17 35.453 Cl CHLORINE	18 39.948 Ar ARGON
4	19 39.098 K POTASSIUM	20 40.078 Ca CALCIUM	21 44.956 Sc SCANDIUM	22 47.867 Ti TITANIUM	23 50.942 V VANADIUM	24 51.996 Cr CHROMIUM	25 54.938 Mn MANGANESE	26 55.845 Fe IRON	27 58.933 Co COBALT	28 58.693 Ni NICKEL	29 63.546 Cu COPPER	30 65.39 Zn ZINC	31 69.723 Ga GALLIUM	32 72.64 Ge GERMANIUM	33 74.922 As ARSENIC	34 78.96 Se SELENIUM	35 79.904 Br BROMINE	36 83.80 Kr KRYPTON
5	37 85.468 Rb RUBIDIUM	38 87.62 Sr STRONTIUM	39 88.906 Y YTTRIUM	40 91.224 Zr ZIRCONIUM	41 92.906 Nb NIOBIUM	42 95.94 Mo MOLYBDENUM	43 (98) Tc TECHNETIUM	44 101.07 Ru RUTHENIUM	45 102.91 Rh RHODIUM	46 106.42 Pd PALLADIUM	47 107.87 Ag SILVER	48 112.41 Cd CADMIUM	49 114.82 In INDIUM	50 118.71 Sn TIN	51 121.76 Sb ANTIMONY	52 127.60 Te TELLURIUM	53 126.90 I IODINE	54 131.29 Xe XENON
6	55 132.91 Cs CAESIUM	56 137.33 Ba BARIUM	57-71 La-Lu Lanthanide	72 178.49 Hf HAFNIUM	73 180.95 Ta TANTALUM	74 183.84 W TUNGSTEN	75 186.21 Re RHENIUM	76 190.23 Os OSMIUM	77 192.22 Ir IRIDIUM	78 195.08 Pt PLATINUM	79 196.97 Au GOLD	80 200.59 Hg MERCURY	81 204.38 Tl THALLIUM	82 207.2 Pb LEAD	83 208.98 Bi BISMUTH	84 (209) Po POLONIUM	85 (210) At ASTATINE	86 (222) Rn RADON