CHM112 Exam 1

MULTIPLE CHOICE (3pts each): Write the ONE letter corresponding to the correct answer on the line next to each question. The LETTER ASSOCIATED WITH THE CORRECT ANSWER MUST BE WRITTEN ON THE LINE NEXT TO THE QUESTION in order to receive full credit.

1.) Which of the following compounds is most likely to dissolve in hexane (C_6H_{14})? 1.) A

(a.) C_5H_{10} b.) CH_3-OH c.) NaCl d.) CH_3-O-CH_3

2.) What is the osmotic pressure of a 1.48M aqueous solution of the ionic compound NaCl at 20.0°C? 2.) C

a.) 35.6atm b.) 4.86atm c.) 71.2atm d.) 492atm

$\Pi = (2)(1.48\ mol/L)(0.0821\ \frac{L\,atm}{mol\,K})(293.15K) = 71.24\ atm$

3.) What is the best way to increase the solubility of CO_2 in water? 3.) B

a.) increase temperature but decrease pressure (b.) decrease temperature but increase pressur

c.) decrease temperature and pressure d.) increase temperature and pressure

4.) When dissolving a compound, if the enthalpy required to separate the particles is 5.68kJ/mol and the enthalpy of mixing is -6.32kJ/mol, what is the overall enthalpy of solvation? 4.) C

a.) 12.0kJ/mol b.) -35.9kJ/mol (c.) -0.64kJ/mol d.) 0.90kJ/mol

$+5.68\ kJ/mol + (-6.32\ kJ/mol) = -0.64\ kJ/mol$

5.) For the reaction $2H_2 + O_2 \rightarrow 2H_2O$, if at one instant in time oxygen is being used up at a rate of 0.856 M/min, what is the rate of production of water at that instant in time? 5.) D

a.) 0.856 M/min b.) 0.428 M/min c.) 1.09 M/min (d.) 1.71 M/min

$0.856\ M/min\ O_2 \left(\frac{2\,H_2O}{1\,O_2}\right) = 1.712\ M/min\ H_2O$

6.) The largest componenet of a solution is referred to as the 6.) C

a.) solubility b.) solute (c.) solvent d.) precipitate

7.) What would be the theoretical value of i for the ionic compound $Sn(NO_3)_3$? 7.) D

a.) 1 b.) 2 c.) 3 (d.) 4

$3NO_3 + 1Sn = 4$

8.) One way to increase the chances that the activation energy needed for a reaction will be reached is to 8.) A

(a.) increase temperature b.) increase concentration

c.) use a smaller container d.) all responses would help reach the E_a

9.) Which of the following is the strongest type of intermolecular attractive force that can be used by ammonia (NH_3)? 9.) B

a.) dispersion forces (b.) hydrogen bonds

c.) dipole-dipole interactions d.) ionic bonds

10.) A series of experiments studying the reaction A + B --> C were run to obtain the following data: 10.) C

Expt	[A]	[B]	rate
1	0.10M	0.10M	0.136M/s
2	0.20M	0.10M	0.272M/s
3	0.10M	0.20M	0.544M/s

What is the order of the reaction with respect to compound B?

a.) 0 b.) 1 (c.) 2 d.) 3

$\left(\frac{0.20}{0.10}\right)^n = \frac{0.544}{0.136}$

$2^n = 4 \quad n = 2$

SHORT ANSWER (10 pts each): Completely answer all of the following questions. Read all questions carefully!!! SHOW ALL WORK. If your work is in a different location, you must make a note of this in the given work area for the problem in order for the work to be considered for partial credit. Make sure to include units and report all mathematical answers to the correct number of significant figures. Write final answers in designated locations when indicated.

1.) What is the vapor pressure of water above a 22.0% by mass aqueous solution of the molecule sucrose at 30.0°C? The vapor pressure of pure water at this temperature is 31.8mmHg. MM H_2O = 18.01528g/mol; MM sucrose = 342.3001g/mol

$P_a = X_a P_a^\circ$

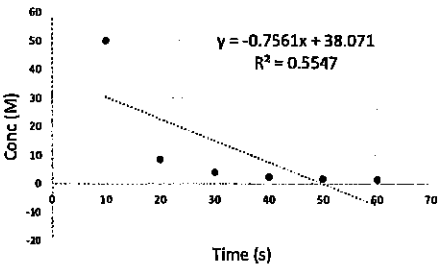
$22.0g\left(\frac{1mol}{342.3001g}\right) = 0.064271\ mol\ sucrose$ Answer: 31.3 mm Hg

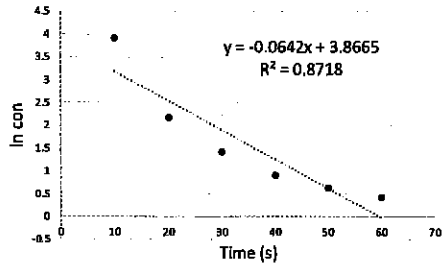
$100g - 22.0g = 78.0g\left(\frac{1mol}{18.01528}\right) = 4.329666\ mol\ H_2O$

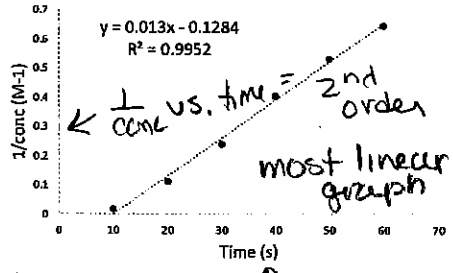
$X_{water} = \frac{4.329666\ mol}{(4.329666mol + 0.064271mol)} = 0.98537$

$P_a = (0.98537)(31.8\ mm\ Hg) = 31.335\ mm\ Hg$

2.) Based on the following set of graphs for the reaction A → B + C:







a.) What is the order of the reaction? Answer: second

b.) What is the value of k for this reaction? Answer: $0.013\ M^{-1}s^{-1}$ units in seconds

(=slope from 2nd order graph)

c.) If the starting concentration of A is 0.872M, what is the concentration of A after 15.0min?

$15.0min\left(\frac{60s}{min}\right) = 900s$

$\frac{1}{[A]} = kt + \frac{1}{[A]_0}$ Answer: 0.0778 M

$\frac{1}{[A]} = (0.013M^{-1}s^{-1})(900s) + \frac{1}{0.872M}$ $\frac{1}{[A]} = 12.847M^{-1}$ $[A] = \frac{1}{12.847M^{-1}} = 0.0778M$

d.) What is the half-life of the reaction? Answer: 88.2 s

$t_{1/2} = \frac{1}{k[A]_0} = \frac{1}{(0.013M^{-1}s^{-1})(0.872M)} = \frac{1}{0.011336s^{-1}}$

$= 88.215s$

solute

7.) If a 0.786M solution of $MgBr_2$ (MM = 184.113g/mol) a has a density of 1.12g/mL, what is the molality of the solution?

Answer: 0.806 m

Assume 1L solution

= 1000 mL solution

0.786 mol $MgBr_2$ in 1L solution

$1000\ mL \left(\frac{1.12g}{mL}\right) = 1120\ g$ solution

$0.786\ mol\ MgBr_2 \left(\frac{184.113g}{mol}\right) = 144.713g$ solute

$1120g - 144.713g = 975.287g$ solvent $\left(\frac{1kg}{1000g}\right)$

$= 0.975287\ kg$ solvent

$$m = \frac{0.786\ mol\ solute}{0.975287\ kg\ solvent} = 0.805916606\ m$$

+273.15 = 298.15K

5.) A given reaction with a rate constant of $0.529 s^{-1}$ at 20.0°C is has a reaction rate that is six times faster at 82.9°C. +273.15 = 356.05K

a.) What is the value of k at 82.9°C? Answer: $3.174 s^{-1}$

$6 \times 0.529 s^{-1} = 3.174 s^{-1}$

b.) What is the activation energy, in kJ/mol, for this reaction? Answer: 24.7 kJ/mol

$$\ln\left(\frac{k_1}{k_2}\right) = \frac{Ea}{R}\left[\frac{1}{T_2} - \frac{1}{T_1}\right]$$

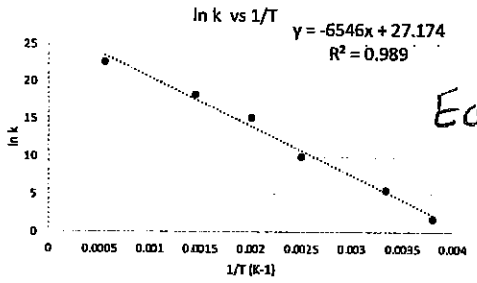
$$\ln\left(\frac{0.529}{3.174}\right) = \frac{Ea}{8.314 \times 10^{-3}\ kJ/mol\ K}\left[\frac{1}{356.05K} - \frac{1}{298.15K}\right]$$

$$-1.79176 = \frac{Ea}{8.314 \times 10^{-3}\ kJ/mol\ K}\left[0.00280816\ K^{-1} - 0.00341112\ K^{-1}\right]$$

$$-1.79176\ kJ/mol\ K = Ea\,(-0.000602629\ K^{-1})$$

$$Ea = 24.71952\ kJ/mol$$

6.) a.) Use the graph provided to calculate the activation energy.



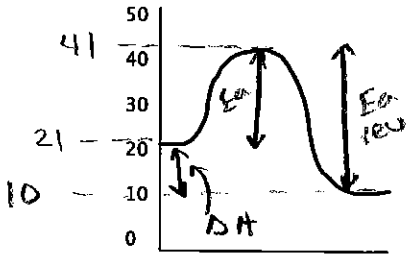
Answer: 54.42 kJ/mol = 54,420 J/mol

Ea = (slope)(−R)

= (−6546K)(−8.314 J/mol K)

= 54423.414 J/mol

Use the provided energy diagram to answer questions b–f. The units on the y-axis are kJ/mol.



b.) What is the activation energy of the forward reaction?

41 kJ/mol − 21 kJ/mol Answer: 20 kJ/mol

c.) What is the activation energy of the reverse reaction?

41 kJ/mol − 10 kJ/mol Answer: 31 kJ/mol

d.) Is the reaction exothermic or endothermic? Answer: exothermic

e.) Briefly explain your answer to part d:

Products have less energy than the reactants

f.) What is the enthalpy of the reaction? Answer: −11 kJ/mol

10 kJ/mol − 21 kJ/mol

3.) If the half-life of a first order reaction is 349s and the initial concentration is 1.50M

a.) What is the value of k for this reaction? Answer: $1.99 \times 10^{-3} s^{-1}$

$t_{1/2} = \frac{0.693}{k} = \frac{0.693}{k} = 349s$

$(349s)(k) = 0.693 \quad k = \frac{0.693}{349} = 1.986 \times 10^{-3} s^{-1}$

b.) How much time will it take for the concentration to fall to 1/3 of its original value?

$\frac{1}{3}(1.50M) = 0.5M$

Answer: 553 s

$\ln[A] = -kt + \ln[A]_0$

$\ln[0.5] = (-1.986 \times 10^{-3} s^{-1})(t) + \ln[1.5]$

$-0.693147 = (-1.986 \times 10^{-3} s^{-1})(t) + 0.4054651$

$-0.4054651 \qquad -0.4054651$

$\frac{+1.0986121}{+1.986 \times 10^{-3} s^{-1}} = \frac{(-1.986 \times 10^{-3} s^{-1})(t)}{-1.986 \times 10^{-3} s^{-1}} \qquad t = 553.2623s$

4.) What is the boiling point of a 0.858m aqueous solution of the ionic compound BaF_2? Report your answer to two decimal places.

$\Delta T = (i)(K_b)(m)$ Answer: 101.34°C

$= (3)(0.52°C/m)(0.858m)$

$= 1.33848°C + 100.00°C$

$= 101.33848°C$